Clinical Significance of Coronary Flow to the Infarct Zone Before Successful Primary Percutaneous Transluminal Coronary Angioplasty in Acute Myocardial Infarction*

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Study objective: To assess the effect of coronary flow to the infarct zone before primary coronary angioplasty on hospital complications in patients with acute myocardial infarction (MI).

Design: Consecutive case series analysis.

Setting: Coronary-care unit in a university hospital.

Patients: Two hundred sixty-four consecutive patients with ST-elevation acute MIs who had successful primary percutaneous transluminal coronary angioplasty.

Interventions: Coronary angiography on hospital admission and serial echocardiography.

Measurements and results: The status of infarct-related artery flow before primary angioplasty was evaluated on hospital admission. Left ventricular wall motion and pericardial effusions were studied by echocardiography. One hundred ninety patients had total occlusions (Thrombolysis in Myocardial Infarction [TIMI] flow grade, 0 to 1) in the infarct-related artery (group 1), and 74 patients had antegrade flow (TIMI flow grade, 2 to 3) [group 2] before undergoing primary angioplasty procedures. When group 1 was subdivided into two groups (for the presence and absence of collateral flow), the patients with total occlusions and no collateral flow had a higher incidence of left ventricular aneurysmal wall motion (11% vs 1%, respectively; p = 0.03) and pericardial friction rub (15% vs 3%, respectively; p = 0.03) than did those in group 2. Moreover, those patients with total occlusions and no collateral flow had higher incidences of pericardial effusion (34% vs 17%, respectively; p = 0.02; and 34% vs 9%, respectively; p < 0.01) and in-hospital mortality (8% vs 1%, respectively; p = 0.04; and 8% vs 1%, respectively; p = 0.06) than did those patients in the other two groups.

Conclusions: Despite successful primary angioplasty, the absence of antegrade flow in the infarct-related artery and collateral flow to the infarct zone before angioplasty resulted in a higher incidence of in-hospital complications.

Key words: acute myocardial infarction; echocardiography; in-hospital complications; primary angioplasty; residual coronary flow

Abbreviations: MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; TIMI = Thrombolysis in Myocardial Infarction

Reduction of the infarct size and mortality rate have been reported by restoring antegrade flow of the occluded coronary artery in the acute phase of myocardial infarctions (MIs),1–6 and primary percutaneous transluminal coronary angioplasty (PTCA) is emphasized as being associated with less recurrent myocardial ischemia than with the thrombolytic therapy.4–6 Some work7,8 has suggested the beneficial effect of establishing coronary reperfusion before primary PTCA for better clinical outcomes. Moreover, the administration of short-acting thrombolytic drugs followed by primary PTCA has been recommended with greater left ventricular functional preservation without augmentation of adverse
effects. However, there are still few reports concerning the relationship between the presence or absence of coronary flow to the infarct zone before primary angioplasty and hospital course in patients undergoing primary PTCA. The present study evaluated the clinical significance of blood supply in the distribution area of the infarct artery before successful primary PTCA in patients who have experienced their first acute MI.

Materials and Methods

Patients

We studied 264 consecutive patients who had experienced their first acute MI who had successful primary PTCA on hospital admission between February 1, 1988, and December 31, 1997. The inclusion criteria were as follows: (1) admission to the coronary-care unit within 12 h from the onset of chest pain; (2) no history of acute MI; and (3) no history of chronic renal failure, collagen disease, cardiac surgery within the previous 6 months, or metastatic disease. Angiographic criteria for exclusion from PTCA included >70% stenosis of the left main coronary artery not protected by collateral circulation if the infarct-related artery was patent or if the morphologic features of the lesion were known to indicate high risk. Among 307 patients fulfilling criteria 1 to 3 during the study period, 15 patients were excluded because of the above exclusion criteria for PTCA. Twenty-one patients were excluded because they had a Thrombolysis in Myocardial Infarction (TIMI) flow grade of ≤2* after undergoing primary PTCA (ie, they experienced an angiographic “no-reflow” phenomenon or technical failure including coronary dissections), and 7 other patients were excluded because they experienced an acute reocclusion and had undergone a repeat PTCA. Therefore, this report is based on the remaining 264 patients. The research protocol was approved by the institutional review board of the Kansai Medical University Hospital.

Clinical Evaluation

A primary PTCA was performed when a patient had experienced chest pain for ≥30 min and had ST-segment elevation (ie, ≥0.1 MV above the TP-segment measured 80 ms after the J point) in more than two contiguous leads on serial electrocardiograms and at least twice the normal elevation in serum creatine kinase levels with MB isoenzyme of ≥5%. Each patient was monitored continuously in the coronary-care unit. Major arrhythmias noted during the hospital stay included transient atrial fibrillation and third-degree atioventricular block requiring temporary pacing during the first 3 days after the patient’s admission to the hospital. Careful auscultation was performed at least twice daily. Pericardial rub was considered to be a scratchy, grating, or creaking noise heard in systole, mid-diastole, and presystole or in any one of these phases. The detection of pericardial rub within 3 days after hospital admission was considered to be diagnostic of infarction-associated pericarditis. A history of hypertension was defined as previously prescribed antihypertensive therapy, diastolic readings that were more than twice those previously documented that were ≥95 mm Hg, or systolic readings that were more than twice those previously documented that were ≥160 mm Hg. Patients were divided into smokers or nonsmokers (ie, those who had never smoked). Patients were defined as having non-insulin-dependent diabetes mellitus if diabetes (of the adult-onset variety) had been documented and therapy had been initiated before the onset of the acute MI. Patients without a previous diagnosis of hypercholesterolemia or diabetes mellitus were examined by blood samples of serum cholesterol and HbA1C, which were taken after an overnight fast on the third to seventh day in the hospital.

Coronary Angiography and Primary PTCA

After informed consent was obtained, the patients were taken to the cardiac catheterization laboratory as soon as possible to undergo an emergency coronary angiogram that was performed using the Judkins’ method. The status of the culprit lesion in the infarct-related coronary artery before primary PTCA was visually evaluated by staff cardiologists according to the work of Chesebro and colleagues. A total occlusion was defined as TIMI flow grade 0 to 1, and a subtotal occlusion was defined as TIMI flow grade 2 to 3 before a revascularization procedure was performed. PTCA was attempted whenever there was total or subtotal occlusion in the infarct-related artery (TIMI flow grade 0 to 2) with the use of exchangeable guidewire systems. Successful PTCA was defined as a ≥50% diameter of stenosis of the infarct-related artery after reflow. After catheterization, patients were admitted to the coronary-care unit for intensive monitoring. The culprit lesion was successfully dilated in all patients. An IV infusion of heparin was maintained for 3 to 5 days after its bolus injection at hospital admission, with the dose adjusted to achieve a therapeutic level of anticoagulation. Angiographically visible collaterals were graded as follows: 0, no visible filling of any collateral channels; 1, collateral filling of branches of the vessel to be dilated without any dye reaching the epicardial segment of that vessel (that is, right coronary artery injection showing retrograde filling of septal branches to their origin from the left anterior descending artery, without visualization of the latter occluded artery); 2, partial collateral filling of the epicardial segment of the vessel being dilated; and 3, complete collateral filling of the vessel being dilated. Collateral channels were graded from the initial angiography, and a patient was considered to have collateral flow to the infarct-related artery if the collateral perfusion grade was 2 or 3. Angiograms were analyzed by three experienced angiographers who did not have knowledge of the patients’ clinical findings.

Echocardiography

Two-dimensional echocardiography was performed with a phased-array sector scanner (model SSD 870; Aloka Co, Ltd; Tokyo, Japan). All classic views were recorded on videotape for subsequent analysis by observers who were unaware of the patients’ clinical data. The presence of pericardial effusion was assessed ≤24 h after the PTCA with the method described by Horowitz et al.11 An epicardial-pericardial separation that persisted throughout the cardiac cycle (D-pattern) was considered to be diagnostic of pericardial effusion. An analysis of the left ventricular wall motion was performed in 11 segments that were assessed by long-axis and short-axis images obtained on the day of hospital admission, and the number of segments with advanced asynergy (akinesia or dyskinesia) was calculated. Left ventricular aneurysmal wall motion was defined by serial observations of two-dimensional echocardiography during hospitalization (<24 h, 3 days, and 7 days after the PTCA) as an area of myocardium that was dyskinetic in systole with distinct diastolic deformity and preserved adjacent wall motion. The left ventricular aneurysmal wall motion was classified as present if aneurysmal wall motion was diagnosed in at least one of these studies. Doppler echocardiography was performed when pericardial rub was first detected in order to rule out mitral regurgitation caused by papillary muscle dysfunction.
Statistical Analysis

Results are reported as the mean ± SD. Statistical analysis between the two groups was performed by Student’s *t* test for continuous variables and Fisher’s Exact Test for discrete variables. The comparison of three discrete variables was made by χ² analysis and Sheffe-type multiple comparison. One-way layout analysis of variance and a Bonferroni multiple comparison were used to compare the three groups. All calculated *p* values are two-tailed. A *p* value < 0.05 was considered to be significant.

RESULTS

Baseline Characteristics

Of the 264 patients with acute MIs, total occlusion (TIMI flow grade 0 to 1) in the infarct-related coronary artery was detected by coronary angiography before primary PTCA in 190 patients (group 1) and antegrade flow (TIMI flow grade 2 to 3) occurred in the other 74 patients in the infarct-related artery (group 2). There were no significant differences in age, gender, location of MI, and the incidence of hypertension, diabetes mellitus, or hypercholesterolemia, but current smokers were more common in group 1 than in group 2 (Table 1). Although there were no significant differences in the elapsed time to PTCA, the number of diseased vessels, and the use of antiplatelet agents (eg, aspirin or ticlopidine) prior to hospitalization between the two groups, collateral flow to the infarct zone was more frequently observed in group 1 than in group 2. Therefore, patients in group 1 were further divided into two groups (group 1a, presence of collateral flow; group 1b, no collateral flow).

Echocardiography

Although there was no significant difference in the number of left ventricular segments with advanced asynergy among the three groups, patients in group 1b had a higher incidence of left ventricular aneurysmal motion than that in group 2. The incidence of pericardial effusion was higher in group 1b than those in group 1a and group 2 (Table 2).

In-Hospital Complications

There were no significant differences in the incidence of transient atrial fibrillation and third-degree atrioventricular block among the three groups. However, pericardial friction rub was more frequently detected in group 1b than in group 2. The overall in-hospital mortality rate was 4%. Nine patients died of left ventricular pump failure, and one patient died of cardiac rupture. Patients who died in the hospital were older (mean age, 75 ± 5 years) than those discharged from the hospital in clinically stable condition (mean age, 61 ± 11 years; *p* < 0.001), but there was no significant difference in the elapsed time from the onset of the MI to PTCA (5.1 ± 1.7 h and 4.2 ± 1.6 h, respectively; *p* = 0.083). The in-hospital mortality rate in group 1b was significantly higher than that in group 1a and tended to be higher than that in group 2 (Table 3).

DISCUSSION

Successful reperfusion therapy, primary PTCA, or the administration of IV thrombolytic agents in the early phase of an acute MI is reported1–6 to be beneficial in limiting the infarct size and the in-hospital mortality rate. On the other hand, Clements et al7 demonstrated that the presence of the blood supply to the infarct zone before direct angioplasty resulted in a smaller radionuclide-estimated final

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*Values given as mean ± SD or No. (%), unless otherwise indicated.

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<th>Table 2—Echocardiographic Data*</th>
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*Values given as mean ± SD or No. (%), unless otherwise indicated.
In-hospital mortality 1 (1) 8 (8) 1 (1) 0.02
Group 1a vs 2 0.99
Group 1a vs 1b 0.04
Group 1b vs 2 0.06

*Values given as No. (%), unless otherwise indicated. AV = atrioventricular.

The patients with no coronary blood supply to the infarct zone before primary PTCA (ie, the occlusion of the infarct-related coronary artery without collateral flow [group 1b]) had a significantly higher incidence of pericardial effusion compared to those with coronary flow to the infarct zone (group 1a and group 2). Pericardial effusion is still a common clinical sign after primary PTCA (21%) and is associated with more extensive myocardial damage.21–24 Although there was no significant difference in the number of left ventricular segments with advanced asynergy among the three groups, patients in group 1b had a significantly higher incidence of pericardial rub and aneurysmal wall motion than those in group 2. An earlier report21 from our laboratory found that patients with pericardial effusion and a pericardial rub had more severe transmural myocardial damage and a higher in-hospital mortality rate. Thus, patients in group 1b had more severe transmural myocardial damage as a result of the absence of coronary perfusion to the jeopardized myocardium before the achievement of coronary recanalization.

Despite there being no significant difference in the elapsed time from the onset of the MI to PTCA, the patients in group 1b had a higher in-hospital mortality rate compared to the other two groups. Although the survival rate of patients who have experienced MIs has improved by the use of mechanical reperfusion, further study is necessary to evaluate combining pharmacologic therapy (to open the infarct artery early) with mechanical reperfusion, because those patients with no coronary perfusion to the infarct zone might benefit from early thrombolytic therapy to prevent the risk of left ventricular pump failure, which leads to a poor prognosis.

Study Limitations

Two limitations of our study should be addressed. First, because this study excluded those patients who had experienced technically unsuccessful PTCA, including the angiographic no-reflow phenomenon after primary PTCA, we are unable to document whether our data hold up in all patients who have undergone primary PTCA. However, angiographic no-reflow after angioplasty has been shown to be an adverse clinical sign of poor left ventricular functional recovery and cardiac death.24,25 Therefore, the present study still provides one of the clinical signs differentiating the patients’ outcomes in the reperfusion era.

Second, infarct expansion, which can play an important role in the left ventricular remodeling, has been considered to begin within hours of an acute transmural MI and usually reaches a peak within 7 to 14 days.26 The diagnosis of left ventricular aneurysmal wall motion in our study was performed by serial echocardiographic observations, but the remodeling is also caused by the dilatation of the viable portion of the ventricle and process for months or years thereafter.27 Although the incidence of aneurysmal wall motion has decreased after successful PTCA,28–30 our data may have underestimated the number of patients with the aneurysmal wall motion.
CONCLUSION

Despite the success of primary PTCA, the absence of antegrade flow and collateral flow to the infarct zone before the patient undergoes primary PTCA results in a higher incidence of in-hospital complications.

REFERENCES


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