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FAT SATURATION MAGNETIC RESONANCE IMAGING OF ACUTE MYOCARDIAL INFARCTION

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In this paper, we report a potential usefulness of the fat saturation technique for cardiac MR imaging to improve image quality. Twenty-seven patients with acute myocardial infarction underwent both conventional and fat-saturated T1-weighted MR imaging. In each patient, contrast-to-noise (C/N) ratio of fat-saturated MR images to plain T1-weighted images was calculated for quantitative assessment. Detectability of an infarcted lesion was assessed, which was depicted as an area of high signal intensity. The overall mean ratio of C/N of fat saturation MR images to that of conventional T1-weighted images was 1.86 ±1.52 (p=0.007). In visual assessment, fat saturation imaging was superior to T1-weighted imaging in 17 cases (63%), and the fat saturation method enabled us to differentiate between the infarcted lesions and the pericardial fat tissues in 3 of the 17 cases. In 9 cases (33%), no apparent distinction in the infarcted area detectability was seen between these two methods. There was one case that fat saturation images was inferior to conventional T1- weighted images. These results suggest that fat saturation MR imaging will be a potentially useful method to diagnose acute myocardial infarction.

Key words: Magnetic resonance imaging (MRI) / Heart / Myocardial infarction / Chemical fat saturation / Gd-DTPA enhancement

Magnetic resonance (MR) imaging has become one of the standard modalities for the diagnosis of acute myocardial infarction (AMI). It is known that infarcted lesions are enhanced by paramagnetic contrast agent(1-7), Gd-DTPA, and low flip angle method is appropriate to improve contrast enhancement under ECG-gated MR imaging. MR imaging is expected to have a potential for quantitative analysis of infarcted myocardium (8-13) and assessment of myocardial viability (7,14-18). However, sufficient images can not be obtained in some cases, because physiological motion induces artifacts, and the pericardial fat tissues of high signal intensity on T1-weighted images are occasionally considered as a causative factor to disturb appropriate diagnosis. Fat saturation MR technique has been recently used to image several areas in the body (19-22). Frequency-selective chemical fat suppression better delineates high signal intensity lesions surrounded by fat and thereby make adjacent structures more visible. Usefulness of Gd-DTPA in combination with the fat saturation technique has been reported by many investigators in the head and neck, including the orbit and the spine (22,23). It allows improvements in contrast between pathologic lesions and normal structures. In this study, we assess usefulness of fat saturation method in a purpose of improving image quality.

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PATIENTS AND METHODS

Twenty-seven patients (8 males, 19 females) with a mean age of 66.3 years (range 49-76 years) with acute myocardial infarction (AMI) were studied by ECG-gated magnetic resonance Imaging (MRI). Diagnosis of AMI was based on clinical history, typical enzyme rise, and characteristic ECG abnormality. In all patients, coronary angiography was performed and reperfusion was achieved in 26 patients. In one patient, the infarct-related coronary artery was remained occluded.

MR imaging was performed with a superconducting system operating at 1.5T (Signa, GE Medical System, USA). ECG-gated multislice imaging was applied using a slice thickness of 8 mm, a 2 mm interslice gap, an echo time (TE) of 20 msec, and a repetition time (TR) equal to one R-R interval. The imaging matrix was 256 × 128 pixels, and two excitations were averaged. Each patient underwent T1-weighted imaging once and fat saturation imaging twice in various turn, after intravenous injection of Gd-DTPA at a dose of 0.1 mmol/kg up to 15 minutes after administration.

Quantitative evaluation of contrast enhancement was performed with computer-assisted determination of signal intensities on both T1-weighted and fat suppression images. Signal intensities were obtained from myocardial areas after selecting the left ventricular slice that showed maximal contrast enhancement. For the same image, the contrast-to-noise (C/N) ratio was calculated, which is a measure for the lesion detectability. The C/N ratio was calculated according to the following formula:

$$C/N = \{ (SI - SN) / SN \} / SD\ noise$$

where SI is signal intensity of the infarcted myocardial lesion and SN is signal intensity of the normal myocardial area. SD noise was defined as an average standard deviation of the background noise for each image.

The MR images were visually assessed for the presence of signs indicative of myocardial infarction, and detectability of those change of signal intensity was compared between T1-weighted and fat saturation images. Quantitative evaluation of contrast enhancement was performed with computer-assisted determination of signal intensities. Signal intensities were obtained from myocardial areas after selecting the left ventricular slice that showed maximal contrast enhancement.

The images were read by two independent observers blinded to the patient identity. In case of disagreement, a third observer was consulted for reaching consensus. To determine inter- and intra-observer variability, measurements were repeated independently.

C/N ratios were expressed as means ± SD. The paired two tails Student's t -test with Bonferroni's correction for multiple tests was used to compare C/N ratios of T1-weighted and fat saturation images. P value of less than 0.05 was considered statistically significant.

RESULTS

Quantitative analysis:

The overall mean ratio of C/N of fat saturation images to that of T1-weighted images (1.00) was 1.86 ± 0.29 (mean ± SD, $p = 0.007$). C/N ratios of each case are shown in Fig. 1.

Visual assessment:

In 17 cases, fat saturation images showed more definitive change of signal intensity which is indicative of infarction (Figs. 2 and 3), and in 3 of the 17 cases, fat saturation imaging enabled to distinguish infarcted lesion from pericardial fat tissues, which is high signal intensity on conventional T1-weighted images. Detectability of those signal intensity change was not different between T1-weighted and fat saturation images in 9 cases. There was one case that fat

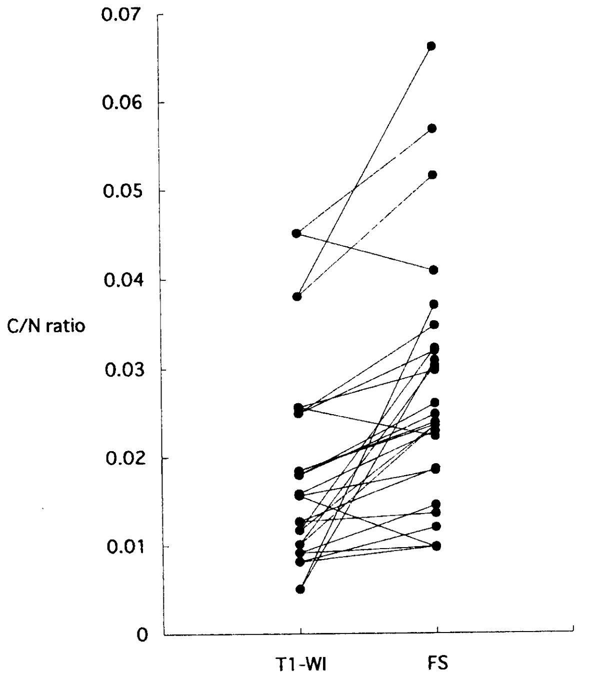
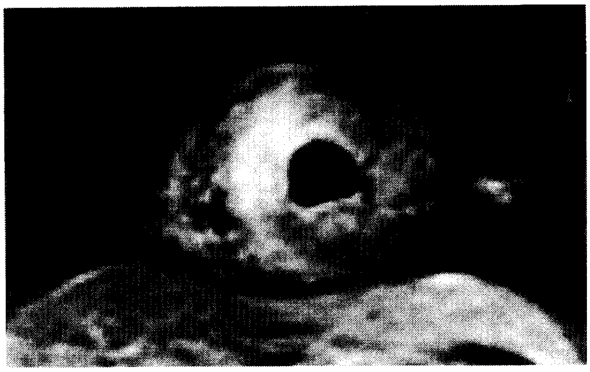


Fig. 1. Comparison of C/N ratios between T1-weighted images (T1-WI) and fat saturation images (FS) in 27 patients.

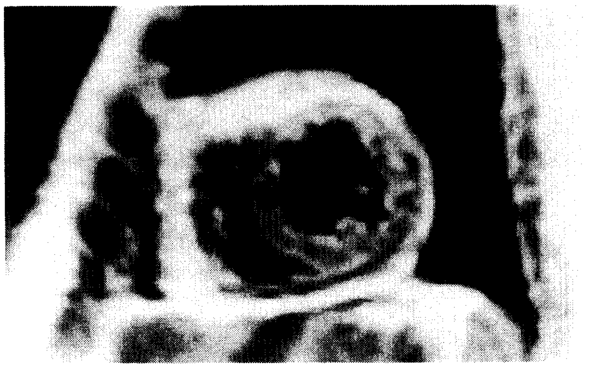
The overall mean ratio of C/N of fat saturation images to that of conventional T1-weighted images was 1.86 ± 1.52 ($p<0.01$).

2 (a)



2 (b)

Fig. 2. A case with anteroseptal wall infarction. Contrast between infarcted and normal myocardium was improved on a T1-weighted image (a), compared with fat saturation image (b).



3 (a)

3 (b)

Fig. 3. A case with anterior wall infarction. A high signal intensity lesion was observed on both T1-weighted image (a), and fat saturation image (b). Fat saturation images made it possible to differentiate pericardial fat tissues and an abnormally enhanced lesion.

saturation imaging was inferior to Tl-weighted imaging in detectability of signal intensity changes.

DISCUSSION

Previous studies have indicated that Gd-DTPA-enhanced MR imaging has a potential for estimating volume of infarcts, but fairly good correlation between MRI and other modalities is available in only a few studies in human. For the quantitative assessment of infarct volume, C/N ratios of the conventional images are not satisfactory because of artifacts and noise, and it is necessary to improve quality of images so that abnormally enhanced areas are delineated. High SI structure of pericardial fat may reduce the C/N ratio in cardiac MR imaging, and it is often difficult to be differentiated from abnormal high SI areas in myocardium.

To our knowledge, there is a question about the period that the infarcted myocardium will be enhanced. Although many previous reports have indicated that infarcted myocardium will be enhanced for about three month after the onset of the symptom (5, 17), we have some cases that it lasted longer on fat saturation images. Therefore, more sufficient images are supposed to show enhancement of infarcted lesion for a longer period.

Tl-201 myocardial SPECT has an important role for assessing myocardial perfusion and viability of injured myocardium (24). But in this method, it is difficult to detect small lesions such as sub-endomyocardial infarction (25, 26). In this regard, MRI is more sensitive because infarcted lesion is depicted as larger high signal intensity area including adjacent ischemic zone. Although Tc-99m-pyrophosphate accumulates in a lesion of infarction with high sensitivity, background accumulation often reduces its specificity. To shorten the examination time and improve quality of images, MRI might be a more useful modality in the diagnosis of ischemic heart diseases.

We conclude that fat saturation MR imaging has a potential to improve detectability of signal intensity changes owing to its higher contrast-to-noise ratio, and to delineate abnormally enhanced myocardium.

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