THE SCORING SYSTEM FOR EARLY TECHNETIUM-99M PYROPHOSPHATE SCINTIGRAPHY AS A METHOD OF EVALUATION OF LIMITING THE MYOCARDIAL INFARCT SIZE BY THROMBOLYSIS

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The usefulness of a scoring system with early technetium-99m pyrophosphate scintigraphy as a method for evaluating the efficacy of myocardial preservation after thrombolysis was studied. The mean time from the onset of acute myocardial infarction to injection of the tracer was 5.6 ± 1.5 h (range 2.8 to 11.9h). All 36 patients underwent successful recanalization. Patients with strongly positive technetium-99m pyrophosphate uptake in anterior acute myocardial infarction had a significantly lower regional ejection fraction and a significantly larger thallium-201 defect score than those with 2+ positive results in chronic stage. Similarly, in inferior acute myocardial infarction, the thallium-201 defect score was significantly larger in patients with strongly positive uptake than in those with 2+ and negative uptake scores. In conclusion, strongly positive results in early technetium-99m pyrophosphate scintigraphy within 12h after the onset of acute myocardial infarction may indicate failure in limiting the infarct size by coronary thrombolysis.

PLANAR imaging using technetium-99m pyrophosphate is a simple and available technique for the detection of acute myocardial necrosis. Recently, early myocardial technetium-99m pyrophosphate uptake induced by the early reperfusion of infarcted coronary arteries has been reported!¹⁻⁶ This phenomenon was introduced as an indicator of early successful recanalization after coronary thrombolytic therapy in acute myocardial infarction.

Recently, early mechanical revascularization (coronary angioplasty or bypass grafting surgery) for severe residual stenosis after

thrombolysis has been examined for the management of viable but jeopardized myocardium within the reperfusion area after thrombolysis.⁷⁻⁹ However, early evaluation for limiting the infarct size by thrombolysis is difficult.

Therefore, we examined whether one can evaluate limiting the infarct size by using a scoring system involving planar technetium-99m pyrophosphate scintigrams recorded immediately after reperfusion (within 12h after the onset of symptoms) in patients with acute myocardial infarction.

METHODS

Study patients: The study group consisted of 36 patients with acute myocardial infarction.

Key words:

Acute myocardial infarction
Coronary thrombolysis
Tc-99m pyrophosphate scintigraphy
Reperfusion injury

(Received July 5, 1990; accepted March 25, 1991)

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Fig. 1. Thallium-201 defect score in chronic stage in anterior myocardial infarction (see text).

Fig. 2. Thallium-201 defect score in chronic stage in inferior myocardial infarction (see text).

Fig. 3. Regional ejection fraction in chronic stage in anterior myocardial infarction (see text). EF=ejection fraction.

Fig. 4. Regional ejection fraction in chronic stage in inferior myocardial infarction (see text). EF=ejection fraction.

tion. All patients were admitted within 6h after the onset of chest pain with ECG signs typical of acute myocardial infarction and had early reperfusion without delayed wash-out of contrast material spontaneously or after intracoronary thrombolysis by using urokinase or angioplasty. Patients without recanalization were excluded in this study. Thirty three of the 36 patients consented to undergo repeat coronary arteriography before discharge. All of the 33 patients had continued infarct artery patency. Seventeen infarcts were anterior, 19 were inferior (or posterior).

The mean ($\pm$ standard deviation) age of the patients (12 women, 24 men) was 66 ± 11 years. The interval from the onset of acute myocardial infarction until the angiographic diagnosis of recanalization was 4.8 ± 1.5 h. Five patients had documented prior myocardial infarctions.

Technetium-99m pyrophosphate scintigraphy: After the angiographic diagnosis of recanalization, each patient received an intravenous injection of technetium-99m pyrophosphate (740 MBq) and underwent myocardial imaging 2h later, using the methods previously described^{3,4}. The mean time from the onset of acute myocardial infarction to injection of the tracer was 5.6 ± 1.5 h (range 2.8 to 11.9h).

All images were analyzed visually by 3 experienced physicians without knowledge of the patient's clinical data. Scintigrams were graded 0 to 4+ as described by Willerson et al.¹⁰ Scintigraphic findings were considered positive if the grade was 2+ or greater.

Thallium-201 scintigraphy and left ventriculography: To evaluate the efficacy of myocardial salvage by early reperfusion, thallium-201 scintigraphy and left ventriculography in chronic stage were employed. Resting planar thallium-201 scintigraphy was performed between 12 and 19 days after the onset of acute myocardial infarction.

Thallium-201 imaging was performed on the anterior, 60° left anterior oblique, and left lateral projections 10 minutes after intravenous injection (74 MBq). Thallium-201 defect size was assessed visually and quantitatively, as described previously.³ The observers divided each view into 5 segments and scored each segment by using a 3 point scoring system in which 0=normal activity, 1=reduced activity and 2=absent activity.

Left cineventriculography was performed on 30° right anterior oblique projection 4 weeks after the onset of acute myocardial infarction. The regional ejection fraction of the infarcted area was calculated by the area method described by Gerberg et al.¹¹ Myocardial regions that corresponded to the perfusion area of the infarct vessel were averaged (anterior myocardial infarction-anteroapical, anterolateral, and apical areas; inferior myocardial infarction-apical, diaphragmatic, and posterobasal areas).

Statistical analysis: Analyses of differences were performed using the Chi-square test or Student's *t* test for unpaired data. Results were expressed as the mean $\pm$ standard deviation. Differences were considered significant at $p < 0.05$.

RESULTS

Early planar technetium-99m pyrophosphate scintigraphic data: In anterior acute myocardial infarction, 7 out of 17 patients showed strongly positive results with scores of 3+ or 4+. Nine other patients showed 2+ positive scores and 1 patient was negative.

In inferior acute myocardial infarction, 6 out of 19 patients were strongly positive, 7 showed 2+ positive scores and 6 showed negative scores.

Grade of myocardial technetium-99m pyrophosphate uptake and thallium-201 defect score (Fig. 1 and 2): All of the 36 patients had adequate thallium-201 imaging in chronic stage.

In anterior myocardial infarction, the thallium-201 defect score of the infarcted area was 5.3 ± 1.7 in patients with strongly positive myocardial uptake and 2.3 ± 1.8 in patients with 2+ positive myocardial uptake. The difference in the thallium-201 defect score was significant ($p < 0.01$). One patient

with negative results exhibited 0 as a thallium-201 defect score. Similarly, in inferior myocardial infarction, the thallium-201 defect score of the infarcted area in patients with strongly positive uptake was significantly larger than in patients with 2+ positive uptake ($p < 0.05$) or in patients with negative uptake ($p < 0.01$).

Grade of myocardial technetium-99m pyrophosphate uptake and regional ejection fraction by left cineventriculography (Fig. 3 and 4): Adequate left ventriculography in chronic stage was obtained in 13 of the 17 patients with anterior myocardial infarction and in 16 of the 19 patients with inferior myocardial infarction. In anterior myocardial infarction, the regional ejection fraction of the infarcted area was significantly ($p < 0.05$) lower in patients with strongly positive uptake than in those with 2+ uptake. One patient exhibiting negative uptake showed a regional ejection fraction of 55% of the infarcted area. In inferior myocardial infarction, the regional ejection fraction in patients with strongly positive uptake was the lowest among the 3 groups, although no significant difference was noted.

DISCUSSION

The intensity of early myocardial technetium-99m pyrophosphate uptake and the extent of infarcted myocardium: The relationship between the intensity of myocardial technetium-99m pyrophosphate uptake and prognosis after acute myocardial infarction has been reported!¹²⁻¹⁵ Massive technetium-99m pyrophosphate myocardial uptake and doughnut patterns in patients with acute myocardial infarction have been described as being associated with poor prognosis!¹²⁻¹⁴ In contrast, it has been reported that most patients with subendocardial infarction showed 2+ positive results!¹⁵ However, these previous results were reported in late technetium-99m pyrophosphate scintigrams more than 12h after the onset of acute myocardial infarction. Recently, the value of early technetium-99m pyrophosphate scintigraphy within 12h after the onset of acute myocardial infarction as a noninvasive technique for the early diagnosis of reperfusion has been introduced!¹⁻⁶ It is considered that massive calcium overload

complicated with the sudden restoration of large blood flow to ischemic cells immediately after reflow results in early myocardial technetium-99m pyrophosphate uptake.^{3,4,16-18} In this study, we showed that patients with strongly positive technetium-99m pyrophosphate uptake within 12h after the onset of acute myocardial infarction had poorer left ventricular functions and larger thallium-201 defect scores than those with 2+ uptake or negative results in chronic stage. Therefore, it is considered that the grading system using early planar technetium-99m pyrophosphate imaging is a simple and available technique for the early evaluation of the efficacy of myocardial preservation by early reperfusion.

Currently, early mechanical revascularization (coronary angioplasty or bypass grafting surgery) is employed for the management of viable but jeopardized myocardium within the reperfused area after thrombolysis.⁷⁻⁹ Therefore, the early identification of the extent of irreversibly damaged myocardium after thrombolysis is a central question for clinical physicians. Patients with strongly positive myocardial uptake by early technetium-99m pyrophosphate imaging may be excluded from these additional interventions after thrombolysis.

Limitations: The method of using a scoring system for early technetium-99m pyrophosphate scintigrams does not directly indicate the extent of viable myocardium within reperfused areas. In contrast, thallium-201 scintigraphy has been widely used to identify myocardial viability.¹⁹ In general, hypoperfused areas with redistribution are considered ischemic but viable myocardium. On the other hand, the areas with persistent thallium-201 defects usually represent irreversible myocardial damage. Recent studies have shown that wall motion abnormalities of the areas with persistent defects were improved after revascularization.²⁰⁻²² Thallium-201 redistribution studies for severely ischemic but viable myocardium may appear to underestimate the presence of reversible myocardium. More recently, assessment of the extent of viable tissue or necrotic tissue has been examined by positron emission tomography using F-18 deoxyglucose, N-13 ammonia and C-11 palmitate.²²⁻²³ The combined use of

these tracers provides a unique tool to identify myocardium with reduced blood flow and to determine the metabolic state of such compromised tissue.²³ However, positron emission tomography can only be performed at a limited number of institutions.

In conclusion, the scoring system of technetium-99m pyrophosphate scintigraphy within 12h after the onset of acute myocardial infarction may be a useful method for the evaluation of limiting the infarct size after thrombolysis.

Acknowledgments

We thank S Fujioka, K Akiyama, K Suzuki and E Murakami for their technical assistance. We also express our appreciation to nurses in the Coronary Care Unit.

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