Study of Electrocardiographic changes with BMI in normal individuals

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ABSTRACT:

Objective: To study the electrocardiogram in asymptomatic obese young adults in the form of shift of the axis; voltage of the ECG complexes; P, QRS and T waves; PR and QT intervals; and ST segment and to assess the risk involved in obesity and predict the future cardiovascular diseases.

Design: Cross-sectional study.

Materials and Methods: 100 volunteered for this study (age range 18-40 years),which were devided in two groups according to BMI.50 subjects with BMI<25kg/m^2 as controls and 50 subjects with BMI >30kg/m^2 as cases. The Body Mass Index (BMI) was calculated by measuring height and weight of the subjects; systolic and diastolic blood pressure and ECG recording by standard method. The results among variables in respective groups of subjects were calculated using relevant statistical method and software program.

Results: There was significant increase in the BMI, SBP and DBP in the case group. Mean QRS axis, P wave duration changes were statistically significant. Although PR interval; QT interval and QTc, QRS duration and ST segment were increased in cases but were not statistically significant.

Interpretation & Conclusion: Our results suggest that asymptomatic obese individuals have abnormal ECG findings which need a regular check to reduce the chances of its manifestation at a future date.

INTRODUCTION

- Obesity is serious public health problem with established cardiovascular co-morbidities and a major cause of sudden death in developed as well as developing countries currently[XII]. Obesity increases cardiac adverse events via risk factors associated with metabolic syndrome like dyslipidemia, hypertension and glucose intolerance, and also effects from sleep disorders associated with obesity[XVI]. Standard 12-lead ECG remains the most commonly used initial screening test for the noninvasive detection of cardiovascular changes in obesity. According to several studies done previously there are age dependent and BMI related ECG changes. Due to several factors, such as horizontal displacement of the heart by the elevated diaphragm, cardiac hypertrophy, increase in the distance between the heart and the electrodes and coexisting sleep apnea-hypoventilation syndrome, causes changes in ECG in obese patients[V]. Obesity is associated with a wide variety of electrocardiographic (ECG) abnormalities like the leftward axis deviation, changes in the P wave morphology, low QRS voltage, features of left ventricular hypertrophy, T wave flattening, prolonged QT interval duration and QTc interval[IV]. So, the search for improved methods for

electrocardiographic detection of cardiovascular abnormalities in the general population has intensified in recent years . So, this study was done to detect any significant electrocardiographic changes occurring in asymptomatic obese young adults, to study the prevalence of abnormal ECG findings .

MATERIALS AND METHODS

- This was a comparative cross-sectional study was done in which 50 cases were randomly selected who were asymptomatic obese young adults in the age group of 18 – 40 years with BMI ≥ 30 kg/m^2. Age and sex matched 50 healthy individuals with BMI < 25 kg/m^2 were taken as controls from the general population. Body weight (Wt) was measured on portable weighing machine without shoes, and Height (HT) was measured in barefoot using a vertical height scale. BMI was measured as body weight in kilogram divided by the square of the body height in meters. **BMI = Weight (kg) / Height (m^2)[XVII].** Apparently healthy male and female young adults between the age group of 18 – 40 years with BMI ≥ 30 kg/m^2 without any previously diagnosed cardiovascular or pulmonary disease, electrolyte imbalance or recent hospitalization history were taken as case and apparently healthy age and sex matched subjects with BMI < 25 kg/m^2 were taken as conrol. Subjects with BMI 25-30 kg/m^2 and with any cardiac disease and taking any medicines which may affect the cardiac function were excluded from the study. General Physical Examination as well as Systemic Examination was done to rule out the exclusion criteria. Informed and written consent was obtained from all subjects. 12-lead ECG was taken after 10 minutes of rest using **12-lead ECG machine** (RMS Vega 201 TMT machine).Standard 12-lead lectrocardiograms were recorded with the patient in the postprandial state and supine position. Heart rate (HR), P wave duration and amplitude, QRS interval, PR interval, QT interval, QTc interval and QRS axis were measured using standard techniques.Data was analyzed by applying appropriate statistical tests .

RESULTS

- This was a comparative cross-sectional study of electrocardiogram done in 50 asymptomatic obese young adults (BMI > 30 kg/m^2) and 50 non-obese (BMI < 25 kg/m^2) controls and different ECG parameters were evaluated in both the groups. The results are expressed as mean ± standard deviation. The mean age (in years) of 50 cases was 34.3 ± 4.8 and that of 50 controls was 34.8 ± 5.2 (P = 0.68) and was statistically non-significant. Table 1 shows gender wise distribution of both age groups where in both groups there were 30 males and 20 females. **Body Mass Index:** The mean BMI (in kg/m^2) in cases was 34.2 ± 3.0 and in controls was 22.0 ± 3.5 which was significant. (P = 0.00)

Table 1: Distribution of subjects in both age groups

	Case (BMI > 30)	Control (BMI <25)
Male	30	30
Female	20	20

Table 2 shows the vital parameters of both groups in which Pulse rate difference was stastically insignificant in both groups but Systolic and Diastolic Blood Pressure was 126.45±5.4 and 85.2±6.5 mmHg respectively in cases whereas 122.9±45.2 and 80.4±5.7 mmHg respectively in control group and was stastically significantly higher in case group.

Table 2: Vital parameters of both groups

Vital signs	Case (Mean±SD)	Control (Mean±SD)	P value
Pulse Rate/min	78.2±11.0	80.6±11.5	0.14
SBP (mmHg)	126.45±5.4	122.9±45.2	0.01*
DBP (mmHg)	85.2±6.5	80.4±5.7	0.00*

*P value <0.05- Significant

Table 3 shows different ECG parameters in both groups. Mean heart rate were increased in cases but were not statistically significant. P wave duration is longer in obese individuals. PR interval, QRS duration and also QT interval and QTc value were increased in control (obese) group. Mean QRS axis in case was 39.2 ± 33.4 degrees and in control group it was 57.4 ± 33.6 degrees and was statistically significant.

Table 3:Mean ECG parameters of both groups

	Case (Mean±SD)	Control (Mean±SD)	P value
HR (per min)	84.6±12.7	81.8±13.1	0.24
P wave duration (msec)	101.40±12.86	93.45±10.71	0.00*
QRS duration (msec)	99.23±12.34	100.40±12.11	0.82
PR Interval (msec)	148.21±21.90	146.86±16.50	0.12
QT Interval (msec)	365.39±31.40	359.89±22.10	0.36
QTc value (msec)	394.80±20.71	383.72±23.26	0.45
Mean QRS Axis (degrees)	39.2±33.4	57.4±33.6	0.00*

DISCUSSION

- In this present comparative, cross-sectional study, we have compared the electrocardiographic parameters of 50 young obese asymptomatic subjects with that of apparently healthy age and sex matched normal weighing controls. Heart rate and Blood pressure was higher in obese individuals. Higher heart rate and blood pressure may be a cause for the development of metabolic syndrome in obese individuals. Shigetoh et al (2009), in their study, suggested three mechanisms by which the higher sympathetic activity may predispose to many cardiovascular ill effects as well as diabetes mellitus[IX]. Heart rate is influenced by both sympathetic and parasympathetic nerve activities. The higher heart rate in our study may be because of sympathetic over activity. However, longitudinal studies in Tecumseh[VII] and Osaka[X] suggest that sympathetic nerve activation may play a role in the development of obesity.

- **Electrocardiographic Parameters:**

i. **QRS Axis**. Mean QRS axis in case was 39.2±33.4 degrees and in control group it was 57.4±33.6 degrees and was statistically significant which suggests that obese persons are likely to have more leftward axis deviation. This is in accordance with many studies like Frank and his colleagues, who reported leftward mean QRS axis in 1029 obese subjects, which became more pronounced with increasing obesity[V]. The cause

of this axis shift is not known, but may be due to a leftward and more horizontal orientation of the heart attributed to the diaphragmatic pressure from visceral obesity[II,III]. Thus, obesity is associated with a leftward shift in QRS axis, that is directly related to the severity of obesity and is reversible with weight loss.

ii. **P wave duration:** In our study, P wave duration in case was 101.40±12.86 milliseconds and in controls was 93.45±10.71milliseconds and was statistically significant. So, it can be said that P wave duration is longer in obese individuals. Obese patients have 50% risk of atrial fibrillation and flutter[XVII].Left atrial enlargement leads to atrial fibrillation which contributes to increase in the P wave duration and amplitude. In obese patients, left atrial enlargement and electrical instability may be caused by elevated plasma volume, ventricular diastolic dysfunction and enhanced neurohormonal activity.Also, the autonomic control of the heart is abnormal in obese subjects due to prevalence of sympathetic over parasympathetic limb of the autonomic balance. This affects intraatrial and interatrial conduction times and leave them prone to develop atrial arrhythmias, such as atrial fibrillation[VIII].

iii. **QRS duration:** QRS duration in case and in controls was 99.23±12.34 milliseconds, and 100.40±12.11 milliseconds respectively which shows higher value in non-obese but it is non-significant. This is in contrast to some other studies like the studies of Frank and his colleagues in 1029 obese subjects suggesting progressive QRS widening in obese persons[V]. A prolongation of the QRS duration (> 0.10 s) was associated with lower left ventricular ejection fraction and larger end-systolic and end-diastolic volumes and thus is a specific indicator of left ventricular dysfunction[XI].

iv. **PR interval:** PR interval was 148.21±21.90 milliseconds in cases and 146.86±16.50 milliseconds in controls and was not significant. So, higher PR Interval was noted in obese persons which is in accordance with the study done by Frank et al[V] and Alpert et al[XI], but they noted progressive increase in PR interval duration with increasing severity of obesity and were independent of age, sex and blood pressure. A 10% increase in obesity was manifested in an increase in PR interval of 0.5 ms. Pipberger et al[XIII] also noted slight increases in the PR intervals with increasing weight.

v. **QT interval:** Mean QT interval was 365.39±31.40 milliseconds in cases and 359.89±22.10 milliseconds in controls, and was not significant. Mean QTc was 394.80±20.71 milliseconds in cases and 383.72±23.26 milliseconds in controls, and was also not significant but was prolonged (> 0.45 seconds) in 5% of cases. There is increasing evidence suggesting that obesity, particularly central obesity is associated with delayed ventricular repolarization as designated by prolongation of the corrected QT interval or QT dispersion[VI,XV]. Several mechanisms have been suggested for QT prolongation: autonomic system imbalance and autonomic neuropathy[XIX], mutations of genes affecting cardiac ion channels involved in cardiac repolarization[XIV], nonconducting scar tissue resulting from myocardial infarction, high glucose level, elevated insulin level, hypokalemia, obesity and ventricular hypertrophy. A small improvement of the QTc was apparent only when the correction was made using the Bazett formula.

vi. **ST segment:** ST segment was isoelectric in 90% (n = 45) cases and 100% (n = 50) controls but was abnormal in 10% (n =5) cases. P value was >0.05 and was statistically non significant. Eisenstein et al[III] found ST segment abnormalities in 10.6% patients and suggested that they were nonspecific repolarization changes and did not correlate with the degree of obesity. In a study of 100 normotensive young morbidly obese patients and 100 young normotensive normal controls, ST segment depression with or without T wave inversion occurred rarely[I].

CONCLUSION:

- This was a comparative cross-sectional study done in the general population of Ahmedabad district where 50 obese persons with BMI>30 kg/m^2 and 50 normal persons with BMI<25kg/m^2. But in this study sample size was too small and also we did not correlate the age, sex and BMI with the ECG parameters. However from the data gathered, it is concluded that apparently healthy obese individuals may have higher anthropometric values and abnormal ECG findings. Hence, a regular check on these parameters will help them in reducing the chances of its manifestation at a future date.

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