Accuracy of technetium-99m tetrofosmin myocardial perfusion imaging in the detection of spontaneous recanalization in patients with acute anterior myocardial infarction

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Abstract. To avoid the haemorrhagic risk of unnecessary thrombolysis in acute myocardial infarction (MI), early and precise diagnosis of spontaneous recanalization (SR) of the infarct-related artery is required. To clarify the accuracy of technetium-99m tetrofosmin myocardial single-photon emission tomography (SPET) in the detection of SR in patients with acute anterior MI, electrocardiography (ECG), echocardiography and 99mTc-tetrofosmin SPET imaging were performed in 49 patients with acute anterior MI before emergency coronary angiography. Defect score was calculated as the sum of the perfusion defects of each segment: from 3 (complete defect) to 0 (normal perfusion). Echocardiographic asynergic score (the sum of asynergic grades) and the greatest ST elevation of the 12-lead ECG on admission were also measured. SR was defined as Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow on emergency coronary angiography. Defect score in 11 patients with SR (9.2±3.7) was significantly lower than that in 38 patients without SR (18.5±5.0) (P<0.001), whereas there were no significant differences in asynergic score and ST elevation between the two groups. From the receiver operating characteristic curves, the optimal cut-off points of defect score, asynergic score and ST elevation for the detection of SR were calculated to be 12, 13 and 3.5, respectively. The sensitivity and specificity of the scintigraphic defect score (91% and 89%) were significantly higher than those of the asynergic score (64% and 68%) and ST elevation (73% and 71%). Thus, 99mTc-tetrofosmin SPET imaging on admission is a very accurate method for the detection of SR in patients with acute anterior MI.

Keywords: Spontaneous recanalization – Technetium-99m tetrofosmin – Myocardial reperfusion – Perfusion image – Acute myocardial infarction

Introduction

The main goal of reperfusion therapy in patients with acute myocardial infarction (MI) is to achieve Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow of the infarct-related artery [1, 2, 3, 4]. However, a subset of patients with spontaneous recanalization (SR) of the infarct-related artery do not require early reperfusion therapy because patients with early SR of the infarct-related artery have an excellent in-hospital prognosis [5, 6]. Because intracranial haemorrhage after thrombolytic therapy may be fatal [7, 8, 9, 10], detection of SR in an emergency room is important to avoid the risk of haemorrhagic stroke from thrombolysis.

Scintigraphic perfusion imaging is a well-established non-invasive method for the evaluation of myocardium at risk and final infarct size in patients with acute MI [11, 12, 13, 14, 15, 16]. Technetium-99m myocardial perfusion agents [17, 18, 19] can accurately distinguish between low- and high-risk patients with chest pain and elucidate a non-diagnostic electrocardiogram (ECG) in the emergency room [20, 21, 22]. Moreover, the abnormal rest image alone predicts acute coronary syndrome when there has been no prior MI, and it has been demonstrated that rest perfusion imaging is superior to ECG for identifying patients with coronary artery disease [23]. On the other hand, scintigraphic imaging with 99mTc perfusion agents can also quantify the myocardial area at
risk, which is determined by the location of coronary occlusion, the duration of the coronary artery occlusion and residual flow to the infarct zone. Therefore, by quantifying the myocardial area at risk on admission, information can be obtained on antegrade flow to the infarct zone in patients with acute MI [12, 13, 14]. The aim of this study was to clarify the accuracy of $^{99m}$Tc-tetrofosmin myocardial perfusion imaging for the detection of SR in patients with acute anterior MI.

Materials and methods

Patients. The study included 59 patients with their first acute anterior MI who met the following criteria: (1) chest pain at the time of admission that was suggestive of MI, and (2) ST segment elevation ($\geq 0.1$ mV from TP segment) in at least two contiguous precordial leads. Ten patients were excluded: six patients in an unsuitable condition (four in cardiogenic shock and two with acute pulmonary oedema) for nuclear study before emergency coronary angiography (CAG), two patients unable to receive $^{99m}$Tc-tetrofosmin and two patients with complete right bundle branch block. The remaining 49 patients, comprising 34 men and 15 women (mean age 66±12 years), formed the study group. The culprit lesion of the left anterior coronary artery (LAD) was segment 6 in 25 patients and segment 7 in 24. Twenty-eight patients had single-vessel disease, nine had two-vessel disease and 12 had three-vessel disease. The time from the onset of MI to CAG was 7.4±4.3 h (range 2.5–20 h) and the time from admission to CAG was 52±8 min (range 35–67 min). Primary percutaneous transluminal coronary angioplasty (PTCA) was performed in patients with TIMI 0–2 flow on the emergency CAG.

Radionuclide study. The study protocol is shown in Fig. 1. All the patients were given a chewable baby aspirin tablet (81 mg) and 3,000 units of intravenous heparin, and were transported promptly to the nuclear laboratory next to the catheterization laboratory. $^{99m}$Tc-tetrofosmin (370 MBq) was injected 0.08 s after the J point with hand-held calipers. The SPET image was divided into 13 segments: the short-axis images were obtained at the middle and lower ventricular levels, and were divided into six segments (anteroseptal, anterior, lateral, posterior, inferior, inferoseptal). The apex of the left ventricle was obtained from the vertical long-axis image. $^{99m}$Tc-tetrofosmin uptake in each of the 13 segments was graded as follows: 3, complete defect; 2, severely reduced perfusion; 1, mildly reduced perfusion; and 0, normal perfusion. The defect score was calculated as the sum of the perfusion defects. The tomograms were visually interpreted by two independent observers who had no knowledge of the clinical and angiographic data.

Echocardiographic study. Two-dimensional echocardiographic analysis of regional wall motion was performed on admission with a Hewlett-Packard Sonos 2500 equipped with a 2.5-MHz transducer. Parasternal long-axis, short-axis and apical two-chamber views were analysed by an experienced echocardiographer who had no knowledge of the clinical and scintigraphic data and were used to assess regional wall motion at the middle ventricular level, the lower ventricular level and the apex. The echocardiographic images were divided into 13 segments representing anteroseptal, anterior, lateral, posterior, inferior and inferoseptal walls. The asynergic grade was calculated on a semi-quantitative scale from 0 to 3, in increments of 1, with normal wall motion scored as 0 and akinetic/dyskinetic wall motion scored as 3. The asynergic score was defined as the sum of the asynergic grades.

ECG analysis. A conventional 12-lead ECG was recorded on admission at a paper speed of 25 mm/s at an amplification of 10 mm/mV. ST segment analysis was performed by two independent observers. The lead showing the greatest ST elevation in the 12-lead ECG was used for analysis and ST elevation was measured 0.08 s after the J point with hand-held calipers.

Angiographic study. Emergency CAG was performed using a conventional technique after the administration of 7,000 units of intravenous heparin. Coronary flow of the infarct-related artery was graded visually according to the TIMI Study Group flow classification [24]. Collateral flow on the initial CAG was graded visually using the classification of Rentrop et al. [25]. Grade 0 collateral flow was defined as the absence of visible collaterals, grade 1 flow as the filling of side branches only, grade 2 flow as the filling of side branches and a portion of the main epicardial artery, and grade 3 flow as complete filling of the side branches and epicardial vessel beyond the point of occlusion. Adequate collateral flow was considered present when the collateral flow was graded 2 or 3. SR was defined as TIMI 3 flow on the emergency CAG.

Follow-up study. In patients with SR, follow-up radionuclide and echocardiographic studies were performed 1 month after the onset of acute MI. Left ventricular ejection fraction was obtained by left ventriculography 1 month after the onset.

Analysis of radionuclide images. The SPET image was divided into 13 segments: the short-axis images were obtained at the middle and lower ventricular levels, and were divided into six segments (anteroseptal, anterior, lateral, posterior, inferior, inferoseptal). The apex of the left ventricle was obtained from the vertical long-axis image. $^{99m}$Tc-tetrofosmin uptake in each of the 13 segments was graded as follows: 3, complete defect; 2, severely reduced perfusion; 1, mildly reduced perfusion; and 0, normal perfusion. The defect score was calculated as the sum of the perfusion defects. The tomograms were visually interpreted by two independent observers who had no knowledge of the clinical and angiographic data.

Fig. 1. Study protocol. ECG and echocardiography were performed on admission. SPET imaging was obtained 15 min after the injection of $^{99m}$Tc-tetrofosmin (370 MBq). All the patients with TIMI 0–2 flow on CAG had primary PTCA. ECG, Electrocardiography; CAG, coronary angiography; PTCA, percutaneous transluminal coronary angioplasty.