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Original Article

QT Interval Parameters: A Screen Test for the Detection of Left Ventricular Hypertrophy

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ABSTRACT

Background: Electrocardiographic parameters for the detection of left ventricular hypertrophy (LVH) as an independent cardiovascular risk factor and signifier end-organ damage in patients with hypertension are known. The aim of this study was to evaluate the relation between QT interval parameters and LVH in patients with hypertension.

Methods: This cross-sectional study recruited 100 patients with primary hypertension who underwent cardiac echocardiography for the evaluation of left ventricular mass (LVM). Standard 12-lead electrocardiography was performed for all the patients, and QT interval parameters (QT_{max}, QT_{cmax}, QT_d [dispersion], and QT_dF [difference between maximum and minimum QT intervals]) were calculated. The data were analyzed using SPSS (version 18). The *t*-test was applied to assess the relationship between QT parameters and left ventricular mass index (LVMI), and the receiver operating characteristic (ROC) curve was drawn to determine the cutoff point for the mentioned electrocardiographic test.

Results: The mean age of the patients was 60.52±9.74 years. The mean of QT_d, QT_{max}, and QT_{cd} in the patients with LVH was significantly greater than that of the patients without LVH ($P<0.05$). ROC curve analyses of QT interval parameters showed that the cutoff points for QT_{max}, QT_d, QT_{cmax}, and QT_{cd} values were 420 (specificity=0.79 and sensitivity=0.40), 50 (specificity=0.58 and sensitivity=0.76), 478 (specificity=0.29 and sensitivity=0.58), and 59 (specificity=0.65 and sensitivity=0.76), respectively.

Conclusions: According to our findings, QT_{cd} and QT_c would be better tests for the detection of LVH. We recommend further research with larger sample sizes to obtain more generalizable findings. ***(Iranian Heart Journal 2015; 16(4): 35-40)***

Keywords ■ Electrocardiography■ Hypertension ■ Left ventricular hypertrophy ■ QT interval

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Hypertension is a major public health concern the world over due to its high prevalence and significant complications such as heart disease and stroke.[1] It is the first and fourth leading cause of death in the United States and in Iran, correspondingly. Hypertension has a rising prevalence in the context of progressive increment in age and body mass index (BMI).[2,3] Indeed, the prevalence of hypertension increases approximately by 0.54% after the age of 20, and the overall prevalence of hypertension in Iran is considerable.[2,3] Hypertension affects the heart and arteries due to various mechanisms such as left ventricular hypertrophy (LVH), increasing the risk for sudden cardiac death and lethal arrhythmias. Arrhythmias occurring in patients with hypertension vary from supraventricular to ventricular tachyarrhythmias, affecting morbidity, mortality, and quality of life.[4,5] Risk indicators for the occurrence of arrhythmias in patients with hypertension include LVH, diminished heart rate variability, QT interval dispersion, and ventricular late potentials.[6] LVH is a strong independent cardiovascular risk factor for sudden death, but the leading cause of this event relevant to LVH is uncertain.[7] In experimental studies, LVH prolongs action potential duration and potentially causes arrhythmogenic ventricular repolarization abnormality. Indeed, LVH increases QT interval and QT dispersion (QT_d).[8,9] Routinely, surface 12-lead electrocardiography (ECG) has been used for the detection of LVH; it is, however, affected by a large number of extra-cardiac factors that interfere with the relationship between ECG voltage and left ventricular mass (LVM). Nevertheless, measuring QT interval can help detect LVH without any reported evidence of modification by such extra-cardiac factors.[10] In patients with hypertension, QT interval parameters are linked to LVM, but Chapman et al.[12] demonstrated that these parameters were no better than were simple voltage criteria for the detection of LVH.[11] Also, a previous study demonstrated an association between increased left ventricular mass index (LVMI) for body size and QT_d. Salles et al.[13] reported that QT_d prolongation was associated with LVH but neither QT_d, nor QT interval parameters had sufficient prognostic values for LVH screening. Accordingly, in this study, we investigated the prognostic value of QT interval parameters in relation to LVH.

METHODS

This study was a cross-sectional study of 100 consecutive patients recruited from the clinics of Dr. Heshmat Hospital after the consideration of one of the following exclusion criteria and suspected LVH on ECG. The exclusion criteria comprised underling disorders such as renal failure, renovascular hypertension, diabetes mellitus, thyroid disorder, cancers, hyperaldosteronism, pheochromocytoma, or coarctation of the aorta. The other factors leading to exclusion from the study were comprised of having no family history of hypertension, having mental disorders, overusing non-antihypertensive drugs, malignant or resistant hypertension, stroke in the previous 6 months, abnormal electrolytes, anemia, cardiopulmonary disease (chronic lung disease and sleep apnea), serum creatinine >140 µmol/L, and taking medications that can increase QT_C (antiarrhythmic, antibiotics, macrolides, quinolones, and some antipsychotic and antidepressants).[14] Patients with hypertension were those with blood pressure ≥140/90 mm Hg measured 3 times with the same mercury sphygmomanometer with 5-minute intervals in the sitting position.

Standard resting 12-lead ECGs were recorded with the same equipment with response frequencies at 25 mm/s paper speed and 10 mm/mv amplitude (Fukuda M-E Gardisuny). Electrocardiographic voltage criteria for LVH were either Sokolow–Lyon (SV1+RV5 or V6 ≥3.5 mV) or Cornell sex-specific (SV3+

RaVL ≥2 mv in women or 2.8 mv in men). QT interval parameters were measured manually in every ECG lead that was possible, with a minimum of 8 leads and 3 precordial ones being necessary. QT intervals were measured from the beginning of QRS complex to the end of T wave, defined as the visual return to TP baseline or as the nadir between T and U waves. Four QT interval parameters were obtained: maximum QT interval duration (QT_{max}), maximum Bazett formula heart rate corrected QT interval (QT_{cmax}), QT interval dispersion (QT_dF: difference between maximum and minimum QT intervals), and rate-corrected QT dispersion (QT_{cdF}: difference between maximum and minimum QT_c intervals).

All the subjects underwent transthoracic M-mode, 2-dimensional, and Doppler echocardiography using a MyLab 50 Vision (with a 3.5-MHz transducer) instrument by the same cardiologist. Echocardiography recordings were performed in the parasternal long-axis plane. Measurements including LVM and LVMI were made according to the guidelines stipulated by the American society of Echocardiography (ASE).[15] LVH was considered present when either one of the following echocardiographic values was obtained: male LVMI ≥115 g/m^2 and female LVMI ≥95g/m^2.[16]

Data were collected and analyzed using descriptive statistics (frequencies, percentages, means, and standard deviations) and analytical statistics (Kolmogorov–Smirnov test to determine data normal distribution, chi-square correlation, Fisher exact test, *t*-test, and ROC curve analyses) in SPSS (version 18) with 95% confidence intervals and test power of 90%. A P value <0.05 was considered significant in all the tests.

This study was approved by the Ethics Committee of the Research Deputyship in Guilan University of Medical Sciences. Written informed consent was obtained from all the subjects at the beginning of the study. All the subjects were informed about the voluntary nature of participation and were assured about the confidentiality of their personal information.

RESULTS

One hundred patients with hypertension were included in this survey. Eighty-six (86%) patients had LVH according to the echocardiographic findings. Table 1 shows the baseline characteristics of the study population. The patients with LVH had a greater mean weight, waist measurement, and systolic blood pressure, while the patients without hypertrophy had a greater mean BMI and heart rate. The correlations between QT interval parameters and echocardiographic measurement are shown in Table 2. The 3 dispersion parameters (QT_d, QT_{cmax}, and QT_{cd}) had significant associations with LVH (P<0.05), and the ROC curves analyses of QT interval parameters showed that the cutoff points for QT_{max}, QT_d, QT_{cmax}, and QT_{cd} values were 420 (specificity=0.79 and sensitivity=0.40), 50 (specificity=0.58 and sensitivity=0.76), 478 (specificity=0.29 and sensitivity=0.58), and 59 (specificity=0.65 and sensitivity=0.76), respectively. These analyses showed that QT_d was a better test for the detection of LVH (Figure1 and Figure 2).

Table 1. Comparison of the demographic variables among the patients in relation to having hypertrophy

Variables	With Left Ventricular Hypertrophy (mean± SD)	Without Left Ventricular Hypertrophy (mean±SD)	P Value
Age	60.55±9.97	60.28±8.52	0.923
Weight	71.83±12.99	66.92±11.05	0.185
Height	157.24 ±10.83	156.42±7.33	0.787
Waist measurement	87.16±16.99	76.28 ±17.35	0.029*
Body mass index	4.8 ±29.02	5.61±27.56	0.305
Systolic blood pressure	173.3 ±17.47	166.07 ±25.43	0.186
Diastolic blood pressure	96.86 ±16.88	96.42±8.41	0.925
Heart rate	70.08 ±10.1	75 ±13.41	0.302

*Significance level was set at P <0/05.

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Table 2. Comparison of QT interval parameters in relation to the left ventricular mass index from echocardiographic findings

Group	Left Ventricular Hypertrophy	N (%)	Mean±SD		T Value	P Value
			Male	Female		
QT_{max}	No	14 (14)	404±20.38	418±20.38	1.79	0.07
	Yes	86 (86)	412±57.15	428±57.15		
QT_d	No	14 (14)	52±22.82	67±22.82	4.52	0.001*
	Yes	86 (86)	87±39.08	97±39.08		
QT_{cmax}	No	14 (14)	430±21.66	459±21.66	5.59	0.001*
	Yes	86 (86)	485±58.99	515±58.99		
QT_{cd}	No	14 (14)	56±27.56	69±27.56	5.41	0.001*
	Yes	86 (86)	104±47.37	117±47.37		

* Significance level was set at P<0/05.

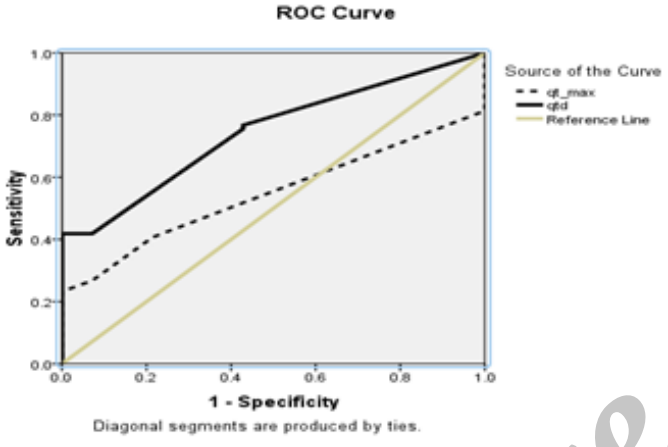

Figure 1. ROC curve for left ventricular hypertrophy prognosis regarding QT_{max} and QT_d values

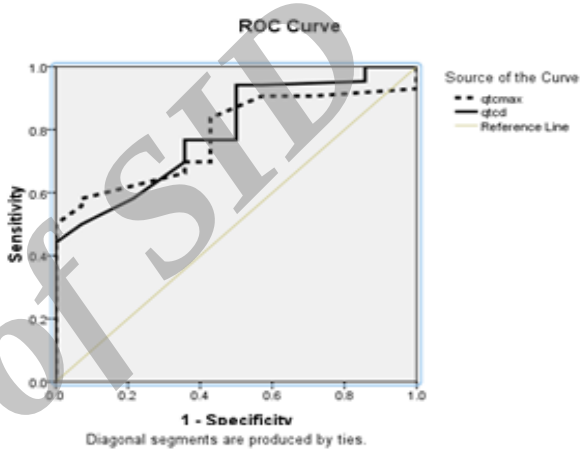

Figure 2. ROC curve for left ventricular hypertrophy prognosis regarding QT_{cmax} and QT_{cd} values

DISCUSSION

The ECG patterns of LVH are independent cardiovascular risk factors and end-organ damage signs in patients with hypertension. In this regard, ECG has a main role in the detection of LVH. Nonetheless, in some studies, ECG parameters suggesting LVH such as QT_d did not have sufficient prognostic performance. For instance, a screening method aimed at obtaining prognostic information in patients with arterial hypertension and its value still remains controversial.[14,17,18] Thus, we investigated the relation between QT interval parameters and LVH to clarify this issue. We found that the patients suffering from hypertension with LVH had greater QT_d and QT_{cd} means than did those who did not have hypertrophy and QT_d was a better test for the detection of LVH. Our results chime in with those reported by Izumi et al.,[16] who reported that QT_{cd} was significantly correlated with VMI and that QT_{cd} played a significant role in rising detectability of LVH with other indices. This prospective study was done on 153 unselected Japanese outpatients referring to a clinical physiology test department. Similar to this study, one of our main findings was that the cutoff point of QT_{cd} for the detection of LVH varied from that in other studies on Caucasians in Western countries, while our study—similar to the Izumi report—was done on Asians. Also, our findings are concordant with those reported by Dimopoulos et al.,[19] who assessed the prognostic value of QT_d in 108 patients with hypertension in Athens. The authors recognized that QT_d was an

independent prognostic risk indicator in elderly hypertensive and normotensive patients; however, their study had a small size and was performed on only elderly patients. Oikarinen et al.[8] evaluated a large number of patients with hypertension with LVH on ECG and showed that QT_d was a significant univariate predictor of mortality. Similar data were shown in the reports of Salles et al.[20] and Porthan et al.[21] The above data confirmed the results of our study vis-à-vis the relation between QT_d and LVH prognosis. In contrast to the aforementioned findings, some studies have reported no significant difference between QT_d value and LVH degree. Among this group of studies was one conducted by Kunisek et al.[11] on the effect of LVH type on QT interval in patients with hypertension. Nonetheless, in their study, patients with hypertrophic cardiomyopathy were not excluded and ECG interpretation was done manually. Salles et al.[13] demonstrated that increased QT interval dispersion was associated with LVM but in isolation neither QT_d nor any QT parameters presented enough predictive performance for LVH screening. It should be noted, however, that the majority of the participants in their study were diabetic and, as such, these results may not be applicable to the general population of hypertensives without diabetes mellitus.[13] First and foremost among the limitations of the present study are its cross-sectional design and small sample size. We recommend that future studies be performed with larger volumes and control groups. Be that as it may, our study is the first of its kind to investigate this topic in the north of Iran. With regard to the existing literature, our survey has this power to suggest that QT_d and QT_{cd} are useful parameters for LVH determination.

CONCLUSIONS

Our ECG findings concerning LVH revealed that QT parameters such as QT_{cd} and QT_c would be better tests for the detection of LVH. We would, therefore, suggest that these parameters be employed as a simple, noninvasive, and adjunctive test for the initial evaluation of LVH in the general population.

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Conflict of Interest

There is no conflict of interest.

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