Introduction
The uptake of gadolinium contrast agent in coronary walls may indicate metabolically-active atherosclerosis (Maintz et al, 2006) and therefore be useful in the setting of coronary allograft vasculopathy (CAV). The interpretation of inversion recovery (IR) images can be hampered by signal from tissues with longer T1 times (particularly the myocardium) as tissue suppression is T1 dependent and only optimal for one specific T1 species (e.g. blood). We sought to improve contrast-enhanced coronary vessel wall imaging using a novel non-selective double inversion recovery (NS-DIR) prepulse that provides signal suppression over a wide user-defined T1-range.

Methods
The NS-DIR prepulse with two time delays, T11 and T12, was implemented on a 1.5T MR scanner. T11 and T12 were optimized in MATLAB simulations by minimizing M2 NS-DIR over a user-defined T1-range for a given heart rate.

A T1-phantom containing 11 T1-samples (T1-range=120-1730ms) was imaged with the IR and NS-DIR pre-pulses for simulated heart rates between 45 and 105bpm. For each prepulse, the signal-to-noise ratio (SNR) was calculated for each sample.

Nine patients who had undergone heart transplantation (ages=12-17y) were imaged ~20 minutes after injection of 0.2ml/kg Gadobutrol using a 32-channel coil on a 1.5T

Figure 1  Simulated Mz values (solid lines) and phantom SNR values (data points) for a) the IR sequence (T1 set to null T1 species 340ms for different heart rates) and b) the NS-DIR sequence (T11 and T12 values optimized to minimize Mz for a range between 200 and 1400ms for different heart rates.) N.B. The theoretical Mz values have been scaled in order to display the data on the same graph.
MR Scanner. Firstly a coronary MRA was performed followed by a targeted, free-breathing, ECG-triggered, 3D-IR segmented gradient-echo (TFE) sequence along the right and left coronary arteries. Imaging parameters included spatial-resolution=1.25x1.25x3mm, TR/TE=3.5/1.4ms, FA=30° and the TI was chosen to null blood from a Look-Locker sequence. Subsequently, identical planes were repeated with the IR replaced by the NS-DIR prepulse with imaging parameters maintained. Inversion times T11 and T12 were set to suppress tissues with T1 values between 200-1400ms according to the patient’s heart rate. Imaging was performed every heartbeat at the mid-diastolic rest period.

**Results**
Simulations and phantom studies show that the IR sequence (fig.1a) only nulls one T1 species whereas the NS-DIR sequence (fig.1b) achieves excellent signal suppression over the desired T1-range. Patient studies showed that the NS-DIR sequence (fig.2a) achieved simultaneous suppression of the blood and myocardium. Only the areas of contrast uptake are visible, which correspond to the path of the LCA (fig.2b). In contrast, interpretation of the IR images (fig.2c and fig.2d) was hampered by the bright signal in the myocardium.

**Conclusion**
Simulations and phantom studies demonstrate that the NS-DIR sequence exhibits excellent tissue suppression over a wide T1-range. Preliminary patient data show improvement in contrast agent visualization in the coronary vessel walls in patients with CAV.

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