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QT Correction Formulas and Laboratory Analysis on Patients with Metabolic Syndrome and Diabetes

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AIMS OF THIS WORK

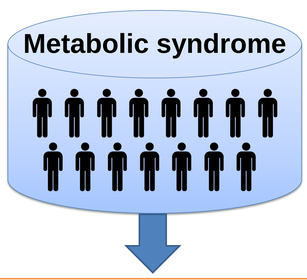
To study the ventricular action potential duration in diabetic and metabolic syndrome (MS) subjects through the analysis of the QT interval corrected by four well-known formulas: Bazett, Fridericia, Framingham and Hodges. Also, to evaluate and compare the level of blood glucose, cholesterol and triglycerides in these populations

BACKGROUND

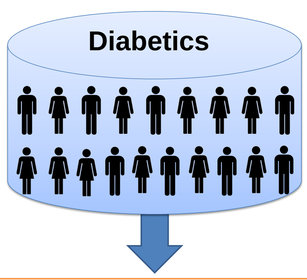
- The MS is a pre-diabetic condition of diabetes (a high prevalence metabolic disease)
- On the ECG, the QT interval represents the duration of the ventricular depolarization and repolarization and is an indirect measure of ventricular action potential duration
- The QT interval is not constant and varies inversely with the heart rate, therefore it must be corrected for heart rate

METHODOLOGY

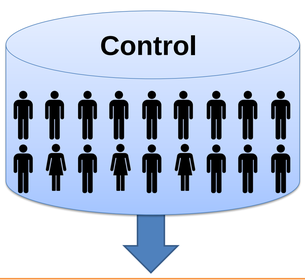
DATA BASES



15 subjects (15 men) 41.95 ± 13.66 years old, non-smoker, without drug treatment, and cardiovascular diseases



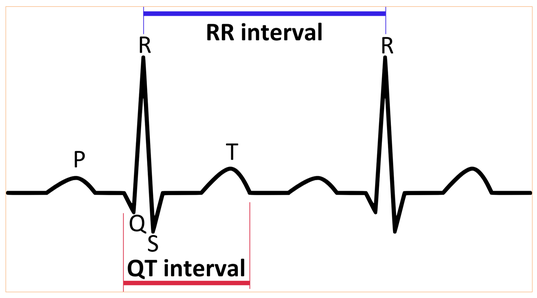
19 subjects (8 men) with type 2 diabetes, 56.44±9.60 years old, with cardiovascular diseases



18 healthy subjects (15 men), 31.40 ± 6.98 years old, without cardiovascular or neurological disease history

12 lead ECG signal, blood glucose, cholesterol and triglycerides were taken for each subject

ECG FEATURE EXTRACTION



- ECG segmentation through a wavelet transform approach
- QRS complex and T wave were detected and delineated
- QT interval measurement: First Q-wave detected in any lead paired with the last T end found
- RR interval measurement: time elapses between successive R-waves

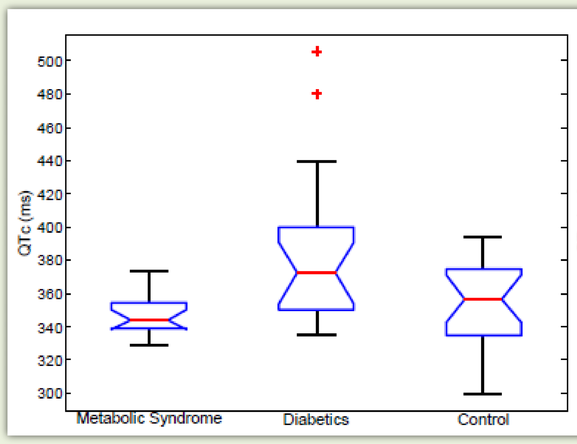
CORRECTING THE QT INTERVAL

$$\mathrm{QT}_{\mathrm{Bazett}} = \frac{\mathrm{QT}}{\sqrt{\mathrm{RR}}} \qquad \mathrm{QT}_{\mathrm{Framingham}} = \mathrm{QT} + 0.154(1 - \mathrm{RR})$$

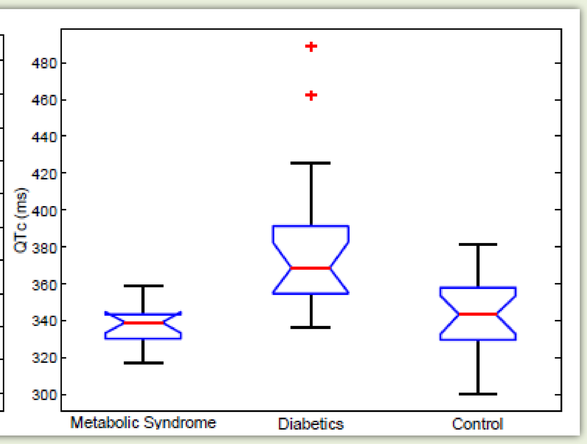
$$\mathrm{QT}_{\mathrm{Fridericia}} = \frac{\mathrm{QT}}{\sqrt[3]{\mathrm{RR}}} \qquad \mathrm{QT}_{\mathrm{Hodges}} = \mathrm{QT} + 105\left(\frac{1}{\mathrm{RR}} - 1\right)$$

RESULTS OBTAINED

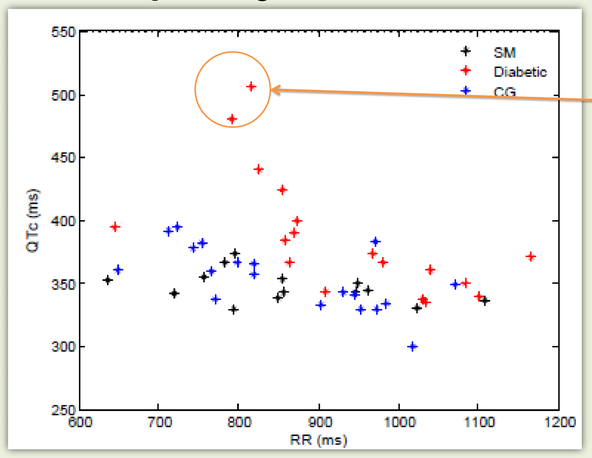
QTc interval determined using Bazett



QTc interval determined using Fridericia



QTc using Bazett vs RR



Two subjects with long QTc interval were medicated for hypertension and hypothyroidism (a condition that increases the QT interval)

MS and control subjects have the similar QTc length

Diabetics subjects present a longer QTc compared to MS and control subjects

- QTc is longer in diabetic subjects ($p < 0.01$)
- MS subjects present few dispersion in the QTc interval
- Hodges' QT correction formula gives the lowest dispersion in diabetic and MS subjects
- RR interval was most correlated to QTc calculated using Bazett and Framingham formulas (r=-0.3348 and r=0.2029) whereas it was less correlated using Fridericia and Hodges formulas (r = -0.0971 and r = -0.1449).

Parameter	Control	MS	Diabetic
Glucose (mg/dL)	93.63 ± 7.24	105.66 ± 7.67	140.78 ± 57.94
Cholesterol (mg/dL)	171.11 ± 36.72	201.20 ± 42.34	180.67 ± 55.25
Triglycerides (mg/dL)	108.84 ± 57.38	223.80 ± 89.24	166.17 ± 65.64

Significant differences between groups for triglycerides and glucose levels were observed: MS subjects have triglycerides values higher than diabetic subjects, probably because diabetics take medication for triglyceride regulation

CONCLUSIONS

Results showed that the four correction formulas give an acceptable value of QTc. However, we consider that Fridericia's formula is the most suitable for diabetic and metabolic syndrome subjects as it presents the lowest correlation coefficient with RR

Metabolic syndrome subjects have normal QTc interval, despite QT interval variability presents significant difference between metabolic syndrome and control subjects

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