

COMPARISON OF IMAGING MODALITIES

## Thallium-201 SPECT and Low-Dose Dobutamine Stress Cine MRI for Predicting Functional Recovery of Regional Myocardial Contraction in Patients with Myocardial Infarction

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### ABSTRACT

*Objectives.* The purpose of this study was to compare the diagnostic performances of Tl-201 single photon emission computed tomography (SPECT) and dobutamine stress cine magnetic resonance imaging (MRI) for predicting functional recovery of regional myocardial contraction in patients after myocardial infarction. *Methods.* Twenty patients underwent Tl-201 SPECT and MRI 3–4 weeks after onset of myocardial infarction. Cine MR images were acquired in the resting state and during dobutamine stress. Tl-201 uptake and systolic wall thickening (SWT) on cine MRI were analyzed on short-axis images by using a 14-segment model. Follow-up cine MR images were obtained 187.1±33.5 days after onset. *Results.* The averaged Tl-201 uptake in 54 segments with impaired SWT was 47%±20%, being significantly lower than that in 226 segments with preserved SWT (75%±18%;  $p<0.0001$ ). The sensitivity, specificity, and accuracy of dobutamine MRI and Tl-201 SPECT for predicting preserved SWT after 6 months were 89% vs. 80%, not significant (NS); 89% vs. 72%,  $p<0.01$ ; and 89% vs. 79%, NS, respectively. In the anterior wall and apex, the sensitivity and specificity of SPECT were not significantly different from those of MRI. In the inferior wall and posterolateral wall, however, the specificity of SPECT was substantially lower than that of MRI (53% vs. 88%,  $p<0.001$ ), resulting in significantly lower accuracy (75% vs. 90%,  $p<0.01$ ). *Conclusions.* Both SPECT and dobutamine MRI showed excellent sensitivity for predicting myocardial viability in all left ventricular segments. Decreased specificity of SPECT in the inferior and

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posterolateral segments resulted in lower overall specificity in comparison with dobutamine MRI.

*Key Words:* Tl-201 SPECT; Dobutamine stress cine MRI; Acute myocardial infarction; Revascularization.

## INTRODUCTION

Previous studies have shown that late recovery of regional left ventricular (LV) dysfunction can be expected in substantial percentage of patients after recent myocardial infarction (Bax et al., 1999; Beller, 1997). This finding indicates the importance of noninvasive detection of myocardial viability in managing patients after myocardial infarction. Several imaging techniques have been used for identifying dysfunctional myocardial regions in which functional recovery can be expected in chronic phase. Positron emission tomography (PET) with 18F-fluorodeoxyglucose (FDG) has become a gold standard for assessing viable myocardium (Burt et al., 1995). However, PET is not readily available in many clinical hospitals. Tl-201 SPECT has been widely used for evaluating myocardial viability in patients with acute myocardial infarction and chronic coronary artery disease (Alfieri et al., 1993; Charny et al., 1994; Marzullo et al., 1993; Pace et al., 1998a; Perrone-Filardi et al., 1996; Ragosta et al., 1993; Senior et al., 1998). Previous studies demonstrated that Tl-201 SPECT imaging has high sensitivity and moderate specificity in assessing myocardial viability (Alfieri et al., 1993; Charny et al., 1994; Kitagawa et al., 2003; Lomboy et al., 1995; Marzullo et al., 1993; Pace et al., 1998a,b; Perrone-Filardi et al., 1996, 1999; Scagra et al., 1998; Senior et al., 1998). The use of low-dose dobutamine for identification of myocardial contractile reserve is another noninvasive approach for determining viability (Bax et al., 1999; Beller, 1997). A better positive predictive value was reported for dobutamine echocardiography than for quantitative Tl-201 scintigraphy in predicting functional recovery of the regional myocardium in patients with myocardial infarction (Senior et al., 1998).

Recently, magnetic resonance imaging (MRI) has emerged as a reliable method for imaging of the heart in patients with coronary artery disease (Baer et al., 1995, 1996, 1998). In a study using PET as a gold standard, MRI-assessed dobutamine-induced systolic wall thickening (SWT) was proved to be a reliable indicator of myocardial viability (Baer et al., 1995). In addition, recent introduction of steady-state cine MRI allows more precise determination and quantification

of regional wall motion and wall thickening for the entire LV myocardium including the area with infarction (Moon et al., 2002). Because MRI allows assessment of regional wall motion using any imaging orientation including short-axis sections of the LV, accurate segment-to-segment comparison between regional myocardial contractile reserve and Tl-201 uptake became feasible. With use of two-dimensional (2D) echocardiography, however, detailed comparison between Tl-201 uptake on SPECT and dobutamine contractile reserve in each myocardial segment has been difficult.

The purpose of this study was to assess the diagnostic performances of resting Tl-201 SPECT and dobutamine cine MRI for predicting functional recovery of regional wall contraction in patients with myocardial infarction who underwent successful revascularization.

## METHODS

### Study Population

Magnetic resonance and Tl-201 SPECT images were retrospectively evaluated in 20 patients with acute myocardial infarction (17 men and 3 women, mean age  $61.5 \pm 10.2$  years) who satisfied the following criterion. The diagnosis of acute myocardial infarction was made by typical chest pain, characteristic abnormal findings on the electrocardiogram, and an increased plasma creatine phosphokinase level of at least twice above the normal values ( $>480$  IU/L). Thirteen patients had a Q-wave myocardial infarction and seven patients had a non-Q-wave myocardial infarction. Inclusion criteria were no prior history of myocardial infarction, successful percutaneous coronary intervention with  $<50\%$  residual stenosis, clinically stable condition, time between dobutamine stress cine MRI and Tl-201 SPECT less than 1 week, rest cine MRI performed at least 4 months after onset of myocardial infarction, and no recurrent coronary event before follow-up rest cine MRI. On coronary angiography obtained prior to revascularization, the infarct-related arteries were the left anterior descending artery territory in 12 patients, the right



coronary artery territory in 5 patients, and the left circumflex coronary artery territory in 3 patients.

**Tl-201 SPECT Protocol**

Tl-201 SPECT imaging was performed as clinical diagnostic studies at  $27.0 \pm 8.0$  days after the onset of myocardial infarction. One hundred eleven MBq of Tl-201 was injected in the resting state in each patient. The SPECT images were acquired 10 min after Tl-201 injection by using a three-headed rotating gamma camera (GCA-9300A/DI, Toshiba, Tokyo, Japan) equipped with low-energy high resolution parallel-hole collimators centered on the 71-keV photo peak with a 20% window. A total of 90 projection images were acquired over  $360^\circ$  in  $4^\circ$  increments with  $128 \times 128$  matrices. Scatter correction was performed by using a triple-energy window method (Ichihara et al., 1993). Attenuation correction was not performed. Transaxial images with  $128 \times 128$  resolutions were reconstructed by using Butterworth and Ramp filters. Short-axis images of the LV were reconstructed from three-dimensional (3D) data sets with a slice thickness of reconstructed image of 12.8 mm.

**MRI Protocol**

Magnetic resonance imaging protocol was approved by the institutional review board and all patients gave informed consent. Low-dose dobutamine cine MR images were obtained at a mean of  $24.7 \pm 5.8$  days (range 17–39 days) after the onset of myocardial infarction and within 1 week of Tl-201 SPECT study. The patient was placed supine in a clinical 1.5-T MR imager (Signa CV/i 1.5T, GE Medical Systems, Milwaukee, WI) with cardiac multicoils placed around the chest. The intravenous catheter was inserted in the left antecubital vein before starting rest cine MRI, and 0.9% saline was slowly infused during rest MR study by using a long tubing line (diameter 1 mm, length 2 m) connected to a perfusion pump (Terufusion TE-311, Terumo, Japan). Cine MR images on transaxial imaging planes and on long-axis imaging planes of the LV were obtained as scout images by using an electrocardiogram (ECG) gated steady-state cine sequence. Then, steady-state cine MR images encompassing the entire LV were obtained on 9–11 contiguous short-axis imaging planes from the apex to the base. Imaging parameters include slice thickness of 10 mm, echo time of 1.7 msec, repetition time of 4 msec, acquisition matrices of  $256 \times 128$ , acquisition pixel size of  $1.25 \times 2.5$  mm and field view of  $320 \times 320$  mm. Imaging time for acquiring cine MR images in each slice location was approximately 8 sec,

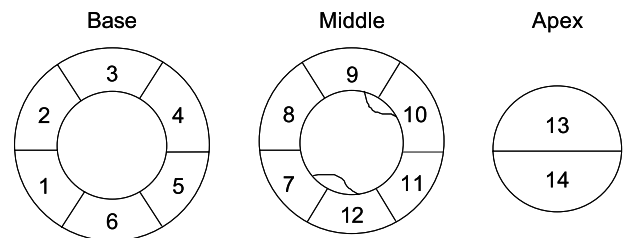
and temporal resolution of cine MR images in the cardiac cycle was 48 msec.

After acquiring cine MRI in the resting state, low-dose dobutamine cine MR images were obtained by using the same imaging planes and acquisition parameters used in the rest study. The patients were instructed not to move between the rest and stress examinations. During a stress protocol, a dosage of  $5 \mu\text{g}/\text{kg}/\text{min}$  dobutamine was initially infused for 3 min. Then, the dose of dobutamine was increased to  $10 \mu\text{g}/\text{kg}/\text{min}$ , and stress cine MR image acquisition was initiated 10 min after the beginning of dobutamine infusion. The presence or absence of the major side effect, such as severe angina,  $>2$  mm ST-segment depression or elevation, major ventricular arrhythmias, systemic hypertension (blood pressure  $>230/120$  mm Hg) and systolic hypotension (defined as a drop in systolic blood pressure  $>20$  mm Hg compared to the previous step) was recorded.

To determine the functional recovery of regional myocardial contraction, follow-up cine MR images in the resting state were obtained at a mean of  $187.1 \pm 33.5$  days after onset of myocardial infarction. Steady-state cine MR images on short-axis imaging planes were acquired in the resting state by using the same imaging planes and data acquisition parameter used in the first dobutamine stress cine MR study.

**Image Analysis**

Dobutamine stress cine MR images, Tl-201 SPECT images, and follow-up rest cine MR images were quantitatively assessed by using a 14-segment (Fig. 1) (Wu et al., 2001). Analyses of dobutamine stress MR images, SPECT images, and follow-up cine MR images were performed on separate days after randomly sorting the order of patients to obviate recall.



**Figure 1.** A 14-segments model used for analyses of Tl-201 SPECT and cine MR images. Segments 1–3, 7–9, 13, and 14 corresponded to the anteroseptal wall and apex, and segments 4–6 and 10–12 corresponded to the inferior and posterolateral walls.

Quantification of Tl-201 uptake was performed by blinded observers (YI, MM). In each patient, small regions of interest (ROI) were placed within these 14 segments. Percent Tl-201 uptake was calculated by using the following formula:

$$\text{Tl-201 uptake (\%)} = \left[ \frac{\text{Tl-201 counts in the segment}}{\text{maximal Tl-201 counts in normal segment}} \right] \times 100.$$

Sixty percent of the peak activity in normal myocardial segments was used as a threshold for determining viability (Qureshi et al., 1997; Scagra et al., 1998).

Systolic wall thickening (SWT) of the LV myocardium on cine MR images was quantitatively determined with a modified centerline method by using commercial software (MASS Plus; MEDIS Medical Imaging Systems, Leiden, Netherlands. One author (MM) manually traced the epicardial and endocardial contours of myocardium. The result was expressed as the percent SWT according to the following formula:

$$\text{SWT (\%)} = \left[ \frac{\text{end-systolic wall thickness} - \text{end-diastolic wall thickness}}{\text{end-diastolic wall thickness}} \right] \times 100$$

On dobutamine stress cine MR images, myocardial segment was considered to be normal when the percent SWT in the segment was equal to or greater than 20% during dobutamine stress. On the follow-up rest cine MR images, myocardial segment was determined as normal when the averaged percent SWT was equal to or greater than 20%.

### Statistical Analysis

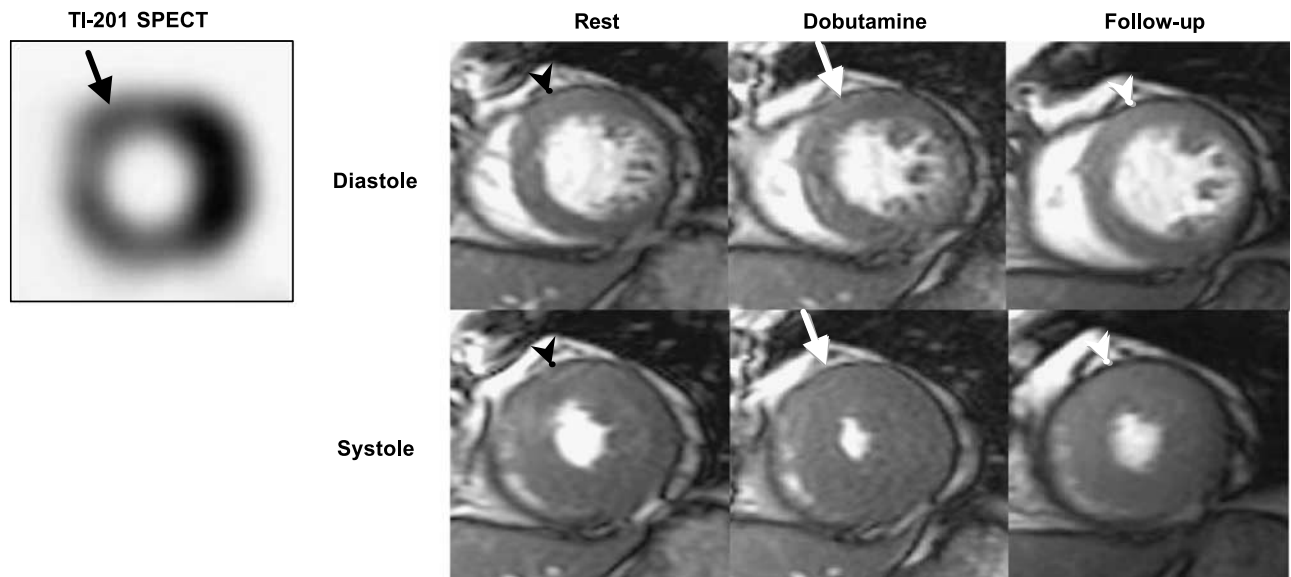
All data were expressed as mean value  $\pm$  standard deviation. Sensitivity was defined as the number of segments classified as viable by Tl-201 SPECT or dobutamine stress MRI divided by the number of segments showing normal contractile function on follow-up rest cine MRI. Specificity was defined as the number of segments classified as nonviable by SPECT or stress MRI divided by the number of segments with impaired contractile function on follow-up MRI. Positive predictive accuracy was defined as the number of segments showing normal contractile function on follow-up MRI divided by the total number of segments classified as viable by SPECT or stress MRI. Negative accuracy was defined as the number of dysfunctional segments on follow-up MRI divided by the total number of segments classified as nonviable by

**Table 1.** Patient's characteristics.

Patient's no.	Age (yr)	Gender	Infarct region	Peak CK (IU/L)	LVEF (%)
1	59	Male	Anteroseptal MI	8104	34
2	76	Male	Anteroseptal MI	3637	33
3	59	Male	Anteroseptal MI	13059	49
4	61	Male	Posterolateral MI	2818	52
5	65	Male	Anteroseptal MI	8201	27
6	45	Male	Inferior MI	3244	35
7	51	Male	Anteroseptal MI	3634	63
8	65	Male	Anteroseptal MI	539	76
9	57	Male	Anteroseptal MI	6780	59
10	66	Male	Posterolateral MI	4039	45
11	77	Female	Anteroseptal MI	2290	53
12	76	Male	Anteroseptal MI	2628	49
13	57	Male	Inferior MI	1236	59
14	57	Male	Inferior MI	3400	48
15	61	Male	Inferior MI	1440	62
16	61	Male	Inferior MI	1324	48
17	51	Female	Anteroseptal MI	1853	52
18	41	Male	Anteroseptal MI	7970	34
19	78	Female	Anteroseptal MI	904	72
20	67	Male	Posterolateral MI	1592	57

**Abbreviations:** CK=creatinine phosphokinase; LVEF=left ventricular ejection fraction measured on rest cine MRI prior to dobutamine stress; MI=myocardial infarction.

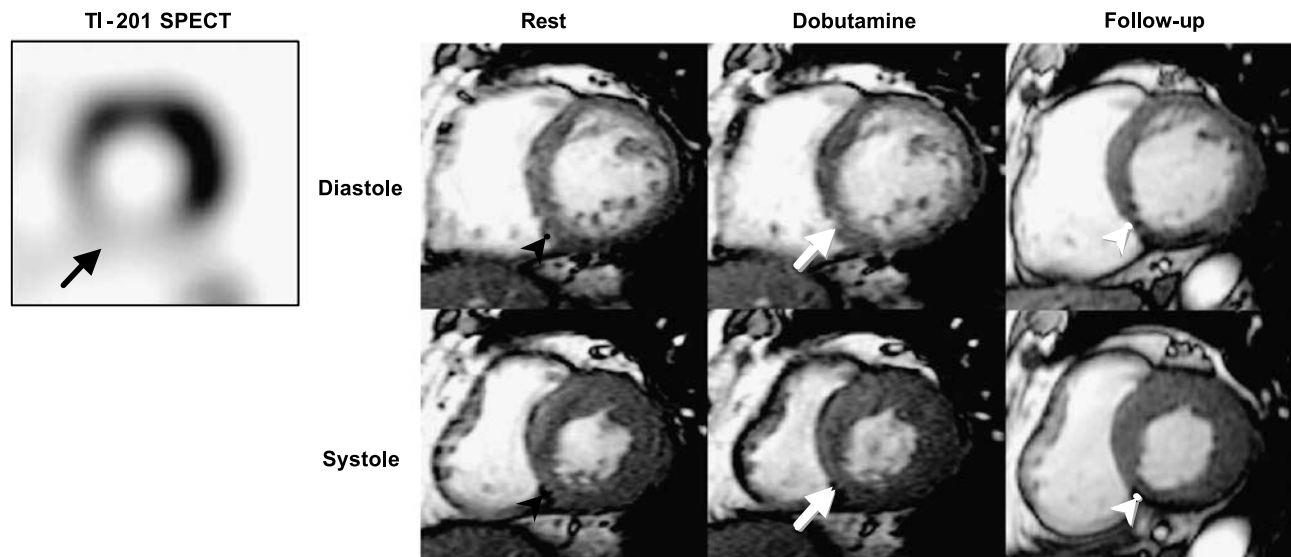




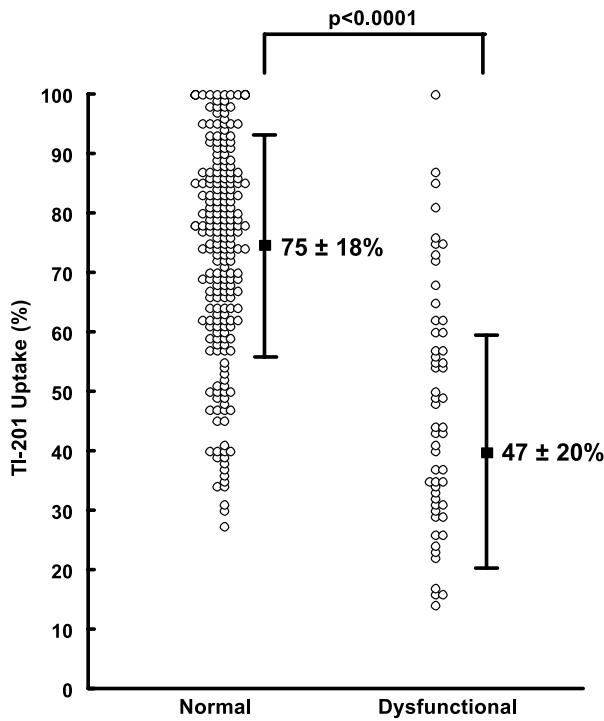
**Figure 2.** TI-201 SPECT and cine MR images in a 78-year-old female patient with anteroseptal myocardial infarction. On TI-201 SPECT images, TI-201 uptake was preserved (74%) in the anteroseptal wall (black arrow). Short-axis cine MR images in the resting state showed a wall motion abnormality in the anteroseptal wall (black arrowheads). During dobutamine-stress, improvement of systolic wall thickening was observed, indicating myocardial viability in this segment (white arrows). Seven months after revascularization, improved wall thickening was observed on rest cine MR images (white arrowheads).

SPECT or stress MRI. Diagnostic accuracy was defined as the number of segments correctly detected as being either viable or nonviable by SPECT or stress MRI divided by the total number of segments. The

diagnostic performances of SPECT and MRI were evaluated in the segments [1–3, 7–9, 13–14] that corresponded to the anteroseptal wall and apex and in the segments [4–6, 10–12] that corresponded to the



**Figure 3.** TI-201 SPECT and cine MR images in a 57-year-old male patient with inferior myocardial infarction. On TI-201 SPECT images, TI-201 uptake was severely reduced (38%) in the inferior wall (black arrow). Short-axis cine MR images in the resting state revealed a wall motion abnormality in the inferior wall (black arrowheads). During dobutamine-stress, no improvement of systolic wall thickening was observed (white arrows). Six months after revascularization, no improved wall thickening was observed on rest cine MRI (white arrowheads).



**Figure 4.** Scatter plots of %TI-201 uptake in normal and dysfunctional segments on the second follow-up cine MRI. Significant differences were observed between the percentage of TI-201 in 226 segments with normal myocardial contraction and that in 54 segments with impaired myocardial contraction. Error bars represent standard deviation.

inferior and posterolateral walls (Bremerich et al., 1997; Kwok et al., 2000). Comparison of the proportions was performed with Fisher's exact test. The *p* values of less than 0.05 were considered to be statistically significant.

Intra- and interobserver variabilities were calculated as the absolute difference between the two measurements divided by the mean of the two measurements.

## RESULTS

### Clinical Characteristics

Characteristics of the patients are summarized in Table 1. The mean peak creatine phosphokinase was 3935 IU/L (range 539–13,059). The mean LV ejection fraction was 50% (range 27–78) on rest cine MRI obtained prior to dobutamine stress.

### Clinical and Hemodynamic Observations During Low-Dose Dobutamine MRI

The stress cine MR protocol with administration of 10μg/kg/min dobutamine was successfully completed in all patients. No major adverse effect was observed. No patient was excluded from data analysis because of technical failure or poor image quality (Figs. 2 and 3). During dobutamine infusion, the heart rate (72±14 beats per minute in the resting state vs. 84±16 beats per min during dobutamine, *p*<0.01), systolic blood pressure (119±15 mm Hg vs. 149±29 mm Hg, *p*<0.01) and rate-pressure product (8643±2371 mm Hg/min vs. 12,489±3174 mm Hg/min, *p*<0.01) showed significant increase.

### TI-201 Uptake in Dysfunctional Segments on Follow-Up Cine MRI

On follow-up cine MR images acquired in the resting state, impaired myocardial contraction was observed in 54 of 280 (19%) segments. Figure 4 shows scatter plots of the percent TI-201 uptake on SPECT images in normal and dysfunctional segments determined by follow-up cine MRI. The averaged TI-201 uptake in 54 dysfunctional segments was 47%±20%, being significantly lower than that observed in 226 segments with preserved function (75%±18%, *p*<0.0001).

**Table 2.** Diagnostic performances and 95% confidence intervals of TI-201 SPECT and dobutamine stress cine MRI for predicting preserved systolic wall thickening in chronic phase assessed in all segments.

	Dobutamine MRI	TI-201 SPECT
Sensitivity	89% (201/226) [84, 92]	80% (181/226) [74, 85]
Specificity	89% (48/56) [79, 95]	72% (39/54) <sup>a</sup> [59, 82]
Positive predictive value	97% (201/207) [94, 99]	92% (181/196) [88, 95]
Negative predictive value	66% (48/73) [54, 76]	46% (39/84) <sup>a</sup> [36, 57]
Diagnostic accuracy	89% (249/280) [85, 92]	79% (220/280) [73, 83]

**Abbreviations:** SPECT=single photon emission computed tomography; MRI=magnetic resonance imaging.

<sup>a</sup>*P*<0.01 compared with dobutamine MRI. Data presented were % (number) of segments.



**Table 3.** Diagnostic performances and 95% confidence intervals of Tl-201 SPECT and dobutamine stress cine MRI for predicting preserved systolic wall thickening in chronic phase assessed in the anteroseptal wall and apex, or the inferior wall and posterolateral wall.

	Anteroseptal wall and apex (160 segments)		Inferior wall and posterolateral wall (120 segments)	
	Dobutamine MRI	Tl-201 SPECT	Dobutamine MRI	Tl-201 SPECT
Sensitivity	88% (108/123) [81, 92]	81% (100/123) [74, 87]	90% (93/103) [83, 95]	79% (81/103) <sup>a</sup> [70, 85]
Specificity	89% (33/37) [75, 96]	81% (30/37) [66, 91]	88% (15/17) [66, 97]	53% (9/17) <sup>b</sup> [31, 74]
Positive predictive value	96% (108/112) [91, 99]	94% (100/107) [87, 97]	98% (93/95) [93, 99]	91% (81/89) [83, 95]
Negative predictive value	69% (33/48) [55, 80]	57% (30/53) [43, 69]	60% (15/25) [41, 77]	29% (9/31) <sup>b</sup> [16, 47]
Diagnostic accuracy	88% (141/160) [82, 90]	81% (130/160) [75, 87]	90% (108/120) [83, 94]	75% (90/120) <sup>b</sup> [67, 82]

*Abbreviations:* SPECT= single photon emission computed tomography; MRI=magnetic resonance imaging.

Data presented were % (number) of segments.

<sup>a</sup>*P*<0.05 compared with dobutamine MRI.

<sup>b</sup>*P*<0.01 compared with dobutamine MRI.



**Table 4.** Intra- and interobserver variabilities in measuring TI-201 uptake and systolic wall thickening on cine MR images.

	Intraobserver variability (%)	Interobserver variability (%)
TI-201 uptake	2.5±1.9	4.1±2.7
Systolic wall thickening on cine MR images	8.8±2.4	11.0±3.3

Values are the means of the absolute difference between the two measurements over the mean of the two measurements plus or minus the standard deviation of the mean.

### Diagnostic Performances of TI-201 SPECT and Dobutamine Stress Cine MRI

Table 2 summarizes the sensitivities, specificities, predictive values, and accuracies of low-dose dobutamine cine MRI and resting TI-201 SPECT for predicting preserved SWT on follow-up cine MRI. The sensitivity, specificity, and accuracy with dobutamine stress cine MRI were 89% (201/226), 89% (48/54), and 89% (249/280), respectively. These values by resting TI-201 SPECT were 80% (181/226), 72% (39/54), and 79% (220/280), respectively. No statistically significant difference was observed between SPECT and MRI for the sensitivity ( $p=0.117$ ) or accuracy ( $p=0.081$ ). The specificity of dobutamine stress cine MRI was significantly higher than that of resting TI-201 SPECT ( $p=0.004$ ).

Table 3 summarizes the diagnostic performances of MRI and SPECT in the anteroseptal wall and apex and those in the inferior wall and posterolateral wall. In the anterior wall and apex, the sensitivity, specificity, and accuracy of SPECT exceeded 80% and were not significantly different from those of dobutamine stress cine MRI. In the inferior wall and posterolateral wall, however, the specificity of dobutamine stress MRI was significantly higher than that of SPECT.

The intra- and intervariabilities in measuring TI-201 uptake—assessed as the mean percentage of the absolute differences in the measurements over the mean of the two measurements—were  $2.5\% \pm 1.9\%$  and  $4.1\% \pm 2.7\%$ . The intra- and interobserver variabilities in assessing systolic wall thickening of the LV myocardium on cine MR images were  $8.8\% \pm 2.4\%$  and  $11.0\% \pm 3.3\%$  (Table 4).

### DISCUSSION

In the current study, we evaluated the diagnostic performance of resting TI-201 SPECT imaging compared with that of dobutamine stress cine MRI for predicting functional recovery of regional myocardial

contraction in patients with myocardial infarction. The segment-to-segment analysis on short-axis imaging planes revealed that excellent sensitivity was observed with TI-201 SPECT (81% in the anteroseptal and apical segments, 79% in the inferior and posterolateral segments). TI-201 SPECT also showed good specificity (81%) in the anteroseptal wall and apex. However, as demonstrated in Fig. 4 in this study, a significant overlap in TI-201 uptake was observed between normal and dysfunctional segments. Due to the limited specificity in the inferior and posterolateral segments, the overall specificity of SPECT was significantly lower than that of MRI. In contrast, the sensitivity and specificity of MRI were consistently high regardless of the LV segments.

### Dobutamine Stress Echocardiography and MRI

Echocardiography during infusion of low-dose dobutamine has been widely used for assessing myocardial viability in clinical patients. There are a number of studies that evaluated the accuracy of low-dose dobutamine echocardiography for predicting improved regional myocardial function. Meta-analysis by Bax et al. (1997) indicated that low-dose dobutamine stress echocardiography adequately detects recovery of contractile function with a mean sensitivity of 84% and a mean specificity of 81%.

Similar to low-dose dobutamine echocardiography, cine MRI during infusion of low-dose dobutamine can be used to evaluate myocardial contractile reserve in patients with myocardial infarction (Bax et al., 1999). Bear et al. evaluated the diagnostic performance of dobutamine stress cine MRI in patients with chronic infarction by using FDG-PET as a gold standard. Dobutamine stress MRI showed excellent sensitivity (88%) and specificity (87%) for predicting myocardial viability determined by FDG-PET (Baer et al., 1995). In patients with acute myocardial infarction, myocardial contractile reserve determined by dobutamine stress cine MRI is also useful in detecting dysfunctional segments that exhibit



improved function in chronic state (Dendale et al., 1995, 1998; Geskin et al., 1998).

There are several advantages of MRI over echocardiography for the assessment of myocardial viability, including independence from acoustic window determined by bone and lung, unlimited choice of imaging orientation, constant image quality for the entire LV, and reduced operator dependency. Baer et al. compared dobutamine MRI and dobutamine transesophageal echocardiography for detecting myocardial viability by using FDG-PET as a gold standard (Baer et al., 1996). The sensitivity and specificity of dobutamine MRI and echocardiography were 81% vs. 77% and 100% vs. 94%, respectively. In our study, dobutamine-induced myocardial contractile reserve was evaluated by using steady-state cine MRI, which can provide excellent contrast between blood and myocardium. The sensitivity and specificity of dobutamine cine MRI was 89% and 89%, respectively.

### TI-201 SPECT Imaging

TI-201 SPECT has been widely used for evaluating myocardial viability in patients with acute myocardial infarction and chronic coronary artery disease (Alfieri et al., 1993; Charny et al., 1994; Kitagawa et al., 2003; Lomboy et al., 1995; Marzullo et al., 1993; Pace et al., 1998a,b; Perrone-Filardi et al., 1996, 1999; Ragosta et al., 1993; Scagra et al., 1998; Senior et al., 1998), because tracer retention in the myocardium predominantly represents integrity of the cell membrane. A number of studies have evaluated the diagnostic accuracy of TI-201 SPECT imaging for predicting reversibility of wall motion abnormalities. Bax et al. performed a meta-analysis of the previously reported data, and the weighted mean of the sensitivity and specificity of TI-201 SPECT was 90% (range 44%–100%) and 54% (range 22%–88%), respectively (Bax et al., 1997). The sensitivity and specificity of TI-201 scintigraphy varied considerably for each study, depending on imaging protocols and criteria to define functional recovery of regional myocardial dysfunction.

Several investigators compared the diagnostic values of TI-201 scintigraphy and dobutamine echocardiography (Bax et al., 1997). In a study by Perrone-Filardi et al., the sensitivity for predicting functional recovery was 100% for TI-201 SPECT and 79% for dobutamine echocardiography. However, the specificity of TI-201 (22%) was considerably lower than that of dobutamine echocardiography (83%) (Perrone-Filardi et al., 1996). Senior et al. also concluded that TI-201 scintigraphy is more sensitive (90%) and less specific

(56%) for predicting recovery, whereas dobutamine echocardiography is less sensitive (74%) but more specific (89%) (Senior et al., 1998).

In these previous studies that evaluated the diagnostic accuracy of TI-201 scintigraphy, echocardiography has been used as a gold standard of functional recovery. However, accurate segment-to-segment comparison between TI-201 uptake and regional myocardial contraction has been difficult because of the limited imaging orientation of echocardiography and operator dependency.

In the current study, TI-201 SPECT demonstrated excellent sensitivity (81%) and specificity (81%) in the anteroseptal and apical segments. As mentioned previously, MRI is free from dependence on acoustic window and can provide continuous short-axis images from apex to base of the LV, allowing an accurate assessment of regional myocardial contraction. These characteristics of MRI can reduce the possibility of anatomic misalignment between TI-201 SPECT and cine MRI and allow more precise detection of recovery of regional myocardial contraction. This may explain the high sensitivity and specificity for TI-201 scintigraphy observed in anterior wall and apex in this study. In the inferior wall and posterolateral wall, the sensitivity (79%) of SPECT was comparable to that in the anteroseptal wall, but its specificity (53%) was substantially lower, presumably due to attenuation on SPECT images.

### Limitations

Several potential limitations should be acknowledged in the present study. The number of patients was relatively small, and global LV function was relatively preserved in the current subjects. Further studies will be required to determine whether the findings in this study hold true in patients with significantly impaired LV function.

We did not use redistribution scanning for TI-201 SPECT. Several investigators reported that delayed SPECT after resting TI-201 injection is useful for detecting myocardial viability (Qureshi et al., 1997; Udelson et al., 1994). However, recent studies (Scagra et al., 1998; Moon et al., 2002) reported that initial resting SPECT images provide equal or greater accuracy than redistribution SPECT images in the prediction of myocardial viability after revascularization.

In the current study, steady-state cine MR images in the resting state were used as a gold standard for assessing functional recovery. Therefore, the possibility still remains that misregistration had a reduced impact on dobutamine cine MRI in comparison with TI-201

SPECT. This might have influenced the sensitivity and specificity of these two methods.

### CONCLUSIONS

Both SPECT and dobutamine stress MRI showed excellent sensitivity for predicting myocardial viability in all left ventricular segments. Decreased specificity of SPECT in the inferior and posterolateral segments resulted in lower overall specificity in comparison with dobutamine stress MRI.

### ABBREVIATIONS

LV	left ventricle
MRI	magnetic resonance imaging
ROI	region of interest
SPECT	single photon emission computed tomography
SWT	systolic wall thickening

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