Volume : 5 | Issue : 5 | May 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Research Paper

A Study of Effect of Obesity on QTc Interval in Young Adults of Punjab

Medical Science

KEYWORDS : Obesity, QTc interval, body mass index

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ABSTRACT

Background: Obesity is one of the leading preventable non communicable disease worldover. Obesity is a pro-inflammatory condition and is a precursor for various diseases like diabetes and hypertension leading to morbidity and mortality. It has significant cardiovascular effects. Of the various electrocardiographic findings in obesity QT interval prolongation may be the precursor of arrhythmias. This may be one cause of sudden cardiac death in obese. The present study intends to find the correlation of obesity with QT interval lengthening.

Aims And Objectives: The purpose of this study was to compare the QTc interval of ECG between subjects with normal BMI, overweight and obese in the age group of 18-40 years and to know whether QTc interval varies with the BMI.

Materials and method: The study was conducted on 150 subjects at Government Medical College, Amritsar who were graded on the basis of their BMI and there corrected QT interval was calculated from their ECG and their correlation was studied.

Summary and conclusion: Normal BMI patients had mean QTc value in the normal range. Of the overweight patients 14% of the patients were found to have QTc in the higher range of the normal but no one had a prolonged QTc. 42% of the obese males and 53% of obese females had a prolonged QTc. Hence QTc interval was positively correlated with obesity. QTc prolongation may be one of the factors leading to an increased incidence of sudden cardiac death in obese.

INTRODUCTION

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems.[1] It is defined by body mass index (BMI) of more than 30 kg/m^2 BMI is closely related to both percentage body fat and total body fat.[2] BMI is defined as the subject's weight (in kilograms) divided by height in meters square.[3]

BMI	Classification
< 18.5	Underweight
18.5–24.9	normal weight
25.0–29.9	Overweight
30.0–34.9	class I obesity
35.0–39.9	class II obesity
≥ 40.0	class III obesity

Classification of obesity on the basis of BMI as per WHO:

Obesity is a leading preventable cause of death worldwide, with increasing prevalence in adults and children and is viewed as one of the most serious public health problems of the 21st century.[4] Increased fat also creates a proinflammatory state and a prothrombotic state.[5, 6]

CARDIAC EFFECTS OF OBESITY

Besides an altered metabolic profile, a variety of adaptations/alterations in cardiac structure and functions occur in an individual as adipose tissue accumulates in excess amounts. A primary mechanism of sudden cardiac death in obesity has been shown to be fatal ventricular arrhythmias which is thought to be correlated with a prolonged electrographic interval between Q and T waves. QTc is a rate corrected QT interval. QTc is calculated by using Bazzet's formula i.e QTc=QT/√RR. The normal QTc interval in a healthy male and female are upto 0.44 sec and 0.46 sec respectively.[7] Prolongation of QTc interval on the ECG represents delayed repolarization of the ventricular myocardium and is considered a precursor of fatal ventricular arrhythmias and sudden cardiac death.

REVIEW OF LITERATURE

EPIDEMIOLOGY OF OBESITY IN INDIA

The Global Burden of Disease Study, 2013 stated that China and India together accounted for 15 per cent of the world's obese population, with 46 million and 30 million obese people, respectively.[8]

According to the National Family Health Survey, the percentage of married women aged 15-49 years who are overweight and obese increased from 11% in NFHS-2 to 15% in NFHS-3. The percentage of people who are overweight and obese is highest in Punjab followed by Kerala and Delhi.[9]

PATHOPHYSIOLOGY OF CIRCULATORY CHANGES IN OBESITY

Obesity affects the cardiovascular system in multiple ways. Obese individuals have an increased total blood volume to meet the perfusion needs of the increased adipose tissue. Increases are seen in both intracellular and extracellular fluid and are associated with increased stroke volume, although resting heart rate remains unchanged. The increased stroke volume increases resting cardiac output and left ventricular (LV) work.[9] The increase in cardiac output is also accompanied by a decrease in systemic vascular resistance in normotensive obese individuals. Because of increased LV workload, oxygen consumption is also increased.[10]

The incidence of hypertension is more in the obese.[9] The exact etiology is unknown but may be related in part to volume overload and resistance for blood transit in the capillaries, particularly vessels in the adipose-filled subcutaneous tissue.[10] In addition, adipocytes themselves have been recognized as a direct source of hormones, such as atrial natriuretic peptide and the renin-substrate angiotensin, which regulate fluid volume.[11]

As a result of the continuous pressure overload, increased blood viscosity, obesity-related hypertension, and concentric left ventricular hypertrophy (LVH) develop. In the absence of hypertension, the myocardium may also be damaged by the chronic fluid overload related to increase cardiac output, which may lead to

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LV dilatation and an eccentric LVH.[12] Concentric and eccentric LVH increase the risk of developing both systolic and diastolic ventricular dysfunction.[13] In the obese, systolic dysfunction is most evident. Increased LV end-diastolic volume is often accompanied by decreased ejection fraction in the chronically obese, putting them at risk for congestive heart failure and cardiac arrhythmias.[13,14] The incidence of premature ventricular contractions is higher in individuals with concentric LVH.[14] Because of dilatation of the atria related to increased fluid volume, the prevalence of atrial fibrillation and stroke is also higher in this population.[15]

ELECTROCARDIOGRAM IN OBESITY

Like physical evaluation, the ECG is influenced by morphological changes induced by obesity, such as (1) displacement of the heart by an elevated diaphragm in the supine position, (2) increased cardiac workload with associated cardiac hypertrophy, (3) increased distance between the heart and the recording electrodes induced by the accumulation of adipose tissue in the subcutaneous tissue of the chest wall (and possibly increased epicardial fat), and (4) the potential associated chronic lung disease secondary to the sleep apnea/hypoventilation syndrome. Electrocardiographic changes that may be seen in obese persons are ↑ heart rate, ↑ PR interval, ↑ QRS interval, ↑ or ↑ QRS voltage, ↑ QT_c interval, ST-T abnormalities, left-axis deviation, flattening of the T wave (inferolateral leads), left atrial abnormalities and false-positive criteria for inferior myocardial infarction. In addition nonspecific flattening of the T wave in the inferolateral leads (attributed to the horizontal displacement of the heart) and left atrial abnormality may be seen.[16,17,18] More frequent ST-segment depression is seen in overweight patients with coronary artery disease.[19]

ARRHYTHMIAS

There is an increase in the incidence of sudden cardiac death and arrhythmias in obesity.[20] Fatal arrhythmias may be the most frequent cause of death among obese patients. According to the Framingham data, sudden cardiac death was 40 times higher in obese men and women.[20] In another study of severely obese individuals, this was 6-fold and 12-fold higher in those aged 25 to 34 years and 35 to 44 years, respectively.[21] Schouten et al found that 8% of obese individuals had a QTc interval of more than 0.44 seconds and, in 2%, it was more than 0.46 seconds.[22] A QTc interval of more than 0.42 seconds was associated with increased mortality in "healthy" obese patients followed for 15 years.[23] QT dispersion, which measures the difference in duration between the maximum and the minimum QT interval in different leads in the ECG is a good noninvasive measurement for quantifying the degree of myocardial repolarization inhomogeneity, which was also increased in the obese. Both QTc interval and QT dispersion are mediated by changes in sympathetic-vagal balance.[24] In addition, increased free fatty acid levels in the obese may also affect repolarization. In 2 independent studies it was found that QTc interval is closely correlated with plasma free fatty acid levels which are elevated in obese patients.[25,26] Papaioannou et al found that QT interval is positively associated with upper body obesity (WHR>0.85) even at the same level of body fat in moderately obese women and abdominal obesity may be one of the risk factors for a prolonged QT interval in premenopausal women.[27]

MATERIALS AND METHODS

This cross sectional study was conducted on 150 subjects in the age group of 18-40 years attending the OPD or admitted at Guru Nanak Dev Hospital attached to Government Medical College, Amritsar.

Inclusion criteria:

The subjects were divided into three groups of 50 each based on BMI:

1. Normal (BMI 18-24.9)
2. Overweight (BMI 25-29.9)
3. Obese (BMI >30)

Exclusion criteria:

All the patients suffering from other diseases, which are likely to affect the QTc interval, were excluded from this study like patients with ECG evidence of ischemia, history of previous arrhythmic episode/episodes, hypertension, diabetes mellitus, dyselectrolytemias, thyroid disease and patients taking medication affecting QT interval

After a detailed history and physical examination patients underwent the following investigations: complete blood count, blood urea, serum creatinine, fasting blood sugar, lipid profile, serum sodium, potassium and calcium levels, thyroid profile and ECG- for QTc prolongation, calculated by using Bazzet's formula i.e $QTc=QT/\sqrt{RR}$

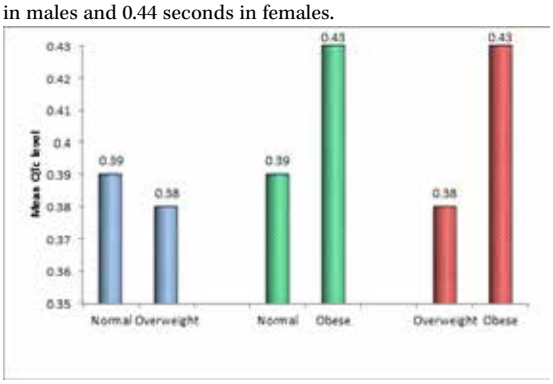
Statistical analysis was done by applying Student's unpaired 't' test.

OBSERVATIONS

Age of the patients in our study varied from 18 – 40 years. Out of the 150 patients included in the study, 98 (65.33%) were males and 52 (34.67%) were females.

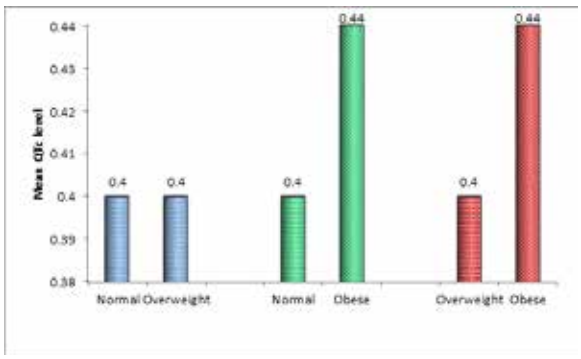
Out of the 50 patients included in normal BMI (<25) group 34 (68%) were males and 16 (32%) were females. Most of the patients belong to 18-25 years of age group (n=19, 38%). Out of the 50 patients included in over weight BMI (25-29.9) group. 34 (68%) were males and 16 (32%) were females. Most of the patients belong to 31-35 years age group (n=15, 30%). Out of the 50 patients included in obese BMI (>30) group, 31 (62%) were males and 19 (38%) were females. Most of the patients belong to 31-35 years age group (n=20, 40%).

Mean QTc interval in normal weight was 0.39 seconds in case of males and 0.40 seconds in females. Mean QTc interval in overweight patients was 0.38 seconds in males and 0.40 seconds in females. Mean QTc interval in obese patients was 0.43 seconds in males and 0.44 seconds in females.



The mean QT_c interval in normal BMI (<25) male patient was 0.39 seconds and in overweight BMI (25-29.9) male patients was 0.38 seconds. Between normal and overweight male patients the difference of average values of QT_c was not significant (P value= 0.92).

However there was a statistically significant difference in the average values of QT_c in normal and obese (P value = 0.001), also in overweight and obese (P value =0.001).



The mean QT_c internal in normal BMI (<25) female patients was 0.40 seconds and in overweight BMI (25-29.9) female patients was 0.40 seconds. So there was no difference in the mean values of QTc interval between normal and overweight groups.

However there was a statistically significant difference in the average values of QT_c in normal and obese (P value = 0.001), also in overweight and obese female patients (P value =0.001). Patients with normal BMI (<25) had mean QTc value of 0.39 seconds in males and 0.40 seconds in females. None of the patients had prolonged QTc. Overweight BMI (25-29.9) patients had mean QTc value of 0.38 seconds in males and 0.40 seconds in females. 14% of the patients were found to have QTc in the higher range of the normal but none of them had prolonged QTc. 42% of the obese males (BMI>30) had prolonged QTc i.e. QTc > 0.44 seconds and 29% of the obese males had QTc value in the range of higher side of normal i.e. 0.43-0.44 seconds. 53% of the obese females (BMI>30) had prolonged QTc i.e. QTc > 0.46 seconds.

It was observed that QTc interval increased significantly with increasing body weight.

DISCUSSION

Obesity in adults is closely associated with a wide variety of ECG changes, including high resting HR, prolongation of PR interval and QRS duration and leftward shifts of electrocardiographic axis. However, the effect of obesity on QTc interval is always been controversial especially in young adults having uncomplicated obesity.

The study population involved 150 subjects with age ranging from 18 to 40 years. The subjects were divided into three groups of 50 each based on BMI as normal (BMI 18-24.9), overweight (BMI 25-29.9) and obese (BMI >30) groups. Out of the 150 subjects included in the study 98 (65.3%) were males and 52 (34.67%) were females. Male to female ratio was 1.88:1. Max number of cases (n=46, 30.67%) were in the range of 31-35 years age group followed by 26-30 years age group (n=36, 24%). .

In the present study the mean QTc in normal BMI group in male patients was 0.39 seconds and in overweight group was 0.38 seconds. So between normal and overweight male patients the difference of average value of QTc was not found as statistically significant (P value=0.92).

Out of 31 obese male patients (BMI>30), 13 (42%) patients were found to have prolonged QTc i.e. QTc >0.44 seconds with maximum value being 0.48 seconds and 9 (29%) patients were found to have values in the range of higher side of normal i.e. 0.43-0.44 seconds.

In the comparison of normal male patients with obese male patients, the mean QTc in obese patients was 0.43 seconds and a statistically significant difference was observed (P value=0.001).

In the comparison of overweight male patients with obese male patients, a statistically significant difference was observed (P value=0.001).

Among the female patients the mean QTc interval in the normal BMI group as well as in the overweight group was 0.40 seconds. Thus there is no difference observed.

Out of the 19 obese female patients, 10 (53%) were found to have prolonged QTc interval i.e. QTc>0.46 sec with maximum value being 0.51 seconds. Mean QTc in obese female patients was 0.44 seconds. Here also a statistically significant difference was observed between normal versus obese (P value=0.001) and overweight versus obese group (P value=0.001).

So the findings in the above study clearly show that as we move out of the overweight group, QTc interval increases significantly. So it was not the weight but the BMI which was influencing this change in QTc interval.

These findings were similar to that observed in the study conducted by Arslan et al in 122 young men. They concluded that uncomplicated obesity in young men is associated with QTc prolongation.[28]

Frank et al also found a statistically significant relationship (r =0.22, P<0.001) between percent overweight and QTc interval in obese patients.[29]

In addition, El- Gamal et al found significant correlations between QTc intervals and BMI in healthy obese people. He concluded that autonomic dysfunction was associated with prolonged QTc.[30]

Carella et al studied QT interval before and after diet therapy in patients with simple obesity and it was found that obesity per se causes a prolongation of QT interval and that weight reduction improves it.[31]

Mshui et al in their study concluded that there is a significant reduction in QT interval duration and amelioration of this abnormality with weight reduction.[32]

In another study, conducted by Park and Swan it was concluded that for each 50% increase in fat mass percentage above normal, there is a 5 ms increase in QTc above upper limit of normal.[33]

CONCLUSION

Prolongation of QTc interval on the ECG represents delayed repolarisation of the ventricular myocardium and is considered as the precursor of ventricular arrhythmias hence may increase the incidence of sudden cardiac death in obese. Further long term studies are required to study the effect of obesity on QTc interval and its association with the incidence of arrhythmias in this sub population.

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Volume : 5 | Issue : 5 | May 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

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