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Original article

Heart rate on admission is an independent risk factor for poor cardiac function and in-hospital death after acute myocardial infarction

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KEYWORDS

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Summary

Background: Increased resting heart rate (HR) due to sympathetic hyperactivity is associated with coronary risk factors and increased cardiovascular events. Acute myocardial infarction (AMI) is accompanied by autonomic imbalance, which is characterized by sympathetic activation and parasympathetic inactivation. Although an increased HR in patients with acute coronary syndrome has been reported to be associated with 30-day and 6-month mortality before the coronary intervention era, it is unclear if an increased HR on admission is associated with the prognosis of AMI in the coronary intervention era.

Methods: We enrolled 200 consecutive patients with AMI within 24 h of symptom onset. All patients underwent coronary angiography. They were divided into quartiles based on resting HR on admission.

Results: There was no difference in coronary risk factors and previous medical treatment among the four groups. Anterior AMI was significantly lower in the lowest quartile compared with other quartiles. There was no difference in peak creatine kinase value among the four groups, however left ventricular ejection fraction (LVEF) before discharge evaluated by echocardiography in the highest quartile group was significantly reduced compared to other quartiles. An increased HR was significantly associated with in-hospital death. Patients in the highest quartile of HR were about nine times more likely to have a poor prognosis after AMI compared to those in the lowest quartile. Multiple logistic analysis revealed that $HR \geq 93$ was an independent risk factor for in-hospital death. HR was significantly associated with Killip class and LVEF on admission.

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Conclusions: These findings indicate that increased HR on admission predicts for poor cardiac function and in-hospital death after AMI.

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Introduction

Acute myocardial infarction (AMI) is a leading cause of death among adults and AMI survivors have an increased risk of developing heart failure. It is important to evaluate patient risk such as cardiac remodeling and future adverse events in the early stage after AMI.

AMI is accompanied by imbalanced autonomic nervous activity, which is characterized by activation of the sympathetic nervous system and inactivation of the parasympathetic nervous system [1–5]. Postinfarct sympathetic hyperactivity leads to high levels of extracellular norepinephrine in the heart after AMI, which increases the risk of cardiac arrhythmias and mortality [6–9]. It is well known that resting heart rate (HR) reflects autonomic activity, and several studies have also shown that resting HR is correlated with hyperglycemia, hyperinsulinemia, metabolic syndrome, and mortality [10–14].

An elevated plasma glucose (PG) and white blood cell (WBC) count have been associated with a poor outcome of AMI both before and after the coronary intervention era [15–19]. Although an increased HR in the patients with acute coronary syndrome has been reported to be associated with 30-day and 6-month mortality before the coronary intervention era, it is unclear if an increased HR on admission is associated with the prognosis of AMI in the coronary intervention era [20,21].

Therefore, we examined the association between HR on admission and cardiac outcome after AMI.

Methods

Study population

We retrospectively studied 200 consecutive patients who were admitted to the Department of Cardiology at Kumamoto Medical Center within 24 h after the onset of AMI and underwent coronary angiography between January 2008 and September 2009 (Table 1). The diagnosis of AMI was made by Universal Definition of Myocardial Infarction [22]. The subjects were divided into quartiles based on resting HR.

Blood pressure, HR, PG, WBC count, glomerular filtration rate (GFR), and hemoglobin (Hb) were measured at the time of arrival at the emergent unit of Kumamoto Medical Center. GFR was calculated using the abbreviated Modification of Diet in Renal Disease Study formula [23]. Creatine kinase (CK) was measured every 4–6 h after admission, and peak CK was obtained in 199 patients. One patient was dead before peak CK was obtained. Blood samples for measures of PG and WBC count were obtained at the time of hospital admission. Total cholesterol (T-Cho), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglyceride (TG), PG, and hemoglobin A1c (HbA1c) were measured in a fasting state on the day after admission.

Analysis of coronary risk factors for coronary artery disease

The traditional risk factors for coronary artery disease used for statistical analysis were hypertension (HT), lipid profiles (T-Cho, HDL-C, LDL-C, and TG), current cigarette smoking habit, body mass index (BMI), and diabetes mellitus (DM).

HT was defined as blood pressure $\geq 140/90$ mm Hg and/or the use of antihypertensive medication. Current cigarette smoking was defined as ≥ 10 cigarettes/day for 10 years including cessation of smoking within 1 year. DM was defined as a fasting blood glucose ≥ 126 mg/dl and/or HbA1c $\geq 6.5\%$ or the use of antidiabetic medication.

Coronary angiography and coronary intervention

Emergent coronary angiography was performed in all patients in the acute phase of AMI. The use of coronary angiography and reperfusion therapy was based on the discretion of the physician. One hundred and eighty-five patients underwent coronary intervention, five patients underwent coronary artery bypass surgery. Four patients were treated with medical treatment due to coronary spastic angina. Six patients were also treated with medical treatment because it was difficult to perform coronary intervention (culprit lesions were located at the peripheral site of coronary arteries).

AMI sites were divided into 2 groups (anterior AMI and non-anterior AMI). Diseased vessel was defined as coronary arteries narrowed $\geq 75\%$ and the patients were divided into 2 groups (single-vessel disease and multi-vessel disease).

Evaluation of left ventricular ejection fraction by echocardiography

All patients underwent echocardiography by laboratory technicians after admission and before discharge. Left ventricular ejection fraction (LVEF) was measured by modified Simpson method. Poor cardiac function was defined as LVEF before discharge $< 50\%$.

In-hospital death

In-hospital death was defined as all-cause death during hospitalization.

Statistical analysis

Results were expressed as the mean \pm SD when variables were continuous and normally distributed, and the median (interquartile range) when variables were continuous but not normally distributed. Continuous variables were compared between groups using a two-tailed unpaired *t*-test

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