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Original article

A new risk score for ventricular tachyarrhythmia in acute myocardial infarction with preserved left ventricular ejection fraction

Seung Hun Lee (MD)[a], Myung Ho Jeong (MD, PhD)[a,*], Ju Han Kim (MD, PhD)[a], Min Chul Kim (MD, PhD)[a], Doo Sun Sim (MD, PhD)[a], Young Joon Hong (MD, PhD)[a], Youngkeun Ahn (MD, PhD)[a], Shung Chull Chae (MD, PhD)[b], In Whan Seong (MD, PhD)[c], Jong Sun Park (MD, PhD)[d], Jei Keon Chae (MD, PhD)[e], Seung Ho Hur (MD, PhD)[f], Kwang-Soo Cha (MD, PhD)[g], Hyo-Soo Kim (MD, PhD)[h], Hyeon Cheol Gwon (MD, PhD)[i], Ki Bae Seung (MD, PhD)[j], Seung Woon Rha (MD, PhD)[k]
other Korea Acute Myocardial Infarction Registry (KAMIR) Investigators

[a] Department of Cardiology, Chonnam National University Hospital, Gwangju, Republic of Korea
[b] Department of Cardiology, Kyungpook National University Hospital, Daegu, Republic of Korea
[c] Department of Cardiology, Chungnam National University Hospital, Daejeon, Republic of Korea
[d] Department of Cardiology, Yeungnam University Hospital, Daegu, Republic of Korea
[e] Department of Cardiology, Chonbuk National University Hospital, Jeonju, Republic of Korea
[f] Department of Cardiology, Keimyung University Dongsan Medical Center, Daegu, Republic of Korea
[g] Department of Cardiology, Pusan National University Hospital, Busan, Republic of Korea
[h] Department of Cardiology, Seoul National University Hospital, Seoul, Republic of Korea
[i] Department of Cardiology, Samsung Medical Center, Seoul, Republic of Korea
[j] Department of Cardiology, Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, Republic of Korea
[k] Department of Cardiology, Korea University Guro Hospital, Seoul, Republic of Korea

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ABSTRACT

Background: Ventricular tachycardia or fibrillation (VT/VF) is a major cause of sudden cardiac death after acute myocardial infarction (AMI). This study aims to investigate the clinical characteristics and outcomes of VT/VF, to identify the variables associated with VT/VF, and to construct a new scoring system.
Methods: Patients with relatively preserved left ventricular ejection fraction (LVEF) (≥40%) included in the Korea Acute Myocardial Infarction Registry-National Institutes of Health registry were enrolled in this study. Among 13,109 patients in the registry, a total of 10,334 (78.8%) had relatively preserved LVEF after AMI. Patients were divided into two groups based on whether they experienced life-threatening VT/VF during hospitalization or not. The predictors for VT/VF during hospitalization were assessed. In-hospital mortality and complications were recorded.
Results: A total of 358 (3.5%) experienced life-threatening VT/VF. The VT/VF group was at an increased risk of in-hospital mortality (odds ratio 2.99) and cardiac death (odds ratio 3.40). Variables of diagnosis, Killip class, smoking, initial rhythm, left bundle branch block, and LVEF were significant indicators of VT/VF. A new risk score system yielded acceptable discrimination function (*c*-statistics = 0.773).
Conclusions: Relatively preserved LVEF patients could still be at risk of life-threatening VT/VF, which is related to a poor prognosis during the admission period. This new scoring system can be adopted to stratify the risk of VT/VF.

Introduction

Ventricular tachycardia or ventricular fibrillation (VT/VF) is one of the most common arrhythmic complications and cause of sudden cardiac death after acute myocardial infarction (AMI). Lower left ventricular ejection fraction (LVEF) is associated with

* Corresponding author at: Principal investigator of the Korea Acute Myocardial Infarction Registry, Director of The Heart Research Center Nominated by Korea Ministry of Health and Welfare, Chonnam National University Hospital, 42 Jaebong-ro, Dong-gu, Gwangju 61469, Republic of Korea.
E-mail address: myungho@chollian.net (M.H. Jeong).

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higher risk of VT/VF, since the lower LVEF reflects systolic dysfunction as a consequence of ischemic or infarcted myocardium. Although the timing of the echocardiogram remains controversial, it has been well established that a lower LVEF (<30–40%) is related to higher mortality after AMI [1–3]. To reduce the mortality of those with reduced LVEF after AMI, the implantation of cardiac defibrillators has been suggested for survival of life-threatening VT/VF. Several clinical trials have proven that defibrillators exert considerable benefits in reducing mortality for patients with remote AMI and reduced LVEF [4,5]. From these findings, current guidelines recommend that a defibrillator should be considered for patients with decreased LVEF and related symptoms of heart failure [6–9]. It is plausible that preserved LVEF may protect against life-threatening VT/VF during hospitalization. However, the use of LVEF is limited in the stratification of patients with a higher risk of life-threatening VT/VF [10,11]. Even though many AMI patients have relatively preserved LVEF after revascularization, they have a probability of life-threatening VT/VF and sudden cardiac death [12]. Among them, it is questionable that the early assessment of heart function by LVEF could be helpful to stratify the risk of early VT/VF during hospitalization. The present study aimed to evaluate the clinical characteristics and outcomes of early VT/VF during hospitalization for patients with relatively preserved LVEF after AMI. The study intended to identify the variables related to VT/VF and to construct a new risk model for predicting VT/VF during hospitalization.

Methods

Study design and patient population

The study population was derived from the Korea Acute Myocardial Infarction Registry-National Institutes of Health (KAMIR-NIH) registry. The KAMIR-NIH registry is a multi-center, open, and observational on-line registry supported by the NIH [13]. Data were collected from individuals with a diagnosis of AMI between November 2011 and November 2015. These AMI patients with relatively preserved LVEF (≥40%) were divided into two groups: the VT/VF group (who experienced VT/VF during hospitalization) and the non-VT/VF group (who had no events of VT/VF). Patients with significant left ventricular systolic dysfunction (LVEF <40%), incomplete data of demographics, outcomes, or no available LVEF data were excluded. The study protocols were verified and approved by the Institutional Review Board of each participating center, and all patients provided written informed consent.

AMI was defined as persistent ischemic symptoms, serial changes on electrocardiogram suggesting infarction, and an increase in cardiac markers, preferably cardiac troponins, with at least one value above the 99th percentile of the upper reference limit. ST-segment elevation AMI (STEMI) was diagnosed by a new ST elevation in ≥2 contiguous leads, measuring >0.2 mV in leads V1–3 or 0.1 mV in all other leads, or a new left bundle branch block on a 12-lead electrocardiogram and an increase in cardiac markers [14]. Left bundle branch block was defined as sinus rhythm with a QRS duration of ≥0.12 s; broad notched or slurred R wave in leads I, aVL, V5, and V6; QS or rS complex in lead V1; and R peak time >0.06 s in leads V5 and V6 [11,15]. LVEF was measured using the biplane Simpson's method by two-dimensional echocardiogram as soon as possible after diagnosis and/or reperfusion therapy [16]. The echocardiogram was performed approximately a mean of 1.3 days after admission. The definition of preserved LVEF was diverse above 40–55% in the literature review [17–19]. For this analysis, the authors defined relatively preserved LVEF as equal or greater than 40%. Early VT/VF during hospitalization was defined as sustained life-threatening ventricular tachycardia or fibrillation requiring anti-arrhythmics and/or defibrillation before, during, and after coronary revascularization during admission period. Non-sustained ventricular tachycardia (<30 s) was not included for this analysis, even if anti-arrhythmics were required.

Study variables and data collection

Baseline characteristics, including demographics, risk factors, and vital signs, were identified at the time of presentation. The following laboratory tests were performed using standardized methods: white blood cell count, creatinine, glucose, cardiac markers, high-sensitivity C-reactive protein, and N-terminal pro-B-type natriuretic peptide levels. Overnight fasted plasma samples were used to measure lipid panels. All procedures were performed under the guidance of current evidence-based guidelines, while critical decisions were made at the discretion of the operators. The primary endpoint was in-hospital mortality, and complications related to AMI or procedures were also recorded. All clinical data were obtained by the attending physicians with the assistance of trained clinical research coordinators. The committee of the KAMIR-NIH registry consisted of healthcare professionals, who governed and reviewed all registered data to ensure the adequacy and accuracy of the study.

Statistical analyses

For discrete or categorical variables, differences are expressed as counts and percentages; continuous variables are expressed as the mean and standard deviation or as the median and 25–75% interquartile ranges according to their distribution. Normality was assessed using the Shapiro–Wilk test and by visual inspection of Q–Q plots. Discrete or categorical variables were analyzed using the Chi-square or Fisher's exact tests. Continuous variables were analyzed using the unpaired *t*-test or the Mann–Whitney rank-sum test according to their distribution. To overcome confounding and selection bias, we performed a propensity score-matched analysis using 1:3 matching. Variables for propensity score matching were selected based on a combination of clinical judgment and statistical significance with a $p < 0.1$ from univariable analyses; age, sex, comorbidities, blood pressure, heart rate, Killip class, diagnosis of STEMI, initial heart rhythm, laboratory and procedural findings, medications, and LVEF. The *c*-statistic for the propensity score deviation was 0.827. Univariable and multivariable logistic regression analyses were performed in both total and propensity score-matched populations to compare the clinical outcomes according to VT/VF. The multivariable models were constructed using all variables with a $p < 0.1$ in the univariable analyses, and variables could be of potential relevance to determine the impact of VT/VF. The final multivariable models were then constructed using backward elimination to identify the best Akaike's information criterion. The odds ratio (OR) and 95% confidence intervals (CIs) were identified.

To establish the risk model to predict VT/VF during hospitalization, we performed multivariable logistic regression analysis. The final model was evaluated for its goodness of fit using the Hosmer–Lemeshow test, and multicollinearity was evaluated using the variation inflation factor. To produce a risk score system, the beta coefficients of the final model were multiplied by 10 and rounded to the nearest integer to derive weights [20]. The discrimination function of the risk score system was quantified using *c*-statistics, which were analogous to the area under the curve. Internal validation was constructed using a 10-fold cross-validation method [21]. The original data set was randomly partitioned into 10 equally sized subsets. A total of nine subsets were used for training, and the remaining subset was used for validation. This method was repeated 10 times, and each of the

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