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RESEARCH ARTICLE

Study of relationship between anthropometric parameters and heart rate-corrected QT interval (QTc) in normal body mass index Indian males with abdominal obesity

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ABSTRACT

Background: Abdominal obesity is seen with increased prevalence in South Asians even among those who have a body mass index (BMI) <25 kg/m^2. Increasing intra-abdominal deposition of fat is closely associated with prolongation of the QTc interval independent of obesity and other cardiovascular risk factors. This may facilitate the development of cardiac arrhythmias and sudden death. **Aims and Objectives:** To determine whether abdominal obesity is associated with a prolongation of the QT interval corrected for heart rate (QTc) on the electrocardiogram (EKG) in Indian males with normal BMI. **Materials and Methods:** It was a cross-sectional study involving 100 males with normal BMI (50 with abdominal obesity and 50 healthy controls). Demographic data and detailed medical history were taken from each participant. Height, weight, waist, and hip circumference were measured. Participants were divided into two groups, one with waist-hip ratio (WHR) <0.9 and other with WHR ≥0.9. A resting standard supine 12-lead EKG was recorded. QTc interval was calculated using Bazett's formula (QTc = QT interval/square root R-R interval). Student *t*-test and Pearson's correlation coefficient were used for statistical analysis. **Results:** There was no significant difference between Groups I and II in mean age, weight, height, and BMI ($P > 0.05$). QTc was found to be significantly higher in Group with WHR ≥0.9 with $P < 0.001$. In the group with WHR ≥0.9, 26% subjects had abnormal QTc, and 50% had borderline prolongation. In the other group, only one participant (2%) had abnormally prolonged QTc and 90% had QTc within normal limits. Significant positive correlation of QTc was found with weight, BMI and WHR with *P* value of $P < 0.05$, while there was no significant correlation of QTc with age and height. **Conclusion:** Distribution of adiposity needs to be taken into account even in normal weight and BMI patients while judging the cardiovascular and metabolic risk. WHR is a better indicator of prolonged QTc interval in these individuals than BMI.

KEY WORDS: Abdominal Obesity; QTc; Waist-hip Ratio

INTRODUCTION

Obesity is defined as abnormal or excessive fat accumulation that presents a risk to health. It is a global public health problem with its prevalence rising substantially in past three decades. Problem is getting more severe in India with data from National Family Health Survey 4 showing a number of overweight/obese men and women increasing to 18.9% and 20.7% in 2015–2016 from 9.3% and 12.6% in 2005–2006, respectively.[1]

Obesity is linked to numerous comorbidities that include, but are not limited to, glucose intolerance, insulin resistance, dyslipidemia, cardiovascular disease, and cancer.[2] It has been implicated as a risk factor for sudden cardiac death as well as cardiovascular morbidity and mortality for several decades.

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Obesity is a heterogeneous disorder with the distribution of adipose tissue determining cardiovascular and metabolic disease risk, rather than the amount of body fat alone. Obesity-related adverse health consequences occur predominately in individuals with upper body fat accumulation, the detrimental distribution, commonly associated with visceral obesity.[3] Abdominal obesity is more common among South Asians than general adiposity in contrast to whites, who have only a slightly higher rate of abdominal adiposity, and blacks who actually have a lower rate of abdominal obesity than general obesity.[4] Abdominal obesity is seen with increased prevalence in South Asians even among those who have a body mass index (BMI) <25 kg/m^2.

The coexistence of abdominal obesity and electrocardiographic abnormalities may facilitate the development of cardiac arrhythmias and sudden death.[5] In addition, abdominal fat deposition has been suggested as an independent risk factor for prolongation of the QTc interval. Peiris *et al*.[6] found that increasing intra-abdominal deposition of fat was closely associated with prolongation of the QTc interval independent of obesity and other cardiovascular risk factors. Delayed cardiac repolarization leading to the prolongation of the QT interval is a well-characterized precursor of arrhythmias, which in turn is the most common cause of cardiac death.

Previous studies have examined the relationship between QTc prolongation in obese/non-obese and upper body obese/lower body obese groups with elevated BMI. A section of the population exists which have BMI within the normal range, but have abdominal obesity as measured by waist-hip ratio (WHR). Very little information is available in this particular domain.[2,5,6]

It was hypothesized that individuals with abdominal obesity would have larger prolongation of QTc interval as compared to individuals without central obesity in this population. Hence, the present study was framed to determine whether abdominal obesity is associated with a prolongation of the QT interval corrected for heart rate(QTc) on the electrocardiogram (EKG) in Indian males with normal BMI.

MATERIALS AND METHODS

It was a cross-sectional study conducted at GMERS Medical College Valsad between April and October 2017. The Human Research Ethics Committee permission was taken before starting the study. Clinically normal males with BMI <25 kg/m^2 and age between 20 and 60 years were included in the study. Subjects having BMI ≥25, hypertension, cardiovascular disease, diabetes mellitus, psychiatric conditions, hormonal disorder, history of alcohol abuse, smoking, or presently taking any medication known to affect QT interval, were excluded from the study. According to inclusion and exclusion criteria total, 100 males between 20 and 60 years of age (50 with abdominal obesity and 50 healthy controls) were selected to be enrolled in the study. Informed written consent was obtained from each participant before enrolment in the study.

Demographic data and detailed medical history were taken from each participant. Weight (kg) and height (meters) were measured (using Omron digital body weight scale HN-286 and SECA 206 wall mounted metal tapes, respectively). BMI was calculated by weight (Kg)/height squared (m^2). Waist circumference (WC) was assessed in the standing position, midway between the highest point of the iliac crest and the lowest point of the costal margin in the midaxillary line, at the end of expiration with person breathing silently. Hip circumference (HC) was measured at the level of the femoral greater trochanter to the nearest 0.1 cm. All anthropometric measures reflect the average of 3 measurements (measured by the same person on the same instrument to avoid inter-instrument and interpersonal variation).[7] Overweight and abdominal obesity were defined as BMI ≥25 kg/m^2 and WHR ≥0.9, respectively. Age was defined as the age in completed years at the time of interview. WHR was calculated as WC in centimeters divided by HC in centimeters.

A resting standard supine 12-lead EKG with the paper speed of 25 mm/s and amplitude of 10 mm/mV was recorded using BPL cardiart 108T-DIGI. QT interval was manually measured by a cardiologist who was unaware of other characteristics of the subject. Efforts were made to ensure minimum intravariability. QTc interval was calculated using Bazett's formula (QTc = QT interval/square root R-R interval). Bazett-corrected QTc values used for diagnosing QT prolongation in adult males were: Normal <430 ms, borderline: 430–450 ms, and prolonged/abnormal: >450 ms.[8]

Statistical analysis was done using SPSS version 20.0 Software. Student *t*-test was used for parametric data. Pearson's correlation coefficient was used to examine the relationship between QTc interval and anthropometric measurements. All tests were two-sided, and the level of significance was established at $P < 0.05$.

RESULTS

The study included 100 male subjects with BMI <25 kg/m^2. They were divided into two groups, on the basis of WHR (Group I ≥0.9 and Group II < 0.9).

Comparison of different variables between the two groups is tabulated in Table 1 as a mean ± standard deviation. Both groups were demographically similar. There was no significant difference between Groups I and II in mean age, weight, height, and BMI ($P > 0.05$). Both groups were significantly different ($P < 0.05$) in waist circumference (WC), HC, and WHR with Group I having abdominal obesity (WHR ≥0.9). As seen in the Table 1 mean QTc was found to be significantly higher in group with WHR ≥ 0.9 with $P < 0.001$.

Table 2 shows the distribution of subjects according to QTc duration. In the group with WHR ≥0.9, 26% participants had abnormal QTc, and 50% had borderline prolongation. Comparatively, in the group with WHR <0.9, only one individual (2%) had abnormally prolonged QTc, and 90% had QTc within normal limits.

The correlation of QTc interval with different demographic/anthropometric variable was obtained using Pearson's correlation coefficient test. Table 3 shows the r and *P* value for Pearson's correlation coefficient test for each variable. Significant positive correlation of QTc was found with Weight, BMI, and WHR with *P* value of $P < 0.05$, while there was no significant correlation of QTc with age and height.

Table 1: Comparison of variables among two groups (Mean±SD)

Variable	Group I (WHR ≥0.9)	Group II (WHR <0.9)	*P*
Age (years)	40.68±9.34	42.44±9.31	0.348
Weight (kg)	68.46±7.94	65.85±6.90	0.082
Height (cm)	171.72±6.69	170.36±6.08	0.291
BMI (kg/m^2)	23.14±1.35	22.68±1.93	0.173
WC (cm)	95.38±4.44	81.62±5.13	<0.001*
HC (cm)	97.08±6.05	93.94±5.62	0.008*
WHR	0.98±0.04	0.87±0.02	<0.001*
QTc (Ms)	441±16	407±20.3	<0.001*

*Statistically significant. BMI: Body mass index, WC: Waist circumference, HC: Hip circumference, WHR: Waist-hip ratio, SD: Standard deviation

Table 2: Distribution of subjects according to QTc duration among Groups I and II

QTc duration (ms)	Group I (WHR ≥0.9) *n*=50 (%)	Group II (WHR <0.9) *n*=50 (%)
Normal (≤ 430 ms)	12 (24)	45 (90)
Borderline (431–450 ms)	25 (50)	4 (8)
Abnormal (>450 ms)	13 (26)	1 (2)
Total	50 (100)	50 (100)

Table 3: Pearson correlation coefficients of QTc with demographic and anthropometric variables in the study population

Variable	*r*	*P*
Age	−0.069	0.495
Weight	0.24	0.016*
Height	0.081	0.421
BMI	0.269	0.007*
WC	0.579	<0.001*
HC	0.231	0.021*
WHR	0.571	<0.001*

*Statistically significant. BMI: Body mass index, WC: Waist circumference, HC: Hip circumference, WHR: Waist-hip ratio

DISCUSSION

This study comprised 100 subjects, all with BMI <25, divided into two groups on the basis of WHR: Group I with WHR ≥0.9 and Group II with WHR <0.9. There was no significant difference between the two groups in terms of age, weight, height, and BMI. Heart rate-corrected QT interval (QTc) is a known risk factor for sudden cardiac death, cardiovascular events, and metabolic syndrome in obese patients. In this study, patients with WHR ≥0.9 had a QTc of 441 ± 16 ms as compared to 407 ± 20.3 ms in Group II with WHR <0.9. In participants with WHR ≥0.9, 26% had abnormal QTc, and 50% had borderline prolongation.

Frank *et al*.[9] have noted abnormal QTc in 4% of patients in a population where on average, study participants were 51.5% overweight. However, Alpert *et al*.[10] found no significant prolongation of the QTc interval in the otherwise healthy morbidly obese patient. Omran *et al*.[11] in a systemic review have found a significantly longer QTc in obese or overweight subjects. Discrepancy between these studies may result from different study populations and design. Prolonged QTc observed in present study in Group I participants is in line with Prasad *et al*.'s[4] finding that abdominal obesity is seen with increased prevalence in South Asians even among those who have a BMI <25 kg/m^2. The same study stated that subjects with abdominal obesity, as assessed by measurement of WC or WHR, are at a greater risk of cardiometabolic risk, independently of risk associated with a raised BMI. While Arslan *et al*.[12] had concluded that uncomplicated obesity in young men without known cardiovascular disease is associated with QT interval prolongation, Girola *et al*.[13] reported no difference between patients with uncomplicated obesity and the controls in terms of QT interval and QT dispersion values.

Obesity causes significant abnormalities in cardiac morphology including left atrial enlargement, left ventricular geometric changes, and diastolic dysfunction. Various mechanisms have been postulated explaining causes of QTc prolongation in patients with increased adiposity: Autonomic dysfunction, electrolyte abnormality, left ventricular hypertrophy, and hyperinsulinemia.[2,14] Both QTc interval and QT dispersion are mediated by changes in sympathetic vagal balance. Catecholamine levels, adipokines are increased in the obese. In addition, increased free fatty acid levels may also affect repolarization.[15]

The relationship between obesity and electrocardiographic variables is well established in a multitude of studies in overweight/obese/morbidly obese populations.[3,5,15,16] Some studies have found high morbidity and mortality even in normal BMI subjects with abdominal or central obesity, especially in

Southeast Asian population, emphasizing the importance of the distribution of body fat rather than the absolute amount of adipose tissue. We chose to study subjects which have normal body mass indices according to the WHO criteria to make a distinction between those at augmented risk as a result of abdominal obesity from those with generalized obesity.

The present study indicates that weight or BMI should not be the only criteria to assess adiposity and cardiovascular risk. Attention should be given to the distribution of fat in the body as individuals with normal weight and normal BMI, but high WC and WHR are also subjected to adverse effects of high adiposity. Bays *et al*.[17] have postulated that abdominal obesity in most cases is due to the excessive caloric intake. Since overall weight and BMI are normal or near normal in our study population, they are less likely to be advised or comply with dietary modifications and lifestyle changes as compared to generally obese person. This leads to a situation where the accumulation of abdominal adipose tissue is not stopped or reversed due to lack of attention to increased adiposity in the presence of normal weight and BMI.

Results of this study are consistent with other studies in subjects with cardiovascular disease showing obesity to prolong QT interval.[18-20] We observed a stronger correlation between QTc and WC and QTc and WHR than between QTc and BMI. This result indicates that abdominal obesity expressed as WC or WHR is a more important predictor of cardiac risk than BMI, not only in obese individuals but also in males with normal BMI. One of the limitations of the present study is that the participants of this study were considered free of other diseases on the basis of history, but specific hormonal, electrolyte and metabolic tests were not conducted to verify the absence of these confounding factors. Any such factor, if present in a participant could have affected the QTc. The clinical significance of this study needs to be confirmed in longitudinal studies.

CONCLUSION

Distribution of adiposity needs to be taken into account even in normal weight and BMI patients while judging the cardiovascular and metabolic risk. WHR is a better indicator of prolonged QTc interval in these individuals than BMI.

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