

Short Inversion Time Gadolinium-enhanced Myocardial Infarct Imaging Yields Improved Infarct to Blood Contrast

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Introduction: Image contrast between myocardial infarction and the left ventricular (LV) bloodpool often remains problematic in hyperenhanced late gadolinium enhanced (LGE) infarct imaging. Typically an inversion recovery pulse sequence is used with the inversion time parameter set to minimize signal from viable myocardium, so-called hyperenhancement (LGE-HYPER). The purpose of this study was to explore the advantages and disadvantages of setting the inversion time parameter such that the signal intensity of infarcted myocardium is minimized, so called hypoenhancement (LGE-HYPO). Theoretical simulations and in vivo experiments were performed and analyzed to describe the image contrast properties of short inversion time gadolinium-enhanced infarct imaging.

Materials and Methods: Theoretical simulations of LGE-HYPER and HYPO imaging showed that the optimal contrast for imaging two species is achieved by setting the inversion time parameter to minimize signal from the species with the longest T_1 relaxation time. Viable myocardium has the longest T_1 relaxation in LGE experiments and this explains the wide spread acceptance of the LGE-HYPER method. When the inversion time was moved from nulling viable myocardium to nulling blood or infarct, image contrast between infarcted myocardium theoretically can be improved.

Thirty-one patients were enrolled in this study. (Infarct Age=9.8±10 years; range:10 days to 31 years). Subjects were imaged with an inversion recovery CINE balanced steady-state free precession (IR-CINE-bSSFP) pulse sequence. In a breath-hold, this sequence provides multiple images at consecutive inversion times during the cardiac cycle. These inversion times spanned image contrasts including hypo- and hyperenhancement of the infarcted myocardium relative to the adjacent myocardium. Images in a slice including LV bloodpool, infarcted and viable myocardium were acquired at 10, 15, 20 and 30 minutes after 0.2 mmol/kg of gadodiamide (Omniscan) was injected at 2 ml/s followed by a 15ml saline flush. Image parameters were: TR/TE=2.5/1.1 ms; FA=50 degrees; BW=965 Hz/Px; Matrix=104x192; Voxel size=2.5x1.8x8mm³. Region of interest measurement were performed in areas of myocardial infarction, viable myocardium and LV bloodpool. T_1 values were calculated for each subject and time point. Images with the least signal from infarcted and viable myocardium were identified as LGE-HYPER and LGE-HYPO images. The relative contrasts between the LV bloodpool, viable and infarcted myocardium were calculated and compared using a two-tailed paired Students t-test. Range and average inversion times for optimal LGE-HYPER and HYPO imaging were tabulated and compared.

Results: Improved contrast was realized between infarcted myocardium and the LV bloodpool with LGE-HYPO imaging (Figure 1). Contrast improved at longer delays after contrast agent administration. Other contrasts (viable to infarct and blood to viable) were less in hypoenhanced images and contrast decreased as imaging time after injection increased. While optimal inversion times for LGE-HYPER changed significantly over 30 minutes, inversion times for LGE-HYPO imaging did not change significantly after 15 minutes.

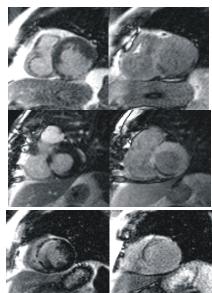


Figure 1: LGE-HYPER (left) and LGE-HYPO (right) images from three subjects. Note that infarcted myocardium and the LV bloodpool are isointense in LGE-HYPER images and have excellent contrast in LGE-HYPO images.

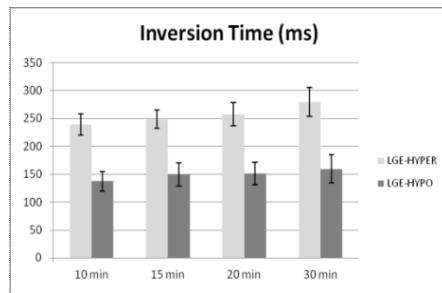


Figure 2: The inversion time for LGE-HYPO was of course less than that of LGE-HYPER. The LGE-HYPO inversion time did not change significantly after 15 minutes.

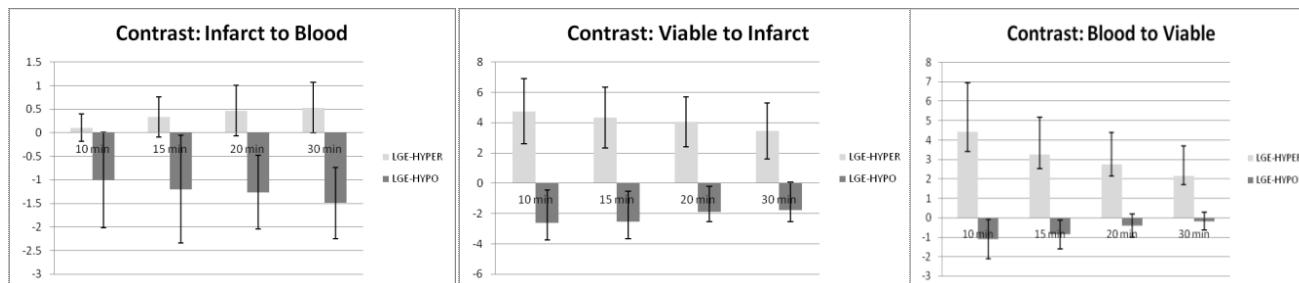


Figure 3: Contrast calculations showed that longer delays after contrast administration significantly increased infarct to blood contrast and decreased viable to infarct and blood to viable contrast.

Conclusions: Short inversion time myocardial infarct imaging (LGE-HYPO) provides improved contrast between the LV bloodpool and infarcted myocardium at the expense of decreased contrast between viable myocardium and both the LV bloodpool and infarcted myocardium. A combination of LGE-HYPER and LGE-HYPO may provide the best image contrast for detection of myocardial infarction.