JACC: CARDIOVASCULAR INTERVENTIONS VOL. 6, NO. 4, 2013

ISSN 1936-8798/$36.00
PUBLISHED BY ELSEVIER INC. http://dx.doi.org/10.1016/j.jcin.2012.11.011

Relationship of Thrombus Characteristics to the Incidence of Angiographically Visible Distal Embolization in Patients With ST-Segment Elevation Myocardial Infarction Treated With Thrombus Aspiration

Kei Yunoki, MD, PHD,* Takahiko Naruko, MD, PHD,* Takeshi Inoue, MD, PHD,† Kenichi Sugioka, MD, PHD,‡ Mayumi Inaba, MD, PHD,§ Yoko Iwasa, MD, PHD,§ Ryushi Komatsu, MD, PHD,* Akira Itoh, MD, PHD,* Kazuo Haze, MD, PHD,* Minoru Yoshiyama, MD, PHD,‡ Anton E. Becker, MD, PHD,‖ Makiko Ueda, MD, PHD§

Osaka, Japan; and Amsterdam, the Netherlands

Objectives This study sought to investigate the association between pathological characteristics of aspirated intracoronary thrombi and the incidence of angiographically visible distal embolization (AVDE) during primary percutaneous coronary intervention (p-PCI) in patients with ST-segment elevation myocardial infarction (STEMI) treated with thrombus aspiration.

Background AVDE of atherosclerotic and thrombotic material has been shown to impair myocardial perfusion and contribute to poor clinical outcome in patients with STEMI. Recent studies have shown that thrombus composition and size are associated with the incidence of AVDE.

Methods Aspirated thrombi from 164 STEMI patients within 12 h of symptom onset were investigated immunohistochemically using antibodies against platelets, erythrocytes, and inflammatory cells.

Results The angiographic results showed that AVDE during p-PCI occurred in 22 (13.4%) patients. Pathological analysis revealed that thrombi from patients with AVDE had a greater erythrocyte-positive area (60 ± 15% vs. 43 ± 21%, $p < 0.0005$) and more myeloperoxidase-positive cells (943 ± 324 cells/mm^2 vs. 592 ± 419 cells/mm^2, $p < 0.0005$) than those from patients without AVDE. Thrombus size, quantified as the thrombus surface area, was positively correlated with the erythrocyte component ($r = 0.362$, $p < 0.0001$). Moreover, multivariate logistic analysis demonstrated that erythrocyte-positive area in the thrombi, glucose levels on admission, larger vessel diameter (≥3.5 mm), and pre-balloon dilation were independent predictors of the incidence of AVDE.

Conclusions This study demonstrated that the erythrocyte-rich component of aspirated thrombi may be associated with the incidence of AVDE during p-PCI in patients with STEMI. (J Am Coll Cardiol Intv 2013;6:377–85) © 2013 by the American College of Cardiology Foundation

From the *Department of Cardiology, Osaka City General Hospital, Osaka, Japan; †Department of Pathology, Osaka City General Hospital, Osaka, Japan; ‡Department of Internal Medicine and Cardiology, Osaka City University Graduate School of Medicine, Osaka, Japan; §Department of Pathology, Osaka City University Graduate School of Medicine, Osaka, Japan; and the ‖Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received July 22, 2012; revised manuscript received November 14, 2012, accepted November 21, 2012.

JACC: CARDIOVASCULAR INTERVENTIONS, VOL. 6, NO. 4, 2013
APRIL 2013:377–85

Primary percutaneous coronary intervention (p-PCI) has significantly improved myocardial perfusion and survival after acute ST-segment elevation myocardial infarction (STEMI). However, despite the recent technical and mechanical improvements in percutaneous coronary intervention (PCI), a substantial number of STEMI patients treated with PCI show inadequate perfusion of the infarcted myocardium (1,2). During PCI, embolization of atherosclerotic and thrombotic material often occurs and can be visible on the coronary angiogram as a distal filling defect with abrupt cutoff in the distal vessel of the culprit lesion. This angiographically visible distal embolization (AVDE) of thrombus and plaque debris was found in 6% to 18% of patients with STEMI treated with PCI and was one of the major complications that could be closely associated with impairment of myocardial perfusion and poor clinical outcome (1–4).

Abbreviations and Acronyms

AVDE = angiographically visible distal embolization
CPK = creatine phosphokinase
DM = diabetes mellitus
GP = glycoprotein
IRA = infarct-related artery
MPO = myeloperoxidase
PCI = percutaneous coronary intervention
p-PCI = primary percutaneous coronary intervention
STEMI = ST-segment elevation myocardial infarction
TIMI = Thrombolysis In Myocardial Infarction

Previous studies have demonstrated that plaque volume and composition, especially necrotic core volume, is associated with AVDE in patients with STEMI (5). Moreover, the presence of an intracoronary thrombus at the lesion site has been shown to provide an increased risk of distal embolization (3,4). In fact, recent studies using thrombectomy or distal protection devices have demonstrated that the use of these devices significantly reduced the incidence of distal embolization and improved myocardial perfusion (2,6,7) and clinical outcome (8). A coronary thrombus consists mainly of platelets, erythrocytes, and fibrin, and often contains inflammatory cells. A recent study showed that thrombus composition and size were associated with AVDE after PCI, and the thrombi aspirated in patients with distal embolization were larger and contained more erythrocytes than thrombi aspirated in patients without distal embolization (4). Moreover, our recent study demonstrated that erythrocyte-rich thrombi were associated with poor myocardial perfusion, as assessed by ST-segment resolution and myocardial blush grade, after PCI in patients with STEMI (9). However, few data are available in detail on pathological characteristics of aspirated intracoronary thrombi in STEMI patients with and without AVDE.

Accordingly, the aim of the present study was to determine the association between pathological characteristics of aspirated intracoronary thrombi and the incidence of AVDE in patients with STEMI treated with thrombus aspiration. This study was a substudy of our previous report using aspirated intracoronary thrombi in STEMI patients (9).

Methods

Study patients. Between January 2004 and December 2008, 310 STEMI patients were admitted to our hospital, and of those, the study included 249 consecutive STEMI patients within 12 h of symptom onset who had undergone thrombus aspiration for de novo lesions. Sixty-one patients were excluded because 55 patients had symptoms for ≥12 h and/or had not had thrombus aspiration performed during PCI, and 6 patients developed stent restenosis/thrombosis. The AngioJet Thrombectomy catheter (Medrad, Warrendale, Pennsylvania) was not used nor were other thrombus disruption techniques performed during PCI. The inclusion and exclusion criteria were almost the same as our previous report (9), but we additionally excluded patients in whom a distal protection device was used during PCI in this study (n = 15). Other reasons for exclusion are as follows: ≥50% left main coronary artery stenosis (n = 6), thrombolytic therapy before PCI (n = 6), previous coronary bypass surgery (n = 2), renal dysfunction (serum creatinine levels ≥2.0 mg/dl; n = 10), concomitant inflammatory diseases or malignant tumors (n = 5), no material obtained by aspiration (n = 32), and not immunohistochemically classifiable due to a small tissue sample size (n = 9). Ultimately, 164 patients (126 men, mean age, 65 ± 12 years) were enrolled in the study. Ninety-six of the 164 patients were already reported in our previous study (9). All patients were taking aspirin and received 200 mg of ticlopidine or a 300-mg loading dose of clopidogrel before the procedure. Glycoprotein (GP) IIb/IIIa inhibitors were not used, because they had not been approved in Japan.

All the studies were approved by the ethics committee of Osaka City General Hospital, and written informed consent was obtained from all patients before the procedure.

Interventional procedure and angiographic outcomes. The infarct-related artery (IRA) was defined as a major coronary artery perfusing an area compatible with the distribution of ST-segment elevation in the 12-lead electrocardiogram. The patency of the IRA was assessed by angiography before PCI according to the Thrombolysis In Myocardial Infarction (TIMI) flow grade. Intracoronary thrombus at baseline was identified by angiography and assigned 1 of 5 scores according to the TIMI thrombus score (9). Subsequent PCI was performed for total occlusive lesions or lesions with >75% diameter stenosis, even with TIMI flow grade 3. All PCI procedures were performed using a femoral approach with a 7-F guiding catheter. After administration of 5,000 IU of heparin and conventional wire crossing, thrombus aspiration was performed using a single thrombectomy device (7-F Thrombuster catheter, Kaneka, Tokyo, Japan) through the target coronary segment ≥2 times until thrombi were angiographically invisible as determined by the operator's judgment. Intracoronary nitroglycerin (0.25 mg) was administered just before angiography both before