

The Effect of Fasting on QT Interval

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Introduction: QT interval reflects the total duration of ventricular depolarization and repolarization in the ECG. Experimental hypoglycaemia and spontaneous clinical episodes of hypoglycaemia lead to the lengthening of the heart rate corrected QT interval or QTc. This is associated with elevated risk of sudden death. **Objective:** To find out the effect of fasting blood glucose levels on QT interval and the corrected QT interval (QTc). **Materials and Methods:** Fasting and post prandial blood glucose levels and ECG of healthy young adults were studied and QT interval, RR interval and QTc were determined. **Results:** The fasting QTc came out to be 0.408 ± 0.020 as compared to the post prandial value of 0.380 ± 0.019 . The student's t test showed a highly significant value ($p < 0.0001$). **Conclusion:** There is significant prolongation of QT interval and QTc during fasting but within normal physiological limits.

Key words: QTc, fasting

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QT Interval reflects the total duration of ventricular myocardial depolarization and repolarization in the ECG. It is usually corrected for heart rate by Bazett formula¹. A prolonged QT interval has been identified as a risk factor for cardiovascular mortality in various populations, such as healthy subjects^{2,3}, patients with cardiac disease^{4,5}, and patients with diabetes^{6,7,8}. The aetiology of acquired forms of prolonged QT interval is still poorly defined; involvement of cardiac ion channels—*analogous to inherited forms and cardiac autonomic neuropathy have been suggested*^{7,9}.

Prolongation of QT interval is seen in type 1 and type 2 diabetes^{10,11} more so in diabetics with autonomic neuropathy¹². Experimental hypoglycemia and just recently, spontaneous clinical episodes of hypoglycemia proved to lead to QTc lengthening^{13,14,15}. Prolongation of the heart-rate-adjusted QT length or QTc is associated with an elevated risk of sudden death¹⁶. There is some evidence that prolonged cardiac repolarization contributes to sudden death associated with nocturnal hypoglycemia in young people with diabetes^{17,18,19,20}. The critical QTc value that confers particular vulnerability to ventricular arrhythmias probably varies individually but is considered to be $\sim 550\text{ms}$ ²¹.

Aims and objectives

The aim of our study was to find out the effect of fasting blood glucose levels on QT interval and the corrected QT Interval. (QTc).

Materials and methods

This cross sectional study was conducted in the Department of Physiology King Edward Medical University over a period of 4 months.

Selection of participants: Healthy young adults 18 – 21 years of age, both male and female were included in this study. The participants were normotensive and non-diabetic. Female participants were non-pregnant and pre-menopausal. Only those participants were included whose ECG's were of adequate quality to measure QT and RR intervals

Exclusion criteria: Participants having ischaemic heart disease, valvular heart disease, liver or kidney disease,

bronchial asthma, systemic infection, arrhythmias or abnormal electrocardiogram or those who had taken any kind of drugs within 2 weeks before study were excluded from the study.

Materials: Used were glucometer, ECG machine, weight machine, vernier calipers etc.

Study protocol: Written informed consent was taken from each subject. Five students were examined each day. They were advised to come to the study site after an overnight fast of 14 hours. They took light supper at 8 to 9 pm. Plain water was allowed till 12 midnight. Fasting Blood Glucose Level was recorded the following morning between 10-11 am at Physiology Lab King Edward Medical University, followed by a 12 lead ECG after which the participants had breakfast which consisted of 2 fried eggs, 2 pieces of bread, butter and a glass of whole milk. Subsequently post prandial ECG and Blood Glucose Levels were recorded. The ECG recording of every subject was studied for QT interval, RR interval and QTc was determined.

Height and weight without shoes and with light clothing was determined and body mass index or Quetelet's index (Weight in kg/ height in meter square) was calculated for each subject. Blood pressure was recorded with mercury sphygmomanometer.

Measurement of QT interval: The QT interval was manually measured by using hand-held calipers from the beginning of the QRS complex to the end of T wave. The end of T wave was defined as the intersection between a tangent to the terminal slope of the T wave and the PR baseline. Only monophasic well defined T waves were accepted for measurement. If a U wave was present, then the tangent was drawn on the terminal slope of T wave and its end was determined as point of intersection of this line with the isoelectric base. The QT interval and preceding RR interval were measured in three consecutive cycles. All ECG's were analyzed by single observer.

The heart rate corrected QT interval or QTc was calculated by Bazette's formula.

$$QTc = QT / \sqrt{RR}$$

Results

Demographic data was tabulated. The blood pressure and BMI values were within normal range. (Table 1). QT interval and RR interval was measured in every lead during fasting and post-prandial states. Data is presented as mean \pm standard deviation. (Table 2). The difference in continuous variables across group was assessed by paired student's t-test. P value < 0.05 were taken as statistically significant. So we found that there is statistically significant prolongation of QTc and in fasting state when compared to post prandial state. (Fig.)

Figure.

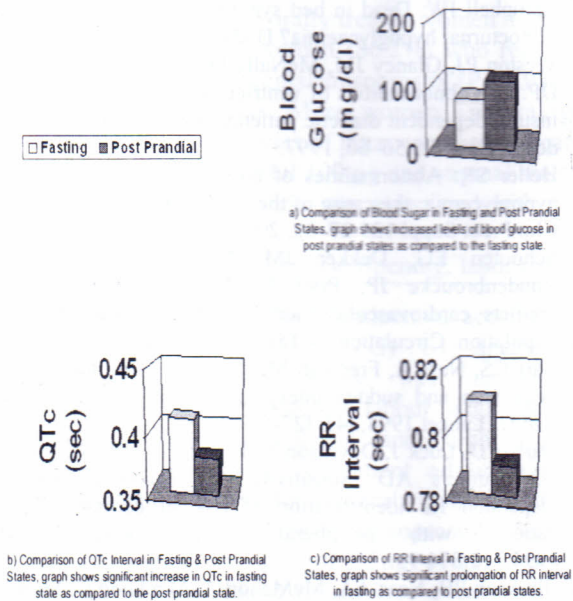


Table 1: Demographic table

Variables	Mean	Mean \pm Standard Deviation
Age (years)	19.9	19.9 \pm 0.632
Height (m)	1.716	1.716 \pm 0.088
Weight (kg)	63.975	63.975 \pm 10.972
BMI (Kg/m ²)	21.656	21.656 \pm 3.072

Table 2 shows blood pressure, blood glucose levels and electrocardiographic variables during fasting state and after meals. The changes in these values were subjected to student t test, p values of blood glucose, RR interval, mean QT interval and QTc were highly significant.

Table 2

Parameter	Fasting	Post prandial	P value
Blood sugar level (mg/dl)	80.35 \pm 7.934	110.275 \pm 16.246	0.0001*
Systolic (mmHg)	120 \pm 8.623	118 \pm 6.375	0.078**
Diastolic (mmHg)	80.375 \pm 8.943	80.213 \pm 3.978	0.102**
Mean arterial pressure (mmHg)	65.882 \pm 6.937	66.243 \pm 7.140	0.091**
RR interval	0.809 \pm 0.101	0.793 \pm 0.101	0.0189
Mean QT	0.366 \pm 0.016	0.337 \pm 0.022	0.0001*
QTc	0.408 \pm 0.020	0.380 \pm 0.019	0.0001*

*Highly significant, **Insignificant

Discussion

The primary intent of the study was to ascertain the effect of normal variations in blood glucose levels during fasting on QT interval and the corrected QT Interval that is QTc in healthy subjects.

Increased QTc, is seen in chronic heart failure²², peripheral vascular disease²³, hypertension²⁴, hypertrophic cardiomyopathy²⁵ and myocardial infarction²⁶. The physiological determinants of QT interval include age²⁷ and sex^{28,29}. Our exclusion criterion was designed to rule out all these causes of QT prolongation. The study was performed on a specified age group of 18-22 years old individuals including both females and males.

In a normal person, with heart rate of 75 beats/min, it varies from 0.35-0.40 seconds. In our study mean QT interval was 0.337 \pm 0.022. The QT interval increased during fasting to an average of 0.366. Although within physiological limits, this increase of QT interval is an important finding, and whether this increase of QT interval is harmful or even causes ventricular arrhythmias in cardiac patients, should be studied later. When we corrected the QT Interval for heart rate, the interval was still prolonged but less as compared to QT.

After 12 to 15 hours of fasting, hepatic glycogen stores are greatly depleted and continuing enhancement of gluconeogenesis fills the void. Much of this pattern of adaptation is mediated by hormonal modification, particularly by decreasing insulin production and by increasing glucagons production. Hypoglycemia exerts haemodynamic effects through stimulation of the autonomic nervous system as well as through systemic release of catecholamines³⁰.

Prolongation of QTc interval during fasting support the idea that ventricular repolarization may be changed during fasting. It has been reported that increase in QTc interval may be due to acidosis and decrease of bicarbonate ion or hypoglycemia, which may all cause a decrease in outward current during repolarization period. However confirmation of this hypothesis needs further investigations. In the presence of hypokalemia and raised serum catecholamines, often present during hypoglycaemia, cardiac repolarization could be prolonged enough to induce cardiac arrhythmias³¹. It is well recognised that potassium depletion leads to increased QTc interval length and to arrhythmogenesis with increased likelihood of development of ventricular dysrhythmia such as torsade de pointes^{32,33}.

RR-intervals were also longer during fasting in contrast to control electrocardiograms but this was not statistically significant. This finding shows that relative bradycardia may occur during fasting.

So, fasting prolongs QT Interval and QTc but within the physiological limits. This is evident from our study when dealing with healthy individuals. Diabetic patients who suffer from hypoglycemic episodes can show exaggeration of this phenomenon that is prolongation of the QT Interval and QTc beyond the physiological limits and

end up with fatal arrhythmias. This warrants another study in which controlled insulin clamps may be used in healthy individuals to create hypoglycemia and associate it with blood electrolytes and hormonal levels.

Conclusion

We conclude that in normal healthy individuals, there is a significant prolongation of QT interval and QTc during fasting but within physiological limits.

Study limitations: Limitations of the present study are that the QT measurements were obtained manually and from a relatively small sample of subjects and need to be confirmed in other racial groups.

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