The Romhilt-Estes left ventricular hypertrophy score and its components predict all-cause mortality in the general population

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Background The same electrocardiographic (ECG) criteria that have been used for detection of left ventricular hypertrophy (LVH) have recently been recognized as predictors of adverse clinical outcomes, but this predictive ability is inadequately explored and understood.

Methods A total of 14,984 participants from the ARIC study were included in this analysis. Romhilt-Estes (R-E) LVH score was measured from the automatically processed baseline (1987-1989) ECG data. All-cause mortality was ascertained up to December 2010. Cox proportional hazard models were used to examine the association between baseline R-E score, overall and each of its 6 individual components separately, with all-cause mortality. The associations between change in R-E score between baseline and first follow-up visit with mortality were also examined.

Results During a median follow-up of 21.7 years, 4,549 all-cause mortality events occurred during follow-up. In multivariable-adjusted models, increasing levels of the R-E score was associated with increasing risk of mortality both as a baseline finding and as a change between the baseline and the first follow-up visit. Of the 6 ECG components of the score, 4 were predictive of all-cause mortality (P-terminal force, QRS amplitude, LV strain, and intrinsicoid deflection), whereas 2 of the components were not (left axis deviation and prolonged QRS duration). Differences in the strengths of the associations between the individual components of the score and mortality were observed.

Conclusions The R-E score, traditionally used for detection of LVH, could be used as a useful tool for predication of adverse outcomes. (Am Heart J 2015;170:104-9.)

For most of the past half century, most research in the clinical use of the electrocardiogram (ECG) has been focused on finding a better method for detecting left ventricular hypertrophy (LVH). This search has not been very productive, and better imaging techniques, such as echocardiographic and magnetic resonance images, now provide a more precise and accurate assessment of LVH.

The Romhilt-Estes (R-E) score[1] was one of the early efforts to improve the ability of the ECG to detect increased LV mass and was developed before any imaging technologies other than radiography were available. It was based on earlier studies in which ECG tracings of autopsied patients and hemodynamic studies were analyzed for the presence or absence of ECG features previously proposed as indicators of increased LV mass.[2,3] The more "reliable" features as validated by these studies were then used in a point score system, proposed for the ECG diagnosis of LVH.

The R-E score assigned points for the presence of each of 6 ECG features. If a given ECG reached a total of 5 points, it was considered positive for LVH, and 4 points were considered as probable LVH. The R-E score proved to be more specific in predicting LV mass than previous systems, but the sensitivity was low, in the range of 60% in the original series of autopsied study patients.[1] Similar to all other ECG LVH criteria, attempts to improve sensitivity of R-E score proved fruitless, as each such modification led to an unacceptable increase in false-positives. The advent of and widely increased availability of imaging technology has made optimizing current ECG LVH criteria less relevant.

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This study aimed at the quantitation and better understanding of the prognostic significance of the ECG features of the R-E score as a predictor of all-cause mortality.

Methods

The population used for this analysis included 15,792 participants, aged 45 to 64 years who participated in the ARIC study. This cohort was recruited and first examined in 1987 to 1989 from 4 US communities. The ARIC study and its methods have been described elsewhere.[4] Follow-up visits were carried out in 1990 to 1992 (93% return rate), 1993 to 1995 (86%), 1996 to 1998 (80%), and 2011 to 2013 (65%).

For the purpose of this analysis, we excluded 808 participants: 196 had no ECG; 136 had ECGs of inadequate quality; 429 had an external pacemaker, Wolff-Parkinson-White pattern, or complete bundle branch blocks; and 47 were neither African American nor white in ethnic origin. No extramural funding was used to support this work. The authors are solely responsible for the design and conduct of this study, all study analyses, the drafting and editing of the paper, and its final contents.

Electrocardiography

At each study examination, a standard supine 12-lead resting ECG was recorded with a MAC PC Personal Cardiograph (Marquette Electronics, Milwaukee, WI) and transmitted to the ARIC ECG Reading Center (Epidemiological Cardiology Research Center, Wake Forest School of Medicine, Winston Salem, NC) for automatic coding. Electrocardiograms were automatically processed using Marquette 12-SL Version 2001 (GE, Milwaukee, WI). Romhilt-Estes score was calculated from 6 ECG features with a specific value of points for each feature as follows: R or S wave in any limb lead ≥2 mV or S wave in V1 or V2 ≥3 mV or R wave in V5 or V6 ≥3 mV (3 points); P-terminal force defined as terminal negativity of P wave in V1 ≥0.10 mV in depth and ≥0.04 ms in duration (3 points); LV strain defined as ST segment and T wave in opposite direction to QRS in V5 or V6, without digitalis (3 points); left axis deviation defined as QRS axis less than or equal to −30° (2 points); QRS duration ≥0.09 ms (1 point); and intrinsicoid deflection in V5 or V6 ≥0.05 ms (1 point).

Covariates

Baseline age, sex, race, education level, income, and smoking status were determined by self-report. Body mass index (BMI) at baseline was calculated as weight (in kilograms) divided by height (in meters) squared. Blood samples were obtained after an 8-hour fasting period. Diabetes was defined as a fasting glucose level ≥126 mg/dL (or nonfasting glucose ≥200 mg/dL), a self-reported physician diagnosis of diabetes, or use of diabetes medications. Hypertension was defined as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or use of blood pressure–lowering medications. Prevalent cardiovascular disease (CVD) was identified by self-reported history or a previous physician diagnosis.

Statistical analysis

Baseline R-E scores were calculated for all participants, and various baseline characteristics of the population were tabulated and compared across increasing levels of the R-E score, grouped as follows: score 0, 1 to 3, 4, and >5. Incidence rates of all-cause mortality per 1000 person years in each of the R-E score levels that occurred during follow-up (from visit 2 until December 2010) were calculated, and Kaplan-Meier survival curves were plotted to compare event-free survival across these ascending score levels.

Cox proportional hazards analysis was used to examine the association between R-E score and all-cause mortality in a series of models as follows: model 1, unadjusted; model 2, adjusted for age, sex, and race; and model 3, adjusted for the model 2 variables plus field center, BMI, systolic blood pressure, smoking status, education, hypertension, diabetes mellitus, cardiovascular disease status, family history of coronary heart disease (CHD), ratio of total cholesterol/high-density lipoprotein, blood glucose, and serum creatinine at baseline. In these models, R-E score 0 was the reference group, and risk of mortality was evaluated in 3 groups of R-E score (1-3, 4, and >5).

Using similar models, the association between change in the score between the baseline visit and the first return visit with mortality was also examined. The group that exhibited no change served as the reference group for this analysis.

The risk of mortality was also calculated for each of the 6 components of the score: P-terminal force in V1, QRS voltage, left axis deviation, QRS duration, intrinsicoid deflection time, and ST/T abnormalities (LV strain). Each of these components was evaluated separately as present/absent at the baseline visit, with the absent value group as the reference group. Models were adjusted in a similar fashion as mentioned above but with an additional model 4 in which the 6 components were added to those in model 3.

Statistical significance for all analyses was $P < .05$. Analyses were conducted using SAS 9.2 (SAS Institute, Cary, NC).

Results

A total of 14,984 participants (age 54.1 ± 5.8 years; 55.8% females; 26.9% African Americans) were included in this analysis. The baseline prevalence of R-E score was as follows: R-E = 0 in 6,342 participants; 1 to 3 in 8,017