Fat Suppressed Delayed Enhancement Imaging

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Introduction

Inversion recovery (IR) techniques are widely used to image infarcted myocardium that exhibits delayed hyperenhancement after administration of contrast agent. Distinction between infarcts and epicardial fat may be difficult due to the short longitudinal relaxation times (T1) in both species post contrast. Fat suppression would be highly desirable when assessing transmural infarct or myocardial cell death at the right ventricular free walls in ARVD patients.

In this work, two methods of fat suppression in infarct imaging were examined. We compared the performance of (1) an IR segmented turboFLASH sequence [1] with fat saturation preparation pulse preceding acquisition and centric *k*-space reordering for image acquisition, with (2) an IR segmented turboFLASH sequence using spectral spatial excitation pulses. The two methods were first evaluated in healthy volunteers. The better method was then tested on patients with myocardial infarction (MI).

Material and Methods

Fat suppression:

Method 1: Fat saturated IR segmented turboFLASH. It was expected that collecting central *k*-space lines (TE/TR=4.9ms/9.9ms) after fat saturation would null the fat signal [2]. This is a time efficient method for fat suppression. However, this method is very susceptible to field homogeneity [3].

Method 2: Spectrally and spatially selective IR segmented turboFLASH. Composite binominal slice selective pulses are frequency selective and effectively excite water protons [4-6]. In this work, two binominal pulses were tested and used for each imaging line: A composite pulse with two elements (1-1) or with three elements (1-2-1) was used. The (1-2-1) pulse has a broader frequency band for off-resonant protons. However, the (1-1) pulse increases the TE/TR by 0.4ms/3.1ms and the (1-2-1) pulse increases the TE/TR by 2.8ms/5.5ms for a readout bandwidth of 140Hz/pixel.

Volunteer study:

Localization scans were run to find the 4-chamber view of the subject. Double dose Gd-based contrast (0.2mmol/kg, Magnevist, Schering AG, Germany) was then injected to the volunteer. A local shim was performed that covered the heart to improve field homogeneity in that region. After about 8 minutes, the appropriate inversion time (TI) needed to null the myocardium was determined. Images were then acquired no fat suppression and with the two methods. The second method was applied twice using the two different excitation pulses. The SNR from epicardial fat from the different fat saturation scheme was divided by the SNR from the non-fat sat images to assess the performance of the different fat suppression methods.

Other typical imaging parameters were: FOV 360, SL 8mm., 144x192 matrix, 19-25 segments per heartbeat. TI was set to null the myocardium.

Patient study:

The best fat suppression method found from the volunteers was used in the patient study. Three patients with infarcts were scanned. Double dose was used in each case. For each patient, the standard technique with no fat sat was first used, followed by the fat suppression method that was found to work best in volunteers.

Tab. 1: *SNR of epicardial fat*	No fat saturation	1-2-1 excitation	1-1 excitation	Fat saturation
Post contrast injection	100	49 ±9	58 ±9	81 ±20

Results

Volunteer study:

Table 1 summarizes the percent of epicardial fat remaining in the four volunteers. Fat suppression was improved by using method 2 and the performance is more reliable; the deviation compared to method 1 is comparatively smaller. The (1-2-1) water excitation method works slightly better than the (1-1) excitation method. Figure 1 a) shows the results of the several methods tested.

Patient study:

Signal from the epicardial fat was attenuated in all the patients with myocardial infarctions (Figure 1 b-c) without compromising the visibility of the MI.

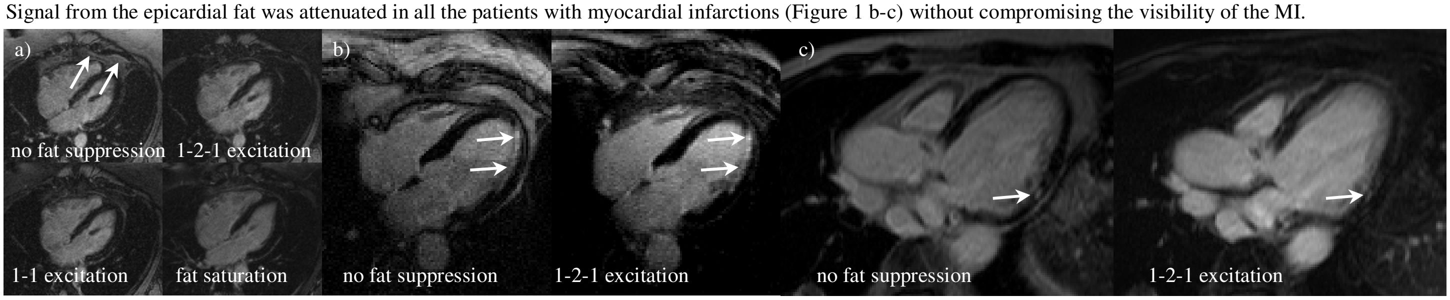

Fig. 1: *(a) Fat suppression in a healthy volunteer. White arrows indicate epicardial fat used for SNR evaluation. The lowest fat SNR was achieved by using (1-2-1) excitation scheme. (b) IR images of an MI patient (67, male) without fat suppression (left) and (1-2-1) excitation (right) 20min post contrast. The MI is clearly visible in both images. The fat is suppressed significantly. (c) IR images of an MI patient (84, male) with (right) and w/o fat suppression (left) 16 min after contrast agent injection. The subtle MI is visualized but compromised due to slightly different slice positions.*

Discussion

The three-pulse scheme for fat suppression potentially improves the evaluation of transmurality of MI in cases of ambiguous morphology and poor contrast between infarcted myocardium and fat. Furthermore, the technique may help assessing fat infiltration and cell death in ARVD patients. This method potentially helps in evaluation of cardiac masses, e.g. distinguishing fatty masses from metastatic cancer.

References

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