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Original Article

Usefulness of upright T wave in lead aVR for predicting short-term prognosis of patients with ischemic stroke

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Abstract

Background: Upright T wave in lead aVR (TaVR) has recently been reported to be associated with cardiovascular death and mortality in general population and in patients with prior cardiovascular disease (CVD). However, the evidence for the predictive ability of TaVR in patients with ischemic stroke (IS) is lacking.

Methods: A total of 625 consecutive patients with IS (mean age: 66 ± 12 years; 379 male) were enrolled in this study between January 2013 and December 2014. Patients were divided into upright TaVR (≥0 mV; $n = 201$) and negative TaVR (<0 mV; $n = 424$) groups. All patients were evaluated with respect to clinical features and in-hospital clinical results.

Results: Overall, the prevalence of upright TaVR was 32.2% at baseline. Patients with an upright TaVR were older, had a higher percentage of CVD and hypertension, higher level of MB isoenzyme of creatine kinase (CKMB), faster heart rate, higher rate of QT prolongation > 450 ms, higher rate of negative T in lead II, higher rate of negative T in lead V6, higher rate of ST depression, and longer QTc duration. During the mean follow-up period of 20.0 ± 5.8 months, 29 (4.6%) patients experienced all-cause death and 12 (1.9%) patients experienced cardiovascular death, the primary end point. Concomitantly, 94 (15%) patients experienced recurrence of IS, the secondary end point. After adjusting for clinical covariates, upright TaVR was independently associated with all-cause death [hazard ratio (*HR*): 2.88, 95% confidence intervals (*CI*): 1.07−7.73], cardiovascular death (*HR*: 3.04, 95% *CI*: 1.07−8.64), and IS recurrence (*HR*: 1.722, 95% *CI*: 1.109−2.673).

Conclusions: Upright TaVR in patients with IS is associated with increased mortality and recurrence of IS.

Keywords: T wave in lead aVR; Ischemic stroke; Prognosis

Introduction

Electrocardiography (ECG) is a routine investigation in patients with stroke and provides essential information about underlying ischemic stroke (IS) etiology. Little evidence, however, exists concerning the prevalence of ECG changes and their prognostic impact for patients with IS.[1] According to previous studies, the most common ECG abnormalities after IS are QT-prolongation, cardiac ischemic changes

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(T-wave inversion and ST-segment depression), and non-hyperkalemia-dependent U-waves.[2,3] However, the prognostic role of T-wave changes in lead aVR has long been underestimated. Lead aVR, an augmented and unipolar limb lead, was constructed to obtain specific information from the right upper part of the heart, including the outflow tract of the right ventricle and the basal portion of the interventricular septum. Several recent studies have validated the role of upright T-wave amplitude in lead aVR (TaVR) as a powerful, independent prognostic predictor of cardiovascular mortality in the general population,[4−6] as well as in some clinical settings.[7−10] However, neither the prevalence, nor the predictive value of upright TaVR, has been evaluated in patients with IS.

We designed this study to evaluate whether upright TaVR is a useful predictor of short-term prognosis in patients with IS.

Methods

Subjects

Eligible patients diagnosed with IS at Renmin Hospital of Wuhan University between January 2013 and December 2014 were enrolled in this study. The exclusion criteria were as follows: (1) non-ischemic stroke (i.e., hemorrhagic stroke); (2) ECG not available; (3) atrial fibrillation; (4) right or left bundle branch block; (5) sick sinus syndrome; (6) presence of cardiac pacing or a defibrillator. The present study was conducted in accordance with the Declaration of Helsinki and was approved by the ethical committee of our hospital.

Electrocardiogram

Twelve-lead ECG (paper speed 25 mm/s; amplitude 1.0 mV/10 mm) was recorded in all patients soon after their admission to the hospital. Upright TaVR was defined as a wave with a positive deflection $\geq$0 mV, and negative TaVR was defined as TaVR <0 mV. Heart rate, QRS complex duration, and QT interval were recorded automatically by the ECG machine. The corrected QT (QTc) was adjusted for the RR interval, using the Bazett formula ($QTc = QT/\sqrt{RR}$). An abnormal Q wave was defined as a wave of $\geq$20 ms in duration or a QS complex in leads V2−V3 and a wave $\geq$ 30 ms in duration and $\geq$1 mm in depth, or a QS complex in other leads. Negative T wave in lead II was defined as a wave <0 mV in lead II. Negative T wave in lead V6 was defined as a wave <0 mV in lead V6. ST depression was defined as a drop of ST segment >0.5 mm in lead V5 from the isoelectric line.

Blood test

Blood test was performed before discharge from the hospital. The blood test included serum potassium (K), sodium (Na), calcium (Ca), B-type natriuretic peptide (BNP), MB isoenzyme of creatine kinase (CKMB), troponin I (cTnI), homocysteine (HCY), uric acid (UA), total glyceride (TG), total cholesterol (TC), and low-density lipoprotein cholesterol (LDL) levels.

Definitions

Hypertension was defined as a systolic blood pressure $\geq$ 140 mmHg, diastolic blood pressure $\geq$90 mmHg, or treatment with antihypertensive drugs. Diabetes mellitus was considered to be present in patients with diabetes controlled by diet, oral hypoglycemic agents, or insulin, as well as in cases discharged from the hospital with a diagnosis of diabetes mellitus and/or prescription of hypoglycemic agents. Hyperlipidemia was defined as the use of lipid-lowering agents, a total serum cholesterol level >240 mg/dl, or a serum triglyceride level >200 mg/dl. In the present study, cardiovascular disease (CVD) included ischemic heart disease that had been diagnosed as acute myocardial infarction (MI), coronary stenosis detected by coronary angiography and treated by percutaneous coronary revascularization, and/or coronary artery bypass grafting, IS, hemorrhagic stroke, peripheral artery disease, and history of macrovascular surgery.

Follow-up and end points

The subjects were followed-up until March 31, 2017. Research coordinators and physicians recorded baseline data of all patients at the time of enrollment, including patient demographics, past medical conditions, and current medication. During the follow-up period, patients or their families were periodically sent a questionnaire and interviewed by telephone. The primary end point of the study included all-cause death and cardiovascular death; cardiovascular death included death due to heart failure, acute MI, aortic dissection, or systemic embolism. The causes of death (including cardiovascular death) were determined from medical records or by direct communication with patients' general practitioners or families.

The secondary end point was unplanned rehospitalization for recurrence of IS. The secondary end point was determined from medical records.

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