Fat/Water Separated Delayed Hyperenhanced (DHE) Myocardial Infarct Imaging

J. W. Goldfarb[1]

[1]Saint Francis Hospital, Roslyn, New York, United States

Introduction: Fat deposition associated with myocardial infarction has been reported as a commonly occurring phenomenon. Magnetic resonance imaging has the ability to effectively detect myocardial infarction using T_1 sensitive contrast-enhanced sequences[1] and fat via its resonant frequency difference[2]. In this work, the feasibility of fat/water separation applied to the conventional delayed hyperenhanced (DHE) infarct imaging technique is demonstrated. A three-point DIXON acquisition and reconstruction was combined with an inversion recovery gradient-echo pulse sequence. This allowed fat/water separation along with contrast-enhanced T_1 sensitive imaging. In the future, characterization of MI using MR imaging may allow further risk stratification and improve patient outcomes.

Materials and Methods: We implemented a 2D inversion recovery gradient echo pulse sequence to collect images with three different echo times (TE= 4.8, 7.2, 9.6 ms). Multi-echo gradient echo sequences are becoming increasingly available and have been used primarily for T_2* quantification in areas such as blood oxygen level dependent (BOLD) and iron overload imaging. The multi-echo gradient echo sequence with gradient reversal allowed collection of multiple echo times in a single TR, reducing acquisition time when compared to repeated acquisitions with increasing individual echo times. The sequence was velocity compensated in slice select and readout directions. Sequence parameters were: (TR/TE/FA=11.5/(4.8/7.2/9.6)/45; Matrix=91x192; voxel size=2.5x1.7x10mm^3; 15 phase encoding lines per segment; interleaved segments; 1 silent heartbeat between acquisitions; BW=540 Hz/pixel; linear filling of k-space; adiabatic non-selective inversion recovery pulse, monopolar gradient sampling of data).

Raw data for each echo and coil of the multi-echo pulse sequence was saved and transferred to a personal computer for fat/water separation reconstruction. A computer program written in the JAVA language implemented the reconstruction algorithm. A region growing phase unwrapping method was used to correct for Bo field inhomogeneities. aFat/water images were generated using a continuous sign function[3].
Examples from three cases using the sequence were acquired in chronic myocardial infarction patients. Opposed phase (TE= 2.2 ms) gradient-echo images were acquired before contrast agent administration of 0.015 mmol/kg Omniscan. After a delay of 25 minutes, IR multi-echo images were acquired for fat/water separation..

Results: Phantom experiments showed excellent fat/water separation over a range of T_1 relaxation and inversion times (Fig. 1). Plots showed that although the signal intensity in the separated images was reduced, the null point and contrast were preserved. This was true over the range of T_1 values expected in DHE imaging and inversion times typically used. Signal intensities were reduced in separated images due to the use of multiple -echo times for the reconstruction of these images.
The first case of a lateral wall infarct showed no fatty deposition. The fat image contained signal primarily from epicardial fat. The second and third cases showed marked fatty deposition (Fig. 2). Both could be seen to be in the mid-wall in the same areas of delayed hyper enhancement. Each case of LV fatty deposition was confirmed using precontrast opposed phase gradient echo imaging.

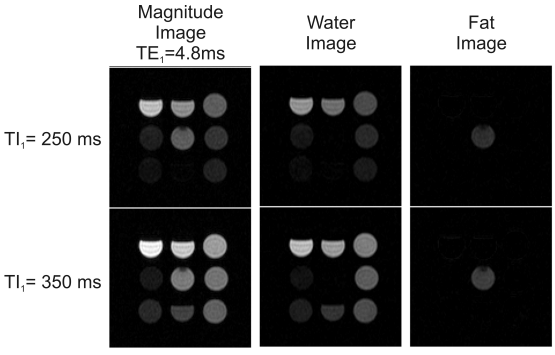

Figure 1. Images from IR multi-echo pulse sequence. Phantom experiments show equivalent T1 weighting after fat/water separation. Center vial is fat. Surrounding vials are increasing concentrations of Gd-doped saline

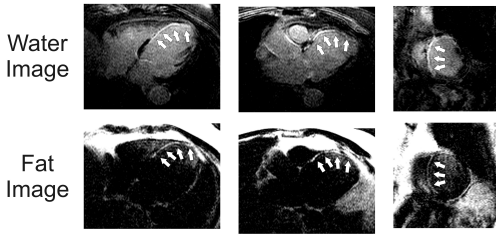

Figure 2. Fat/Water separated DHE infarct images of patient with a chronic myocardial infarct having fatty deposition.

Conclusions: Multi-echo fat/water separation can be combined with inversion recovery DHE imaging. Results show that areas of DHE can have significant fatty deposition.

References:

1. Kim RJ et al, N Engl J Med. 2000 Nov 16;343(20):1445-53.

2.Dixon, WT, Radiology. 1984 Oct;153(1):189-94.

3. Wang Y et al J Magn Reson Imaging. 1998 May-Jun;8(3):703-10.