SHORT COMMUNICATION

Assessment of Myocardial Viability with Contrast-enhanced Magnetic Resonance Imaging and Technetium Scintigraphy

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Abstract

Background: In patients with coronary artery disease (CAD), assessment of viable myocardium has important prognostic implications. The aim of this study was to compare contrast-enhanced magnetic resonance imaging (ce–MRI) with single–photon emission computed tomography (SPECT), using ^{99m}TC–sestamibi for detection of myocardial viability.

Methods: Twenty-seven patients with coronary artery disease and an ejection fraction (EF) <40% were enrolled. For the ce–MRI, the segmental extent of hyperenhancement (SEH) was quantified after the administration of a gadolinium–based contrast agent, and for the SPECT a 4-hour redistribution protocol was used. For the assessment of EF, we used echocardiography. Comparison of viability assessment was performed in 1458 segments.

Results: Agreement between two modalities was obtained in 1332 (91.4%) segments, resulting in a kappa value of 0.8. In 126 segments, we had discordant results. 102 SPECT viable segments were non-viable according to ce–MRI and 24 ce–MRI viable segments were described as non-viable by SPECT.

Conclusions: SPECT was comparable to ce–MRI for myocardial viability assessment, but we were not able to define which of them was superior.

Keywords: Magnetic resonance imaging; Single photon emission computed tomography; Myocardial viability

Introduction

In patients with coronary artery disease (CAD), assessment of viable myocardium has important prognostic implications.[1] It has been generally acknowledged that only patients with a considerable amount of dysfunctional but viable myocardium benefit from revascularization procedures.[2,3]

Positron emission tomography (PET) in combination with perfusion imaging or single-photon emission computed tomography (SPECT) have long been accepted as reference methods for the detection of myocardial viability.[4] These techniques are relatively time-consuming and exposes the patient to radiation.

Ce–MRI as a new imaging modality has also been used for the assessment of myocardial viability. This technique provides direct imaging of necrotic tissue with high contrast and high spatial resolution.[5-7] In patients with CAD, the transmural extent of the scar tissue predicts functional recovery after myocardial revascularization.[8,9] Several studies suggest that areas of hyperenhancement represent irreversible ischemic injury.[10]

This study was conducted to compare ce–MRI with SPECT, using ^{99m}TC–sestamibi in detecting myocardial viability.

Materials and Methods

Thirty-six patients with CAD and an ejection fraction (EF) <40% determined by echocardiography with

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clinical indication for myocardial viability assessment were included in this study. Three patients were excluded due to the use of pacemakers, two owing to cerebrovascular disease and two due to significant valvular heart disease. Two patients refused to undergo ce–MRI. Thus, 27 patients completed the examination.

Characteristics of the patient population are shown in Table 1. This research was approved by the Ethics Committee of Mazandaran University of Medical Sciences and informed consent was obtained from all patients.

Table 1: Characteristics of Patients

Characteristics	Frequency
Number of patients (women)	27 (5)
Age (years)	57 (± 10)
History:	
Diabetes mellitus	9 (33.3%)
Arterial hypertension	11 (40.7%)
Hyperlipidemia	22 (81.5%)
Smoking	8 (29.6%)
Myocardial infarction	24 (88.8%)
Ejection fraction (%)	35.5 ± 3.6
Extent of coronary artery disease:	
Three vessel disease	14 (51.8%)
Two vessel disease	8 (29.6%)
One vessel disease	5 (18.5%)

A dual-head rotating gamma camera (Picker/Prism 1000) was used. Myocardial perfusion SPECT was performed 60 minutes after injection of about 400MBq of ^{99m}TC–sestamibi. Cardiac slicing in the long and short axis views of the left ventricle was performed, using a conventional software processing system.

A 1.5 Tesla MR system (1.5 GE, Torso Coil, Phase array, USA) was used for ce–MRI. The images were acquired in short and long axis views. From the apex to 1 cm below the insertion of the mitral valve, the short axis views were acquired at 1 cm increments. Thus, 8–10 short–axis and three long–axis views were obtained. Then, 0.2 mmol/kg gadolinium-based contrast agent was administered intravenously and after 15-20 minutes contrast–enhanced images were acquired, using an inversion recovery Turbo Flash (fast low-angle shot) sequence with a slice thickness of 10 mm in plane resolution 1.5 mm×1.8 mm. The inversion time was set in each patient to null the signal of the normal myocardium. The segments were evaluated by two experienced observers visually. The segments with ≤50% scar were designated as viable and those with >50% scar as non-viable.[11,12]

SPSS software (version 13, Chicago, IL, USA) was used for statistical analysis. Chi-Square test was used to compare the two groups. The Kappa statistics was used to calculate the level of agreement in the distinction between viable and non-viable myocardium.

Results

Characteristics of the study population are shown in Table 1. The majority of the patients had a previous history of myocardial infarction and most of them were three vessel disease. Myocardial viability assessment was done in 1458 segments acquired from the 27 patients. Table 2 shows a comparison of the two methods in terms of evaluation of segmental myocardial viability.

Table 2: Pairwise Comparison of Myocardial Viability between ce–MRI and SPECT

		SPECT (n)		
		Viable	**Nonviable**	
ce–MRI (n)	Viable	911	24	935
	Nonviable	102	421	523
		1010	448	

Kappa=0.8; Myocardial viability was defined as contrast enhancement≤50% of segmental area and technetium activity ≥50% of the maximum in the evaluated myocardium. SPECT indicates single–photon emission computed tomography using ^{99m}TC–sestamibi n; number of segments; and ce–MRI contrast enhanced magnetic resonance imaging.

In 91.3% of the segments, we had an agreement between the two methods, which denotes a Kappa value of 0.8. While only 24 SPECT non-viable segments were viable by ce–MRI, 102 non-viable ce–MRI segments were shown to be viable by SPECT.

SPECT non-viable/ce–MRI viable segments were found in 6 patients (22.2%) and were significantly more frequent in the inferior wall (p<0.001). However, SPECT viable/ce–MRI non-viable segments were localized in 12 patients (44.4%) and this accounts for 15.7% of the relevant segments.

Discussion

The results of this study demonstrate a high agreement between ce–MRI and SPECT. It had previously been proved that 50% of the segmental extent of hyperenhancement in ce–MRI would be a good discriminator for functional recovery after revascularization,[8]

so we considered segments with >50% SEH as non-viable. A high agreement was also reported between ce–MRI and a combined ^{18}F–FDG-PET/^{99m} Tc–sestamibi SPECT hybrid protocol for the prediction of regional and global improvement of the left ventricular function after revascularization by Kühl *et al.*[13] On the other hand, there are reports with only moderate agreement between these two methods.[12,14] In comparison with septal and antrolateral segments, inferior and inferolateral segments showed lower agreement. It was also reported that in the presence of discordant results between the two imaging modalities, ce–MRI was superior to PET/SPECT for predicting lack of recovery of segmental myocardial function after revascularization.[13]

The discordant results can be attributed to both imaging artifacts and the principal differences in the definition of myocardial viability between the two methods. Thinning of the myocardium without irreversible damage may result in a viability defect in a SPECT study, while ce–MRI allows determining directly the amount of viable myocardium within the thin segment.[15] Thus, ce–MRI may be especially important in identifying myocardial viability in patients with a thin myocardial wall.[13]

Imaging artifacts might result in discordant results in some cases. In an experimental model of acute myocardial infarction, overestimation of infarct size was reported by ce–MRI.[16] Soft tissue photon attenuation artifacts which are often observed in myocardial SPECT imaging might represent themselves as myocardial viability defects especially in the inferior and lateral myocardial wall.[17-19] This effect could explain some of our discordant results particularly in the inferior wall territory. In addition, the time required to perform a viability study with MRI is usually less than one hour, whereas this time extends to about 3 hours for SPECT, which is apparently an additional benefit of MRI compared with SPECT.

There were limitations to our study, the most important of which could be a lack of follow up imaging study after revascularization procedures. But it was proved that recovery of function was highly likely when both modalities demonstrated a preserved viability and was negligible when both techniques indicated non-viability.[13] Since there was a high agreement between these two techniques in our study, it seems that it was not so much necessary for post revascularization viability imaging in this study.

In our study, assessment of myocardial viability with SPECT was comparable with ce–MRI. Although ce–MRI defined more non-viable segments than SPECT, we were not able to find superiority of any of these methods.

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Conflict of interest: None declared.

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