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Original article

Predictors of nonoptimal coronary flow after primary percutaneous coronary intervention with stent implantation for acute myocardial infarction

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KEYWORDS
Primary percutaneous coronary intervention;
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Summary
Background: Predictors of suboptimal coronary flow in the infarct-related artery (IRA) after stent-based primary percutaneous coronary intervention (PCI) in patients with acute myocardial infarction (AMI) have not been fully investigated.
Methods and results: Using the AMI-Kyoto Multi-Center Risk Study database, we retrospectively compared clinical manifestations and in-hospital prognosis between AMI patients undergoing stent-based primary PCI with final Thrombolysis In Myocardial Infarction (TIMI) grade $\leq$2 in the IRA (nonoptimal group, $n=69$) and those with final TIMI grade 3 (optimal group, $n=1200$). The nonoptimal group had higher prevalence of Killip class $\geq$3

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at admission, higher frequency of mechanical support devices during procedures, larger value of maximal creatine phosphokinase, and a significantly higher in-hospital mortality rate (27.5% for nonoptimal vs. 9.0% for optimal, $P < 0.001$), compared with the optimal group. On multivariate analysis, Killip class $\geq$3 at admission was the independent predictor of the final nonoptimal flow (odds ratio 2.33, 95% confidence intervals 1.27—4.26 $P = 0.006$), but TIMI 3 flow before primary PCI and elapsed time (symptom onset-to-admission time) < 24 h were not.
Conclusions: Killip class $\geq$3 at admission is an independent predictor of the final nonoptimal flow in AMI patients undergoing primary PCI with stent implantation.

Introduction

Primary percutaneous coronary intervention (PCI) is now established as a first-line therapeutic strategy for patients with acute myocardial infarction (AMI). Prompt restoration of optimal antegrade coronary flow (Thrombolysis In Myocardial Infarction [TIMI] grade 3) in the infarct-related artery (IRA) could limit infarct size and improve clinical outcome in patients with AMI. Nevertheless, primary PCI is associated with 4—11% incidence of suboptimal coronary flow (TIMI grade $\leq$2), even in the coronary stent era [1—4], and furthermore the suboptimal primary PCI result is related to poor prognosis in AMI patients [5,6]. Speculated mechanisms for this suboptimal epicardial coronary blood flow include not only mechanical epicardial vessel obstruction, such as significant residual stenosis, dissection, or thrombus, but also coronary microcirculation disturbances, such as distal embolization of thrombus and plaque debris, microvascular damage, or reperfusion injury. However, the clinical manifestations and the predictors of suboptimal postintervention coronary flow in AMI patients undergoing stent-based primary PCI have not been fully investigated. The AMI-Kyoto Multi-Center Risk Study, a large multi-center observational study in which collaborating hospitals in Kyoto Prefecture have collected demographic, procedural, and outcome data on AMI patients, was established in 2000 in order to analyze these data and build an emergency-hospital network for heart diseases in Kyoto [7,8]. The purpose of the present study is therefore to compare clinical background, angiographic findings, and in-hospital prognosis between AMI patients undergoing stent-based primary PCI with final TIMI grade $\leq$2 in the IRA and those with final TIMI grade 3, using data from the AMI-Kyoto Multi-Center Risk Study.

Methods

Patient population

From January 2000 to December 2005, 2230 consecutive patients with a diagnosis of AMI, who were admitted to AMI-Kyoto Multi-Center Risk Study Group Hospitals within 1 week after the onset of AMI, were enrolled in the present study. Of these, 1817 patients received primary PCI, of whom data on clinical background were available in 1785 and 1394 out of the 1785 patients had stent implantation in the culprit lesions during primary PCI. Data on TIMI flow grades in the IRA before/after primary PCI were available in 1269 out of the 1394 patients undergoing stent-based primary PCI. Nonoptimal coronary blood flow was defined as TIMI $\leq$2 flow and optimal flow as TIMI 3 flow in the IRA at final coronary angiography (CAG) after primary PCI. We retrospectively compared clinical background, coronary risk factors, angiographic findings, and in-hospital prognosis between patients undergoing stent-based primary PCI with final nonoptimal flow in the IRA (nonoptimal group, $n = 69$) and patients with final optimal flow (optimal group, $n = 1200$). The diagnosis of AMI required the presence of two of the following three criteria: (1) characteristic clinical history; (2) serial changes on the ECG suggesting infarction (Q-waves) or injury (ST-segment elevations); and (3) transient increase in cardiac enzymes to more than twofold the normal laboratory value.

Data collection

The patients' demographic information, cardiovascular history, and risk factors (i.e., smoking, hypercholesterolemia, hypertension, and diabetes mellitus) as well as the hospitals' information were recorded. Hypercholesterolemia was defined as total cholesterol $\geq$220 mg/dl or the use of cholesterol-lowering agents; hypertension was defined as systemic blood pressure $\geq$140/90 mmHg or the use of antihypertensive treatment; diabetes mellitus was defined as fasting blood sugar $\geq$126 mg/dl or the use of specific treatment. Sixteen collaborating hospitals were classified into low-volume hospitals and high-volume hospitals based on the annual volume of primary PCI during the study period and the guidelines for PCI published by American Heart Association, the American College of Cardiology, and the Society for Cardiovascular Angiography and Interventions in 2005 [8,9]. After informed consent to participate in the AMI-Kyoto Multi-Center Risk Study was confirmed by each patient, all in-hospital data were transmitted to the center located at the Department of Cardiovascular Medicine in Kyoto Prefectural University School of Medicine for analysis. The study protocol was approved by each hospital's ethics committee.

Emergency coronary angiography and reperfusion therapy

Emergency CAG was performed using the standard technique. The coronary flow in the IRA was graded according to the classification used in the TIMI trial. Significant coronary artery stenosis was defined as at least a 75% reduction in the internal diameter of the right, left anterior descending, or left circumflex coronary arteries and their major branches, or a 50% reduction in the internal diameter of the left main trunk (LMT). Non-significant stenosis was defined as coronary arterial narrowing less than a significant stenosis. Patients