

RESEARCH ARTICLE

Evaluation of corrected QT interval in hypertensive and normotensive subjects of Andhra Pradesh, India

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Received: February 19, 2019; Accepted: March 14, 2019

ABSTRACT

Background: Hypertension being a significant cause of morbidity and mortality worldwide demands research. Left ventricular hypertrophy which is one of its complications may lead to fatal arrhythmias and sudden death. Corrected QT interval (QTc) obtained from electrocardiogram (ECG) may be used to screen high-risk hypertensive patients. **Aims and Objectives:** The aims of the study were to evaluate the QTc interval of hypertensive cases and normotensive controls, also to study the gender differences in QTc interval among hypertensive and normotensive groups, and further to explore the correlation of QTc interval with systolic BP (SBP) and diastolic BP (DBP). **Materials and Methods:** A total of 50 hypertensive cases and 50 normotensive controls in the age group 35–45 years were the subjects. Blood pressure (BP) was recorded thrice with 2 min interval, and the average was considered for analysis. A standard 12-lead ECG was recorded, and QT and RR interval was measured. QTc interval in seconds was calculated using Bazett's formula. Unpaired-Samples *t*-test and Pearson's correlation were used to analyze the data. **Results:** QTc interval was significantly longer in the hypertensive group when compared to normotensives. It was also significantly longer in hypertensive females when compared with hypertensive males. However, there was no significant difference among normotensive males and females. Further, QTc interval was positively and significantly correlated with both SBP and DBP. **Conclusion:** QTc interval being a cheaper, non-invasive ECG parameter may be used in detecting ventricular repolarization defects in hypertension and should not be neglected especially in developing countries like India. This would help in risk stratification and prognosis of hypertensive patients and prevention of fatal arrhythmias and sudden cardiac death.

KEY WORDS: Corrected QT Interval; Systolic Blood Pressure; Diastolic Blood Pressure; Hypertensive; Normotensive

INTRODUCTION

Hypertension is a pan-endemic global health challenge. It is an important leading cause of morbidity and mortality worldwide, especially in developing nations like India.^[1] It

has been suggested that one in three individuals are prone to develop hypertension in India.^[2] One of its complications is left ventricular hypertrophy which can cause ventricular repolarization defects. These defects if present can be easily detected using electrocardiogram (ECG) parameters like QT interval.

QT interval is the duration from the beginning of Q wave up to the end of T wave in a simple standard ECG. It reflects the ventricular complex, i.e., both ventricular depolarization and ventricular repolarization. The QT interval is influenced by heart rate. Corrected QT (QTc) interval is obtained by Bazett's formula. QT interval is prolonged due to autonomic

Access this article online	
Website: www.njppp.com	Quick Response code 
DOI: 10.5455/njppp.2019.9.0307714032019	

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dysfunctions between sympathetic and parasympathetic supply to the heart, the parasympathetic being protective against the prolongation of QT interval.^[3] Prolonged QTc can lead to fatal cardiac arrhythmias.^[4] Females are shown to have a longer QT interval than males, making them more susceptible to cardiac arrhythmias.^[5] Subjects with hypertension and consequent left ventricular hypertrophy are more susceptible to sudden cardiac death (SCD). Thus, QT interval could play a key role in screening hypertensive patients.^[6]

The present study tries to explore if there is any statistically significant difference in the QTc interval among hypertensive and normotensive subjects,^[7] thereby enabling us to understand the screening and prognostic role of this non-invasive marker.^[8] Furthermore, the present study is to determine if the QTc interval is correlated to blood pressure (BP).^[9] The relationship between QTc interval and BP has not been sufficiently elucidated.^[10] Further, the present study tries to compare the QTc intervals among males and females. There is a paucity of information regarding this from the South Indian population. Due to increased cardiovascular deaths, it necessitates research on hypertension and we believe this to be the first study of this nature in this region.

Aim

The aim of the study was to evaluate the QTc interval of hypertensive and normotensive subjects in the age group of 35–45 years belonging to Andhra Pradesh, India.

Objectives

The objectives are as follows:

- To investigate whether there is a statistically significant difference in the QTc interval among hypertensive and normotensive subjects.
- To explore whether there is a statistically significant difference in QTc interval among hypertensive males and hypertensive females and normotensive males and normotensive females.
- To study the correlation of QTc interval with systolic BP (SBP) and diastolic BP (DBP).

MATERIALS AND METHODS

Study Design and Study Type

The present study is a cross-sectional case-control study. The study was conducted at our institute hospital. The study included 50 willing hypertensive subjects according to the JNC8 guidelines for management of hypertension, and 50 willing control subjects with normal BP. The cases and controls were randomly selected from the people visiting our institute hospital. The controls were mainly the institute's staff members and relatives of patients.

Inclusion Criteria

SBP >140 mm of Hg and/or DBP > 90 mm of Hg or those taking BP lowering medications were considered to be hypertensive cases. The cases were on regular anti-hypertensive treatment. With the treatment, if the BP was under control, they were still considered as hypertensive cases. The controls were those who had their SBP <140 mmHg and DBP <90 mmHg and were never earlier diagnosed as hypertensive nor were under any anti-hypertensive medications. All participants belonged to the age group of 35–45 years to reduce the presence of confounding factors and diseases. Both men and women were included in the study. The hypertensive cases and normotensive controls were age- and sex-matched.

Exclusion Criteria

Subjects who were smokers, alcoholics, tobacco chewers, and diabetics, those with a history of myocardial infarction, pulmonary embolism, stroke, and peripheral vascular disease were excluded from the study. Cases that were on irregular anti-hypertensive treatment and cases and controls who were on medications which would prolong QT interval were also excluded from the present study.

The Institutional Ethical Committee approval and written informed consent from the subjects were obtained. Further, it was explained to the subjects the nature and purpose of the study and that their confidentiality would be maintained.

Methodology

History was gathered from all the participants who later underwent anthropometric measurements and thorough general clinical examination. Later, the analytical data were collected from them.

BP was recorded using a mercury sphygmomanometer from the participants after a 10 min rest period in the supine position. BP was recorded using a mercury sphygmomanometer. The subject was lying down (supine) and physically and mentally relaxed. In the supine position, with the arm resting on the bed, the BP apparatus, and the arm to be wrapped by the cuff are all at the level of the heart. The cuff was placed over the arm of the subject and wrapped around firmly with its lower edge about 3 cm above the elbow. First, the palpatory method was used to record the SBP. The reappearance of the radial pulse was taken as the approximate SBP. Then, the auscultatory method was performed. The level of mercury at which the first Korotkoff sound (clear, sharp, and tapping phase I) is heard is taken as the SBP. The reading at disappearance or muffling (phase V or phase IV) of Korotkoff sound was taken as DBP. It was repeated for 3 times with 2 min interval in between, and the average was considered for analysis.

A resting ECG was obtained from the subjects using a 12-lead electrocardiograph. Lead-II was used to measure the QT interval and RR interval. The resting supine subjects each had to undergo 12-lead standard ECG recording according to universal norms. Since the lead II had the most unambiguous T wave, QT interval and RR interval were determined from the lead II ECG strip.^[3] Lead II ECG recording with minimum of 10 waveforms was used. The interval from one R wave peak to the next successive R wave peak gives the RR interval. QT interval was estimated by the tangent method. It is the interval from the beginning of Q (or R wave) to the end of T wave. A tangent is drawn along the steepest slope of the last limb of the T wave, and the intersection of the tangent with the baseline defines the end of the QT interval. Moreover, QTc in seconds was obtained by correcting the QT interval for heart rate using the Bazett's formula.^[3]

$$\text{Bazett's formula: } \text{QTc} = \text{QT}/\text{RR}^{1/2}$$

For heart rate <60 bpm, QT interval was not corrected using Bazett's formula. QTc was considered to be abnormally prolonged when it was >450 ms in males and > in females.^[11]

The data were analyzed using the Statistical Package for the Social Sciences (SPSS 20). Continuous data are represented as mean $\pm$ Standard deviation (SD). Conventional test value of $P < 0.05$ was considered as statistically significant. The statistical tests used are independent groups *t*-test and Pearson's correlation.

RESULTS

The measured anthropometric parameters of the subjects are presented in Table 1. The data are represented as mean $\pm$ SD. The hypertensive and normotensive subjects were age- and sex-matched.

The SBP, DBP, and QTc interval were significantly higher in the hypertensive group than the normotensives. None of the subjects had abnormally prolonged QTc interval (>450 ms in males and >460 ms in females) [Table 2].

The QTc interval of the hypertensive females was significantly longer than that of hypertensive males. However, there was no significant difference between the QTc interval of female and male normotensive groups and between total male and female subjects [Table 3].

The QTc interval was positively and significantly correlated with both SBP and DBP [Table 4].

DISCUSSION

The present study revealed a statistically significant difference for QTc interval among hypertensive cases and normotensives controls. QTc interval was significantly longer in hypertensive females than males, though there was no gender difference among normotensives. We also found a positive correlation between QTC with both SBP and DBP.

Table 1: Measured data of hypertensive cases and normotensive controls

Measured parameters	Hypertensive cases (n=50)	Normotensive controls (n=50)	P-value
Age (Y)	47.8 $\pm$ 5.5	46.9 $\pm$ 4.6	0.3769
Males (n)	25	25	
BMI	28.1 $\pm$ 5.8	25.2 $\pm$ 4.8	0.0076*
WHR	0.98 $\pm$ 0.13	0.89 $\pm$ 0.09	0.0001*
Heart rate from ECG (bpm)	86.3 $\pm$ 11.2	79.3 $\pm$ 14.9	0.0092*

* $P < 0.05$ =Statistically significant. BMI: Body mass index, WHR: Waist-hip ratio, ECG: Electrocardiography

Table 2: Comparison of SBP and DBP and QTc interval of hypertensive cases and normotensive controls

Measured variable	Hypertensive cases (n=50)	Normotensive controls (n=50)	P-value
Systolic BP (mm Hg)	153.84 $\pm$ 19.82	117.8 $\pm$ 6.61	<0.0001*
Diastolic BP (mm Hg)	95.2 $\pm$ 9.31	75.2 $\pm$ 8.06	<0.0001*
QTc interval (ms)	381.71 $\pm$ 23.78	360.94 $\pm$ 20.27	<0.0001*

* $P < 0.05$ =Statistically significant. BP: Blood pressure, QTc: Corrected QT interval, DBP: Diastolic blood pressure, SBP: Systolic blood pressure

Table 3: Comparison of QTc intervals of male and female participants

QTc interval	Males	Females (n=25)	P-value
Hypertensive cases	374.71 $\pm$ 21.39 (n=25)	388.71 $\pm$ 24.03 (n=25)	0.0345*
Normotensive controls	361.93 $\pm$ 18.96 (n=25)	359.86 $\pm$ 21.41 (n=25)	0.7190
Total (both groups)	368.32 $\pm$ 21.20 (n=50)	374.29 $\pm$ 26.94 (n=50)	0.2211

* $P < 0.05$ =Statistically significant. QTc: Corrected QT interval

Table 4: Correlation of QTc interval with BP

BP	Correlation coefficient (R value)	P-value
SBP	0.303	0.002*
DBP	0.324	0.001*

* $P < 0.05$ = Statistically significant. BP: Blood pressure, QTc: Corrected QT interval, DBP: Diastolic blood pressure, SBP: Systolic blood pressure

Earlier studies have established prolonged QTc to be an indicator of increased morbidity and mortality among hypertensive cases as well as normotensive controls.^[12] The lasting impact even in under control hypertensive cases such as left ventricular hypertrophy has the potential to cause fatal arrhythmias and sudden death.^[13] Our study is in line with earlier studies which reported significantly prolonged QTc interval in hypertensive cases when compared to normotensives.^[6] Another study concluded that hypertension and left ventricular hypertrophy were both associated with a prolonged QTc interval.^[14] Further, the present study's positive significant correlation of QTc interval with SBP and DBP is similar to a previous study that reported that the SBP, DBP, and MAP had a significant correlation with QTc interval.^[15] Hypertension leads to cardiovascular autonomic imbalances. The increased sympathetic activity results in QTc prolongation, whereas parasympathetic activity shields against QTc are lengthening. It is also suggested that left ventricular hypertrophy due to hypertension results in prolonged repolarization and QTc lengthening.^[16-18] Our study's gender difference in QTc interval is similar to an earlier study showing significant longer QTc intervals in hypertensive females than hypertensive males.^[3] However, several other studies reported longer QTc intervals even in healthy females than healthy males.^[19-21] Castrated men were found to have longer QTc interval, whereas virilized women had shorter QTc interval.^[19] Men after puberty were found to have shorter QTc interval.^[20] It is suggested that sex hormone differences result in differences in QTc intervals between males and females. The present study is unlike these studies as we report differences in QTc intervals of normal females and normal males, and total females and total males to be statistically insignificant. We infer that sex hormonal differences play a more vital role only among hypertensive females and hypertensive males.

The present study is a cross-sectional study and hence is inconclusive. The number of subjects in our study is small to give a decisive result. Thus, a longitudinal study with a considerably larger sample size would better support our results. Hypertension has several confounding factors which need further investigation. The antihypertensive therapy and the number and combination of drugs used by the hypertensive subjects may differ and alter the QTc interval.

CONCLUSION

Our study establishes the significantly higher levels of QTc intervals in hypertensive subjects when compared

to normotensive subjects and also reports the positive association between QTc interval with both SBP and DBP. Thus, this easily available ECG parameter should be given its due credit especially in developing countries like India where they have been conventionally neglected. It is cheaper, the non-invasive measure which is available even to the general practitioners and its significance should be appreciated. It is proposed that this parameter can be used to assess hypertensive patients and identify high-risk groups. Thereby, this would help in preventing hypertension related life-threatening complications such as cardiac arrhythmias and SCDs. Thus, QTc interval from ECG would help in screening, risk assessment and risk stratification, management, and prognosis of hypertensive patients.

ACKNOWLEDGMENTS

The authors would like to thank the Department of Physiology of Nimra Institute of Medical Sciences, Vijayawada, Andhra Pradesh, India, for their support and guidance. The authors also acknowledge the subjects who participated in the study.

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How to cite this article: Karthik M, Venkateswarlu V. Evaluation of corrected QT interval in hypertensive and normotensive subjects of Andhra Pradesh, India. *Natl J Physiol Pharm Pharmacol* 2019;9(6):476-480.

Source of Support: Nil, **Conflict of Interest:** None declared.