Clinical Significance of Reverse Redistribution on 24-Hour Delayed Imaging of Exercise Thallium-201 Myocardial SPECT: Comparison with Myocardial Fluorine-18-FDG-PET Imaging and Left Ventricular Wall Motion

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Clinical significance of reverse redistribution on 24-hr delayed images after exercise ^{201}Tl myocardial SPECT was investigated in 16 patients with recent myocardial infarction. **Methods:** Findings of 24-hr delayed ^{201}Tl SPECT imaging were compared with those of glucose-loaded ^{18}F-fluorodeoxyglucose (FDG) imaging by myocardial PET and with left ventricular wall motion obtained by bi-plane contrast left ventriculography. In each patient, transaxial thallium images and corresponding ^{18}F-FDG images were divided into five ROIs. **Results:** Reverse redistribution was found in 15 of 80 regions. The mean FDG activity score in regions with reverse redistribution was significantly lower than that in regions having normal or slightly decreased thallium activity on 24-hr delayed imaging; it was significantly higher than that in regions having severely decreased or no thallium activity on 24-hr delayed imaging. The mean wall motion score in regions with reverse redistribution was significantly lower than in regions with normal or slightly decreased thallium activity, however, it was significantly higher than that in regions with moderately or more decreased thallium activity. **Conclusion:** These findings demonstrate that in regions showing reverse redistribution on 24-hr delayed ^{201}Tl imaging, myocardial exogenous glucose utilization and left ventricular wall motion had deteriorated, but were not on a level with the scar.

Key Words: thallium-201; SPECT; reverse redistribution; FDG PET; myocardial infarction

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Exercise ^{201}Tl myocardial scintigraphy has been used to diagnose chronic coronary artery disease (*1–4*). Several investigators have reported clinical significance of reverse redistribution on 3- to 4-hr delayed imaging (*5–7*). Recently, 24-hr delayed imaging of exercise ^{201}Tl myocardial SPECT has been employed to evaluate myocardial viability which may be underestimated on 3- to 4-hr delayed imaging in patients having a fixed ^{201}Tl perfusion defect (*8–10*). In patients with a history of prior myocardial infarction, we frequently have found reverse redistribution on 24-hr delayed imaging. Therefore, we investigated the clinical relevance of such reverse redistribution on 24-hr delayed imaging in patients with recent myocardial infarction. Findings were compared with PET images of ^{18}F-labeled fluorodeoxy glucose (FDG) for evaluating myocardial exogenous glucose utilization (*11–13*) and with the left ventricular wall motion.

METHODS

Subjects

Subjects comprised 16 consecutive male patients (mean age 60 ± 8 yr, range 55–70 yr) suffering from recent myocardial infarction who were able to undergo ^{18}F-FDG PET, cardiac catheterization and exercise ^{201}Tl SPECT 4–8 wk after the onset of myocardial infarction. They did not have apparent diabetes mellitus. Myocardial infarction was diagnosed by either the presence of typical chest pain, depression or elevation of ST-T segment on the standard 12-lead electrocardiogram, and having more than twice the normal upper limit of serum creatine kinase. Three patients had a history of prior myocardial infarction, while one had a prior aorto-coronary bypass operation to the left anterior descending artery. We evaluated the clinical significance of reverse redistribution on 24-hr delayed imaging as compared with glucose-loaded FDG PET imaging and with left ventricular wall motion. Patients received long-acting nitrate, aspirin and sublingual nitroglycerin during the test period. All provided written informed consent for participation in the study. Procedures were performed according to the protocol approved by the Ethical Guideline Committee of the Nagoya City University Medical School.

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Exercise Thallium-201 SPECT

The symptom-limited supine ergometer exercise test was performed by starting the exercise at 25 watts and increasing it by 25 watts every 3 min while monitoring with a 12-lead electrocardiogram and blood pressure. Exercise end points were the development of severe angina, physical exhaustion, frequent ventricular premature contractions or exertional hypotension. At near maximal exercise, 148 MBq of ^{201}Tl was injected intravenously, and exercise was continued for an additional minute. Patients were imaged by a rotating gamma camera equipped with a low-energy, all-purpose parallel-hole collimator (Starcam 3000 XC/T, General Electric Medical Systems, Milwaukee, WI) at 10 min, 3 hr and 24 hr after ^{201}Tl injection. Thirty-two projections were obtained over a semicircular 180° arc extending the 45° right anterior oblique to the left posterior oblique projection. The stress and 3-hr delayed imagings were acquired at 20 sec/projection, while the 24-hr delayed imaging was obtained at 40 sec/projection. A series of contiguous transaxial slices of the left ventricle was reconstructed by the filtered backprojection method using a Ramp-Hanning filter with a 0.82 cycle/cm cutoff frequency. In all subjects, the 24-hr delayed imaging had sufficient quality for interpretation of ^{201}Tl activity. When the reconstructed ^{201}Tl images were displayed on a computer screen, the following conditions were always employed in order to eliminate a potential overestimation of reverse redistribution. Stress, 3-hr delayed and 24-hr delayed ^{201}Tl images were displayed on the screen while the current upper window level was automatically white on a color scale at the pixel of current maximum counts, and the lower window level in each imaging was set at 0% of the upper window level.

FDG-PET

The positron study was performed using a whole-body, multislice positron tomograph (PCT 3600W, Hitachi Medical Co., Tokyo, Japan). This camera had eight rings which simultaneously provided 15 slices of tomographic images at 7-mm intervals, and had an in-plane resolution of 4.7 mm. Patients were studied after they had fasted for 6 hr. Before imaging, patients ingested a solution containing 50 g of glucose and then underwent a 20-min transmission scan to correct for attenuation. Immediately after the transmission scan, 300 MBq of ^{18}F-FDG was administered intravenously. A 20-min emission scan was taken 60 min postinjection to obtain transaxial slices of the myocardium.

Tomographic Image Analysis

In each patient, transaxial ^{201}Tl images and the corresponding ^{18}F-FDG PET images were divided into five regions of interest (ROIs), representing septal, anterior, apical, lateral and infero-posterior myocardium for a total of 80 regions for the 16 patients (Fig. 1). The regional ^{201}Tl activity was then graded by the consensus of two observers who were not aware of the data obtained by FDG PET and cardiac catheterization. They used a visually scored five-point scale for evaluating each of the stress, 3-hr delayed and 24-hr delayed imagings. In the five-point scale, grade 0 represented no ^{201}Tl activity, while grade 4 represented normal ^{201}Tl activity. Between grades 0 and 4, grade 1 represented severely decreased ^{201}Tl activity, grade 2 represented moderately decreased ^{201}Tl activity and grade 3 represented mildly decreased ^{201}Tl activity. The regional ^{18}F-FDG activity was also evaluated by the consensus of two other observers on the same five-point scale. Reverse redistribution of ^{201}Tl was considered to be present if regional activity scores deteriorated by at least one point on the 3-hr or 24-hr delayed imaging compared with stress imaging. The

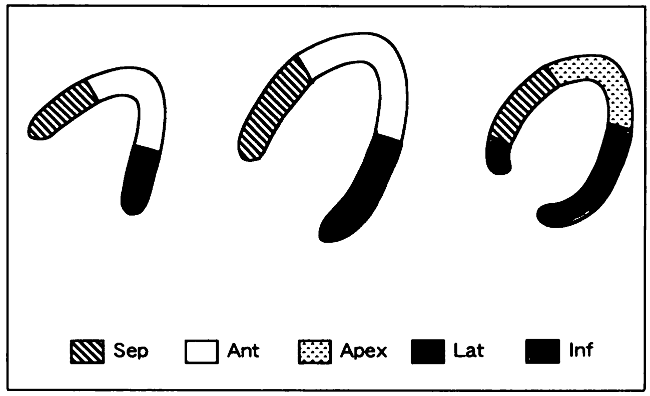

FIGURE 1. Three contiguous transaxial slices of left ventricular radionuclide imaging. Left ventricular images were divided into five ROIs. Sep = septum; Ant = anterior wall; Lat = lateral wall; and Inf = infero-posterior wall.

incidences of reverse redistribution on 3-hr delayed imaging and 24-hr delayed imaging were compared.

A total of 80 regions were divided into four types according to the findings of ^{201}Tl 24-hr delayed imaging; i.e., regions with reverse redistribution; those having no ^{201}Tl uptake or severely decreased ^{201}Tl uptake (activity score 0 or 1); those having moderately decreased ^{201}Tl uptake (activity score 2); and those having mildly decreased or normal ^{201}Tl uptake (activity score 3 or 4). The mean FDG activity score was calculated on each type, and those scores were compared among the four types of regions.

Cardiac Catheterization

Bi-plane (30° right anterior oblique and 60° left anterior oblique) contrast left ventriculography and selective coronary arteriography in multiprojections were performed on all subjects. The left ventricular wall was divided into seven areas according to the classification of the American Heart Association (AHA) (*14*). Two experienced observers reviewed regional wall motion in seven areas and scored it as normal = 4; mildly hypokinetic = 3; severely hypokinetic = 2; akinetic = 1; or dyskinetic = 0. Then, the mean wall motion score was calculated on each type of ^{201}Tl scintigraphic finding. The scores were compared among the four types of regions. Coronary artery stenosis related to the regions with reverse redistribution was evaluated using electric calipers. The correspondence between the radionuclide studies and the contrast left ventriculography was defined as follows: septum in transaxial radionuclide imaging is left ventriculographic AHA segment 6, anterior wall is AHA segment 2, apex is AHA segment 3, lateral wall is AHA segment 7 and infero-posterior wall is AHA segment 4.

Interobserver Variabilities for Interpretation of Radionuclide Imagings and Left Ventricular Wall Motion

The stress, 3-hr delayed and 24-hr delayed ^{201}Tl images were scored in all 80 regions independently by a third observer who was unaware of the data from the original two observers. Then, interobserver variability in each image was evaluated as a concordance rate in scores reported by the original observers and by the third observer. In interpretation of FDG-PET images and left ventricular wall motion, the same procedure was performed. The concordance rates in evaluation of stress, 3-hr delayed and 24-hr delayed ^{201}Tl images were 95%, 93% and 95%, respectively. Those in evaluation of FDG-PET images and left ventricular wall motion were 91% and 93%, respectively. In radionuclide studies, there was no difference of more than one point between the activity score reported by the original observers and by the third observer on each discordant region. In evaluation of left ventricular wall motion, disagreement came about only between mildly hypokinetic and severely hypokinetic.

Statistical Analysis

Results are presented as mean ± 1 s.d. The mean FDG activity scores and mean wall motion scores were compared using analysis of variance with the Bonferroni method among the four types of regions. The incidences of reverse redistribution on 3-hr delayed imaging and 24-hr delayed imaging were compared by Fisher's exact probability test. Probability levels less than 0.05 were considered statistically significant.

RESULTS

Thallium-201 activity scores on stress, 3-hr and 24-hr delayed imagings in each patient as well as ^{18}F-FDG activity scores are shown in Table 1. Reverse redistribution on 3-hr delayed ^{201}Tl imaging was observed in 3 of the 16 patients. On a segmental basis, it was found in 3 of the 80 regions. In 2 regions with reverse redistribution on 3-hr delayed imaging, ^{201}Tl activity scores worsened further one point on 24-hr delayed imaging. The incidence of reverse redistribution on 3-hr delayed imaging was 3.8%.

Reverse redistribution on 24-hr delayed ^{201}Tl imaging was identified in 8 of the 16 patients. On a segmental basis, it was observed in 15 of the 80 regions. An example of reverse redistribution on 24-hr delayed ^{201}Tl image and the corresponding FDG-PET image are shown in Figure 2. The incidence of reverse redistribution on 24-hr delayed imaging was 18.8%, higher than that on 3-hr delayed imaging ($p < 0.001$).

Thirteen of the 15 regions with reverse redistribution on 24-hr delayed imaging were related to recent myocardial infarction, one was associated with a previous aorto-coronary bypass, and one was observed on the anterior wall in a patient having lateral wall myocardial infarction. In 37 of the 80 regions, ^{201}Tl activity scores were normal or slightly decreased on 24-hr delayed images. In 19 of the 80 regions, severely decreased or no ^{201}Tl activity was found. The remaining 9 regions showed moderately decreased ^{201}Tl activity on 24-hr delayed imaging. The mean FDG activity score in regions with reverse redistribution was significantly lower than that in regions with normal or slightly decreased ^{201}Tl activity, and it was significantly higher than that in regions with severely decreased or no ^{201}Tl activity (Table 2). However, the mean FDG activity score in regions with reverse redistribution did not differ significantly from that in regions with moderate decrease in ^{201}Tl activity (Table 2). All 15 regions with reverse redistribution had normal or slightly reduced uptake of ^{201}Tl on stress imaging.

Regional left ventricular wall motion scores and coronary angiographic findings are shown in Table 3. The mean left ventricular wall motion score was significantly lower in regions with reverse redistribution than in regions with

TABLE 1
Thallium-201 Activity Scores on Stress, 3-Hour Delayed and 24-Hour Delayed Myocardial SPECT Images and Fluorine-18-FDG Activity Scores on Glucose-Loaded Myocardial PET Imaging

Patient	Stress imaging					3-hr delayed imaging					24-hr delayed imaging					FDG imaging				
no.	Sep	Ant	Apex	Lat	Inf	Sep	Ant	Apex	Lat	Inf	Sep	Ant	Apex	Lat	Inf	Sep	Ant	Apex	Lat	Inf
1	*4*	*4*	*3*	4	4	4	4	3	4	4	*3*	*2*	*2*	4	4	*3*	*2*	*1*	4	4
2	4	4	*4*	*4*	*3*	4	4	*3*	4	3	4	4	*2*	*3*	*2*	4	4	*2*	*3*	*2*
3	4	*4*	*4*	0	1	4	4	4	0	1	4	*3*	*2*	0	2†	4	*4*	*2*	0	1
4	1	*3*	2	4	4	1	3	2	4	4	2†	*2*	2	4	4	1	*1*	2	4	4
5	4	*4*	*4*	0	0	4	4	*3*	1	0	4	*3*	*2*	1	1	4	*2*	*1*	2	1
6	2	2	0	4	*3*	2	2	0	4	3	2	2	0	4	*1*	2	1	0	4	*1*
7	4	4	4	4	*3*	4	4	4	4	3	4	4	4	4	*2*	4	4	4	3	*2*
8	4	4	4	*4*	*3*	4	4	4	4	3	4	4	4	*3*	*2*	4	4	3	*3*	*2*
9*	4	4	*4*	0	1	4	4	*3*	0	1	4	4	4	0	1	4	4	*4*	0	3
10	1	1	0	4	1	2	1	0	4	2	2†	2†	0	4	2†	2	2	1	4	2
11	1	0	0	4	4	1	0	0	4	4	1	0	0	4	4	1	0	0	4	4
12	1	1	1	4	4	2	2	2	4	4	3	3	3	4	4	2	2	3	4	4
13	1	0	0	4	4	2	0	0	4	4	4	0	0	4	4	4	1	1	3	4
14	1	0	0	4	4	1	1	0	4	4	1	1	0	4	4	1	0	0	4	4
15	0	2	0	4	4	0	2	0	4	4	0	2	0	4	4	0	2	0	4	4
16	4	0	0	4	4	4	0	0	4	4	4	0	0	4	4	4	0	0	4	4

Activity scores in regions with reverse redistribution are shown in italics.
*This patient showed reverse redistribution only on 3-hr delayed imaging.
†Regions having moderate decrease ^{201}Tl activity on 24-hr delayed imaging and showing redistribution on 3-hr delayed or 24-hr delayed imaging.
Sep = septum; Ant = anterior wall; Lat = lateral wall; and Inf = infero-posterior wall.
Thallium-201 or ^{18}F-FDG activity score; normal activity = 4; slightly decreased activity = 3; moderately decreased activity = 2; severely decreased activity = 1; and no activity = 0.

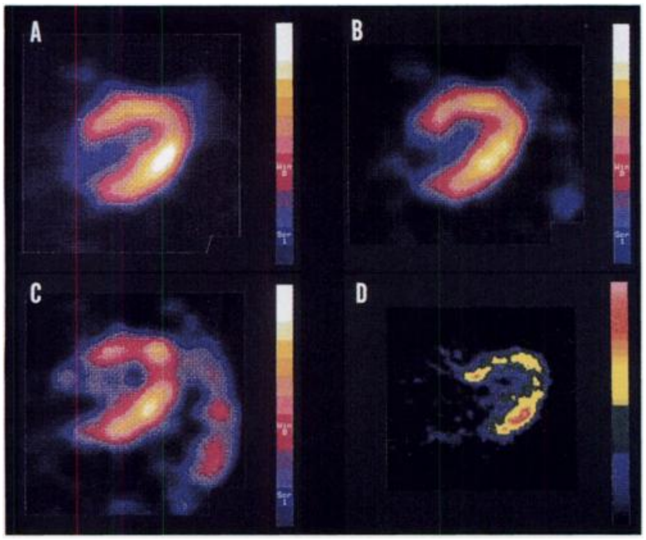

FIGURE 2. Reverse redistribution on 24-hr delayed imaging (Case 1 in Table 1). Reverse redistribution was found in the regions where ^{201}Tl activity was normal or slightly decreased on stress and 3-hr delayed images. Deterioration of FDG activity was observed on the regions with reverse redistribution. Thallium-201 stress imaging (A), ^{201}Tl 3-hr delayed imaging (B), ^{201}Tl 24-hr delayed imaging (chest wall is also seen in this image) (C), glucose-loaded ^{18}F-FDG imaging (the color scale in this image is different from others) (D).

normal or slightly decreased ^{201}Tl activity, while this score was significantly higher in regions with reverse redistribution than in those with moderately or more decreased ^{201}Tl activity (Table 2). Five of the 9 regions with moderately decreased ^{201}Tl activity on 24-hr delayed images showed redistribution of ^{201}Tl on 3-hr or 24-hr delayed images. These regions also demonstrated severe hypokinesis or akinesis on the left ventriculogram (Table 1 and 3). All coronary arteries related to reverse redistribution were patent, with the maximum percent diameter stenosis being 53%.

DISCUSSION

This study demonstrates that reverse redistribution of ^{201}Tl on 24-hr delayed imaging indicates myocardial damage, because ^{18}F-FDG activity on glucose-loaded PET imaging in regions with reverse redistribution was significantly decreased compared with that in regions where ^{201}Tl uptake was normal or only slightly decreased. The regional wall motion in regions with reverse redistribution was also reduced compared with those with normal or slightly decreased ^{201}Tl activity.

Thallium-201 is a monovalent cation which is predominantly transported by active processes via the sodium/potassium pump, which is driven by adenosine triphosphatase (Na^+, K^+-ATPase) (*15,16*). The initial ^{201}Tl myocardial accumulation is proportional to regional myocardial blood flow, because the first-pass myocardial extraction fraction of ^{201}Tl is considerably high and ^{201}Tl extraction is not diminished when myocytes are subjected to ischemia or hypoxia that does not produce cell death (*4,17–20*). Therefore, ^{201}Tl uptake in the myocardial regions fed by coronary arteries without significant stenosis is considered to reach peak levels within several minutes after intravenous ^{201}Tl injection. Thallium-201 is then washed from the myocardium with a half-life of 4–8 hr (*4*). The ^{201}Tl washout rate primarily reflects the ^{201}Tl concentration gradient between the myocardium and blood (*4*). After the initial ^{201}Tl uptake, there is a continuous ^{201}Tl exchange between the blood and myocardium, with a continuous extraction and release of ionic ^{201}Tl by viable myocytes (*4*). As 24 hr is a sufficiently long time compared with the half-life of ^{201}Tl being in myocardium, the 24-hr delayed ^{201}Tl images may be regarded as a myocardium-blood equilibrium ^{201}Tl distribution imaging. The myocardium-blood equilibrium ^{201}Tl image reflects the distribution of the potassium ions in myocardium because the affinity of the ^{201}Tl ion for the Na^+, K^+-ATPase is similar to that of

TABLE 2
Differences in Mean FDG Score and Mean Left Ventricular Wall Motion Score among the Four Types of Regions Classified by Results from 24-Hour Delayed Thallium-201 Imaging

Findings of 24-hr delayed ^{201}Tl imaging	n	Mean FDG score	Mean left ventricular wall motion score
Normal or slightly decreased ^{201}Tl activity	37	3.8 ± 0.53	3.6 ± 0.78
Moderately decreased ^{201}Tl activity	9	1.7 ± 0.47*	1.3 ± 0.47*
Severely decreased or no ^{201}Tl activity	19	0.6 ± 0.82*†	1.1 ± 0.51*
Reverse redistribution	15	2.1 ± 0.85*‡	2.6 ± 0.80*†‡

*$p < 0.01$ vs. regions with normal or slightly decreased ^{201}Tl activity.
†$p < 0.01$ vs. regions with moderately decreased ^{201}Tl activity.
‡$p < 0.01$ vs. regions with severely decreased or no ^{201}Tl activity.
Values are means ± s.d.

TABLE 3
Findings of Contrast Left Ventriculography and Coronary Angiography

Patient no.	LV wall motion score in the AHA segments							Percent coronary stenosis in the AHA segments		Intervention for AMI related segments
	1	2	3	4	5	6	7	MI related	Other findings	
1	4	*2*	*3*	4	4	*3*	4	seg. 6–50%	seg. 2–31%	PTCA
2	4	4	*3*	*2*	4	4	*2*	seg. 2–35%	seg. 6–46%	PTCA
3	4	*4*	*2*	$1^{\dagger}$	4	4	1	seg. 13–94%		IVCT
4	4	*2*	2	2	4	$1^{\dagger}$	4	seg. 6–38%	seg. 9–56% S1-90%	PTCA
5	4	*2*	*3*	1	1	4	1	seg. 12–100%	seg. 2–100% CABG for LAD	not done
6	4	1	1	*1*	4	1	4	seg. 7–39%	superdominant LAD	PTCA
7	4	3	3	*3*	4	4	3	seg. 3–53%		PTCA
8	4	4	4	*3*	4	3	*4*	seg. 2–16%		PTCA
9*	4	4	*4*	2	2	4	2	seg. 13–31%		PTCA
10	4	$2^{\dagger}$	1	$1^{\dagger}$	4	$1^{\dagger}$	4	seg. 6–100%	seg. 4PD–100% collateral from LAD proximal to distal	IVCT
11	4	1	1	1	4	1	4	seg. 6–14%		ICT
12	4	3	4	4	4	1	4	seg. 6–79%		not done
13	4	2	0	4	4	1	4	seg. 7–99%	S1-45%	IVCT
14	4	1	1	2	2	1	4	seg. 6–66%	seg. 5–57% seg. 2–100%, collateral from LAD to RCA	ICT
15	4	2	0	4	4	1	4	seg. 7–100%		not done
16	4	1	1	1	4	3	4	seg. 6–62%		PTCA

*This patient showed reverse redistribution only on 3-hr delayed imaging.

†Regions having moderate decreased ^{201}Tl activity on 24-hr delayed imaging and showing redistribution on 3-hr delayed or 24-hr delayed imaging.

AHA = American Heart Association; AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; ICT = intracoronary thrombolysis; IVCT = intravenously coronary thrombolysis; LAD = left anterior descending artery; LV = left ventricle; MI = myocardial infarction; PD = posterior descending artery; PTCA = percutaneous transluminar coronary angioplasty; RCA = right coronary artery; and S1 = first septal branch.

Wall motion scores in segments corresponding to reversed redistribution are in italics. Left ventricular wall motion score: normal wall motion = 4; mild hypokinesis = 3; severe hypokinesis = 2; akinesis = 1; and dyskinesis = 0.

the potassium ion (*15,16*). Consequently, the distribution of ^{201}Tl on 24-hr delayed imaging, which corresponds to that of the potassium ions, represents viable myocardium; ^{201}Tl activity on 24-hr delayed imaging should correspond to the amount of viable myocardium. We thus theorize that a decrease in ^{201}Tl activity on 24-hr delayed imaging denotes the existence of myocardial damage. In an experimental study of coronary ligation followed by reperfusion, Okada et al. (*21*) reported that the clearance rate of ^{201}Tl from damaged myocardium increases compared to normal myocardium, despite an initially normal ^{201}Tl uptake in damaged myocardium. Although their results may not apply to the reported clinical setting, we consider that their investigation provides the evidence that under some conditions, damaged myocardium shows an initially normal ^{201}Tl uptake and high ^{201}Tl washout rate. Weiss et al. (*6*) indicated that in patients with myocardial infarction, reverse redistribution on 3-hr delayed images results from a higher than normal washout rate of ^{201}Tl. In the present study, reverse redistribution on 24-hr images was observed in regions with normal or slightly decreased ^{201}Tl activity on stress imaging, and most regions with reverse redistribution on 24-hr delayed images did not show reverse redistribution on 3-hr delayed images. We speculate that the faster washout rate in damaged myocardium than in normal myocardium would be reflected more distinctively on 24-hr delayed imaging as a distribution of damaged myocardium than on 3-hr delayed imaging.

Fluorine-18-FDG has been widely employed to noninvasively assess exogenous glucose utilization as a intermediary of myocardial viability (*11–13*). The myocardial uptake of FDG is highly dependent on availability of substrate; i.e., whether patients are fasting or receiving a glucose load, and/or whether they have diabetes (*13*). In the present study, FDG imaging was obtained with a glucose load; patients with overt diabetes were not included. We thus believe that glucose metabolism is disturbed in regions with reduced FDG uptake, and that there must be myocardial damage in those regions (*11–13*).

In one patient, reverse redistribution on 24-hr delayed imaging was observed in the regions which were not directly related to recent myocardial infarction. Several previous studies with reverse redistribution on ordinary delayed imaging have not shown a fixed view with this problem. Weiss et al. (*6*) showed that reverse redistribution on 3-hr delayed images is a sign of nontransmural myocardial infarction with a patent infarct-related coronary artery. Langer et al. (*7*) showed that patients with reverse redistribution have a more open infarct-related coronary artery compared with those having reversible or fixed defects. However, Silberstein and DeVries (*5*) showed that reverse redistribution in 4-hr delayed imaging does not closely correlate with the degree of coronary artery disease nor with the location of stenosis. The relationship between reverse redistribution and coronary artery stenosis is controversial. In the present study, coronary arteries related to reverse redistribution were patent and stenoses was not severe. Patency of the involved coronary arteries may be necessary for the reverse redistribution on 24-hr delayed imaging.

It has been reported that left ventricular wall motion evaluated by radionuclide ventriculography is normal or near normal in regions with reverse redistribution on 3-hr delayed images (*6,7*). The result of regional wall motion analysis in the present study was different from the previous studies. We evaluated left ventricular wall motion using a standard method for analyzation, i.e., bi-plane contrast left ventriculography, and obtained the finding that the mean wall motion score in regions with reverse redistribution was 2.6 ± 0.8. This value indicates that the left ventriculography showed hypokinesis in regions having reverse redistribution, but it was better than the mean wall motion score in regions having moderately decreased ^{201}Tl activity. However, we found no significant difference in the mean ^{18}F-FDG activity scores on glucose-loaded images between the regions with reverse redistribution and those with moderately decreased ^{201}Tl activity. A difference in coronary blood supply to these two types of regions, which was apparently recognized by the ^{201}Tl activity scores on stress imaging, may be responsible. In regions with moderately decreased ^{201}Tl activity on 24-hr delayed imaging, more than half of the areas showed redistribution of ^{201}Tl on 3-hr delayed or 24-hr delayed imaging and severe wall motion abnormality. This finding suggests that hibernating myocardium may have been in such areas (*22–24*). On the other hand, we believe that there was no hibernating myocardium in regions with reversed redistribution, because coronary blood supply to these regions was considered adequate.

Although this study suggests that reverse redistribution on 24-hr delayed images corresponds to myocardial damage, it is unknown what kind of myocardial damage is in regions with reverse redistribution.

Study Limitations

Thallium-201 SPECT and ^{18}F-FDG PET images were evaluated on the transaxial myocardial views, while left ventriculography was evaluated on the right and left anterior oblique views of the heart. Accordingly, there may have been incorrect correspondence of ROIs between the radionuclide studies and the contrast left ventriculographic study. It may be necessary to evaluate the left ventricular wall motion abnormalities in transaxial slices using MRI. Another limitation is that qualitative evaluation of radionuclide images and left ventricular wall motion was done in this study. However, we believe that the results are objective and reliable because the interobserver variabilities in interpretation of radionuclide studies and left ventriculography had sufficiently low values.

CONCLUSION

In patients with recent myocardial infarction, mild myocardial damage in regions having sufficient myocardial blood flow can be evaluated by reverse redistribution on 24-hr delayed imaging of exercise ^{201}Tl SPECT without acquiring metabolic imaging.

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