Influence of left ventricular type on QT interval in hypertensive patients

Left ventricular hypertrophy (LVH) is a common cardiac adaptation for the increased afterload seen in patients with systemic hypertension. It is a strong risk factor for congestive heart failure, acute myocardial infarction, and cardiovascular mortality, including sudden death, independent of blood pressure (1-3). However, a large portion of deaths in patients with LVH can be sudden, likely due to polymorphic ventricular tachycardia (VT) leading to ventricular fibrillation (3, 4). LVH can increase the risk of ventricular arrhythmogenesis by several mechanisms, including dilatation of the ventricle, stress of the subendocardium, and impaired coronary reserve. Regression of ventricular hypertrophy has been found to be associated with decreased prevalence of ventricular arrhythmias.

A substudy of the LIFE study (Losartan Intervention For Endpoint Reduction), that included 577 patients free of overt coronary artery disease, showed that increasing echocardiographic left ventricular mass index was associated with prolongation of the corrected QT apex (onset of q wave to the peak of T wave) and QT end (onset of q wave to the end of T wave) intervals, even when adjusted for QRS duration in both men and women (5). The concentric and eccentric subsets of LVH were associated with increased QT interval duration and QT dispersion. Oikarinen et al. (6) reported in a substudy of LIFE, which included 317 patients, that regression of both echocardiographic and electrocardiographic LVH with antihypertensive therapy led to a decrease in the QT apex and QT end intervals. Increased LV mass index and LVH are associated with a prolonged QT interval and increased QT dispersion. The increase in these intervals may be associated with repolarization-related arrhythmias and might partly explain the increased risk of sudden death in hypertensive patients with increased LV mass. Increased QRS duration and maximum rate-adjusted QT apex interval were significant predictors of cardiovascular and all-cause mortality in another subset of the LIFE study (7). Electrocardiography has a good specificity for diagnosis of LVH, but its sensitivity is low compared to echocardiography. We recently reported that QTc interval was significantly and independently associated with sudden cardiac death among patients with LVH determined by echocardiographic criteria (1).

QT and QT apex dispersions were significantly higher in patients with hypertension compared to those without it, indicating possible heterogeneity in repolarization. Other ECG indices of heterogeneity, like complexity of T waves using principal component analysis, have been reported to be higher in patients with hypertrophic cardiomyopathy compared to controls (8). Prolonged QTC has been reported to be associated with a 2-fold increased risk of cardiovascular death in patients with uncomplicated hypertension (9).

In experimental studies, the increase in vulnerability to ventricular arrhythmias appears to be due to arrhythmogenesis related to repolarization. LVH is associated with prolongation of action potential duration (APD) due to downregulation of potassium channels responsible for repolarization (10). Prolongation of APD might occur in a nonhomogeneous manner, causing dispersion of repolarization (11, 12). There are several proposed mechanisms for repolarization changes in LVH, including changes in ion channels, interstitial fibrosis resulting in electrical uncoupling, myocardial ischemia, and increased wall stress (13). Prolongation of APD in isolated ventricular tissues has been found to be due to downregulation of potassium channels. Increased arrhythmogenicity has also been attributed to increased hyperpolarization-activated cyclic nucleotide gated channel activity in hypertrophied myocytes.

As mentioned above, polymorphic VT can occur in patients with LVH and can lead to sudden death. Although polymorphic VT may originate locally, transmural reentry results in the propagation of this arrhythmia (14). Transmural dispersion of repolarization (TDR) is one of the mechanisms proposed for the origin of such arrhythmias. This is due to the existence of cell types with different repolarization properties within the ventricular walls. Preferential prolongation of action potential duration in the subendocardium was associated with marked increases in TDR, especially at low pacing rates (15). Phase 2 EADs can originate in the absence of agents that prolong action potential duration in experimental models of the hypertrophied heart. Early after depolarization can be associated with "R on T" extrasystoles, which, when conditions permit, may give rise to polymorphic ventricular tachycardia (10). The prolongation of APD at the cellular level is expected to manifest as prolongation of QT interval and change in T wave morphology in the ECG.

The available data regarding the QTc prolongation, QT dispersion, and complex ventricular arrhythmias among the different subtypes of LH is scarce. The article by Kunisek et al. (11), titled "Influence of the left ventricular types on QT intervals hypertensive patients," published in this edition of Anatolian Journal of Cardiology, sheds light on this aspect of LVH and QT

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intervals. The authors identified patients with LVH (based on ECG and confirmed later by echocardiography) due to essential hypertension using rigorous inclusion and exclusion criteria. They classified these patients into 3 types: concentric (relative wall thickness >0.42, interventricular septum/left ventricular posterior wall ≤1.3), eccentric (left ventricular diameter in systole >32 mm, relative wall thickness <0.42), or asymmetric (interventricular septum/left ventricular posterior wall thickness >1.3). They also subdivided them into 3 subgroups depending on the severity of LVH: mild (interventricular septum or left ventricular posterior wall 11-12 mm), moderate (interventricular septum or left ventricular posterior wall 13-14 mm), and severe left ventricular hypertrophy (interventricular septum or left ventricular posterior wall ≥15 mm). A cardiologist measured the QT interval and QT dispersion. They also assessed the left ventricular mass index and the presence of ventricular arrhythmias utilizing the Lown classification system. The upper limit of normal for QT interval was considered 450 ms for men and 460 ms for women and 70 ms for QT dispersion. They found that the QT interval and dispersion were increased in patients with severe concentric and eccentric LVH but was not statistically significant. QT interval was significantly longer in patients with complex ventricular arrhythmias. They conclude that there is no significant association of QT intervals or dispersion with the type and degree of LVH. The corrected QT interval and QT dispersion increased proportionally to left ventricular mass only in the concentric and eccentric types of LVH.

This study is very informative and provides data about QT intervals and QT dispersion in patients with different subtypes of LVH in patients without coronary artery disease. As the authors point out, the failure to attain statistical significance of QTc in this study could have been because of the small number of patients with severe LVH.

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