

Heart rate–corrected QT interval duration is significantly associated with blood pressure in Chinese hypertensives

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Abstract

Introduction: Many studies demonstrated that a prolonged heart rate–corrected QT interval (QTc) increases the risk of malignant ventricular arrhythmias and sudden death.

Methods: We measured the electrocardiogram and blood pressure of 1480 hypertensive patients and assessed the relationship between the length of QTc and blood pressure.

Results: The mean QTc is longer in female than in male participants. There was a positive association between QTc and blood pressure in both men and women. The estimated increase in systolic and diastolic blood pressure for each 100-millisecond increase in QTc was 6.4 and 5.0 mm Hg in men and 3.7 and 2.5 mm Hg in women, respectively.

Conclusion: Our study demonstrated a significant positive relationship between the QTc interval and baseline blood pressure in a Chinese hypertensive population.

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Keywords:

Essential hypertension; QTc interval; ECG; Blood pressure; Association; Epidemiology

1. Introduction

The QT interval represents the duration of ventricular depolarization and subsequent repolarization. Clinical studies have shown that long QT intervals predispose people to malignant ventricular arrhythmias and sudden death [1]. Prolongation of the QT interval may be a consequence of an unfavorable balance between sympathetic and parasympathetic activity. It has been noted that imbalance in cardiac autonomic function (increased or decreased sympathetic activity) shortens or prolongs the QT interval of the

electrocardiogram (ECG). Because QT interval is dependent on heart rate, it is typically adjusted using Bazett formula: $QTc = QT/RR^{1/2}$.

Although some studies indicated a correlation between QTc interval and blood pressure levels, their relationship is poorly understood. Karjalainen et al [2] studied 11 026 Finnish subjects aged 30 to 59 years and found that both systolic blood pressure (SBP) and diastolic blood pressure (DBP) were associated with nomogram-corrected QT (QT_{Nc}) in both men and women. Schouten et al [3] studied 3091 middle-aged, apparently healthy servants in The Netherlands and found that DBP was significantly associated with QTc in both sexes. Pontiroli et al [4] found that obesity and arterial hypertension resulted in prolonged QTc intervals. QTc also correlated positively with SBP and DBP in patients with type 2 diabetes [5]. There is a

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significant association between the QTc interval and SBP among very old (>80 years) Japanese hypertensive subjects [6]. In addition, previous reports have consistently shown a sex difference in the length of the QTc interval. In a study conducted on a sample of 23 female and 20 male healthy volunteers, Burke et al [7] found that the baseline QTc interval tended to be longer in women than in men. In a sib-pair study of normal dizygotic twins, Busjahn et al [8] also found that women had a longer QTc interval than men. No study has been conducted on a Chinese hypertensive population.

In this report, we investigated the relationship between QTc interval duration and baseline SBP and DBP using a population-based Chinese hypertensive cohort from a large-scale pharmacogenetic study.

2. Materials and methods

2.1. Study site and population

The study was carried out in Huoqiu and Yuexi counties, Anhui province, China from July 2000 to May 2001. Hypertensive patients willing to participate in the study provided a written consent. The institutional review board of Anhui Medical University and Harvard School of Public Health approved the study procedures. Subjects meeting the following criteria were enrolled: (1) DBP of 90 to 120 mm Hg, SBP of 140 to 200 mm Hg, or both, on 3 separate occasions; (2) 21 to 65 years of age; and (3) residence in Houqiu or Yuexi County for at least 2 years. To avoid misclassification and severe adverse response, we excluded patients who (1) were diagnosed with secondary hypertension; (2) received antihypertensive treatment or had taken others drugs within 2 weeks; (3) had a body mass

index greater than 33 kg/m²; or (4) had been diagnosed with another severe disease or disorder. Consented hypertensive patients were invited to our study center at 8:00 AM the next day after an overnight fasting.

2.2. Blood pressure measurements

Supine blood pressures were measured at approximately 9:00 AM after 60 minutes of resting in the supine position. No alcohol, cigarettes, coffee or tea were consumed during the 60 minutes before the measurements. Blood pressure was measured using the previously described method [9].

2.3. Questionnaire

After the measuring blood pressure, a structured baseline questionnaire was administered by trained interviewers. They interviewed all enrolled patients and collected information including sociodemographic characteristics, occupation, education, age, sex, cigarette smoking, alcohol consumption, and so on.

2.4. Electrocardiography

Standard resting 12-lead ECG recording was performed on each participant. Because the “T” wave was most unambiguously defined at S₂, QT and RR intervals were read from the S₂ lead. The beginning of the QT interval was defined as the first deflection of the QRS complex and the end as the intersection of the descending part of the T wave with the isoelectric line [10]. All QT intervals were measured by trained and certified technicians.

2.5. Statistical analysis

SAS 6.12 (SAS Institute, Inc, Cary, NC) and Splus 2000 Professional (Mathsoft Inc, Cambridge, Mass) were used in data management and analysis. The primary independent variable, QTc, was defined as the ECG QT interval over the square root of the RR interval (in seconds). A total of 1689 hypertensive patients (Huoqiu 1190 and Yuexi 499) were invited to participate in this study. We excluded 209 subjects (Huoqiu 136 and Yuexi 73) because they did not take the ECG measurement or their QTc interval was outside the range of mean \pm 2.58 SD. Therefore, 1480 subjects were included the analysis. We investigated the differences in the means and prevalences of sociodemographic and clinical characteristics by sex using both Student *t* tests (for continuous variables) and χ^2 tests (for categorical variables). We used ordinary linear regression to model the association between baseline blood pressure and QTc. In the multiple linear regression model, we adjusted important covariates including age, age², weight, weight², height, height², alcohol consumption and smoking status, occupation, educational status, sex, and county of residence. In addition, we equally divided the entire sample into 4 categories according to QTc quartiles: Q1: 0.291 to 0.385 seconds, Q2: 0.385 to 0.406 seconds, Q3: 0.406 to 0.425 seconds, and Q4: 0.425 to 0.518 seconds. Then we plotted the mean blood pressure and 95% confidence interval (CI) for each category. The QTc

Table 1
Clinical characteristics of study cohort

Category	Men (n = 701)	Women (n = 779)	P
Age (y)	47.7 \pm 8.3	47.4 \pm 7.3	.4442
Height (cm)	166.6 \pm 6.2	156.1 \pm 5.6	<.0001
Weight (kg)	66.9 \pm 11.5	60.1 \pm 10.1	<.0001
Baseline SBP (mm Hg)	149.7 \pm 18.0	154.9 \pm 16.5	<.0001
Baseline DBP (mm Hg)	95.2 \pm 10.1	93.9 \pm 9.2	.0135
QTc interval (s)	0.40 \pm 0.03	0.42 \pm 0.03	<.0001
Education (illiterate)	512 (73)	682 (87.5)	<.0001
Occupation (farmer)	222 (31.7)	554 (71.1)	<.0001
Current smokers	336 (47.9)	32 (4.1)	<.0001
Former smokers	79 (11.3)	14 (1.8)	<.0001
Current alcohol drinkers	345 (49.2)	29 (3.7)	<.0001
Former alcohol drinkers	44 (6.3)	27 (3.5)	.01619
Huoqiu County	507 (72.3)	547 (70.2)	.40291

Values are expressed as mean \pm SD or number (%).

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