Title: Multi-contrast Delayed Enhancement Provides Improved Imaging of Sub-Endocardial Myocardial Infarction

Authors: Peter Kellman, Yiu-Cho Chung, Orlando P. Simonetti, Elliot R. McVeigh, Andrew E. Arai

Introduction:
Delayed enhancement imaged using an inversion-recovery sequence exhibits excellent contrast between infarcted and normal myocardium; however, the contrast between the MI and the blood pool is frequently suboptimal. Since a large fraction of infarctions caused by coronary artery disease are subendocardial, it is often difficult to assess the precise size of the infarct or to detect small infarcts. The T2 of blood is significantly longer than either acute or chronic MI. The proposed Multi-COntrast Delayed Enhancement (MCODE) imaging method produces a series of images with both T1 and T2 weightings which provides both excellent contrast between normal and infarcted myocardium, and between blood and MI. This enhances detection of the infarcted region and improves infarct measurement accuracy.

Purpose:
To demonstrate that multi-contrast delayed enhancement imaging of myocardial infarction improves contrast between MI and blood pool.

Methods:
The MCODE imaging method produces separate images with T1 and T2-weighting. Both images are acquired during the same breath-hold at the same cardiac phase and are therefore registered, which is critical to discriminate subendocardial MI. Both single-shot trueFISP and turboFLASH sequences are being evaluated. For the single-shot trueFISP sequence, T2 weighting is achieved using a large flip angle readout after magnetization recovery, whereas the segmented turboFLASH sequence uses a T2 preparation.

The sequences were implemented on a Siemens Sonata 1.5T scanner. Results are shown for the single-shot phase-sensitive inversion-recovery (PSIR) trueFISP sequence. The multi-contrast sequence required a single 3 heartbeat acquisition to acquire T1-weighted (IR image), PSIR reference, and T2-weighted images at the same cardiac phase in mid-diastole. A B_1-weighted phased-array combined phase-sensitive reconstruction method was used [1].

N=6 patients with chronic MI were imaged approximately 20 minutes after administering a double dose of Gd-DTPA. CNR between MI and blood were measured.

Results:
A scatter plot of signal intensities for MI, blood, and normal myocardium regions (Fig. 1) shows how T2 may be used to separate blood and MI despite similarity in T1 weighted intensities. The measured MI-to-blood CNR (m±sd) was better in the T2-weighted image than T1-weighted image (15.7±8.5 vs. 4.4±3.9, N=6, P=0.009). Short axis images for a patient with chronic MI are shown in Fig. 2. The MI and normal myocardium are easily discerned in (a) while the MI and blood are easily discerned in (b). Fig 2(c) displays a ratio image which enhances the MI-to-blood contrast. Alternatively, the endo and epi contours may be traced on (b) and copied to (a) (not shown) as an effective means of visualization and detection. Long axis

images from a second patient are shown in Fig. 3 illustrating enhanced detection of a small sub-endocardial MI. The MI indicated by arrow might easily be missed in the T1-weighted image (a) but is easily distinguished from the blood pool by comparison with T2-weighted image (b).
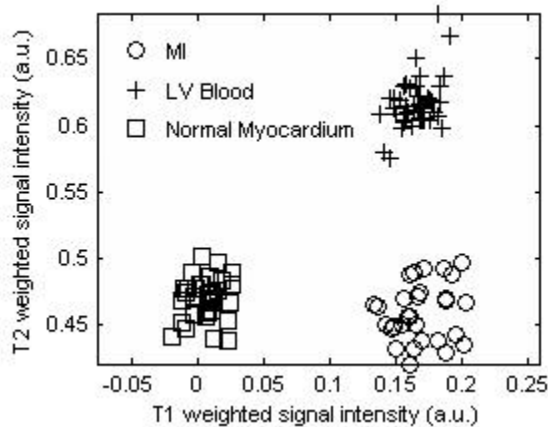

Figure 1. T1 and T2-weighted signal intensities in MI, blood, and normal myocardium regions illustrating the discrimination of the MCODE method.
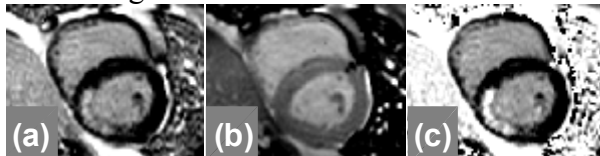

Figure 2. (a) T1-weighted, (b) T2-weighted, and (c) ratio image illustrating improved MI-to-blood contrast.
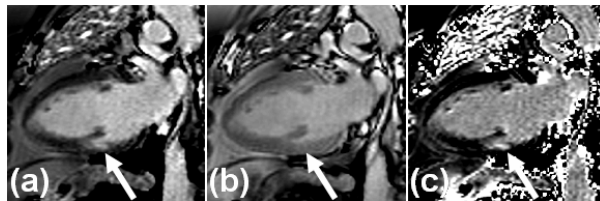

Figure 3. (a) T1-weighted, (b) T2-weighted, and (c) ratio image illustrating improved MI-to-blood contrast.

Conclusions:

Multi-COntrast Delayed Enhancement (MCODE) imaging provides a significant improvement in the ability to detect subendocardial MI by providing a T2 weighted image with high contrast between blood and MI. MCODE improves both the detection and sizing of MI and has the potential to image edema allowing differentiation of acute vs chronic MI.

References:
1.   Kellman P, et al. MRM. 2002; 47:372-83.