Dual inversion recovery pre-pulse improves blood suppression and allows earlier late gadolinium enhancement imaging of atrial scar after radiofrequency ablation

Sarah Anne Peel[1], Aruna Arujuna[1], James Harrison[1], Reza Razavi[1], Kawal Rhode[1], Jaswinder Gill[1], Tobias Schaeffter[1], and Rene Botnar[1]
[1]*Division of Imaging Sciences and Biomedical Engineering, King's College London, The Rayne Institute, London, United Kingdom*

Introduction: Pulmonary vein isolation (PVI) is an established catheter ablation strategy in treating patients with drug refractory symptomatic paroxysmal atrial fibrillation (AF). Recurrences however are common and are related to PV reconnection secondary to incomplete circumferential or transmural ablation (1). A good correlation has been found between late gadolinium enhancement (LGE) using the inversion recovery (IR) technique and procedural outcome (2). However, scar visualization is hampered by strong residual blood signal. Therefore imaging is often performed at least 25 minutes after contrast administration to ensure the contrast agent has cleared from blood. Recently, the dual-IR pre-pulse was shown to improve blood suppression in LGE images of myocardial scar (3). In this study, we assessed whether the dual-IR pre-pulse improves blood suppression in LGE atrial scar imaging and whether it allows imaging earlier after contrast administration.

Methods:

LGE Sequence: LGE imaging was performed using a 3D free breathing, respiratory-navigated, ECG-triggered gradient echo (GE) sequence (2). Image acquisition was timed at end diastole using a preceding balanced steady state free precession (bSSFP) cine image. Imaging parameters included: TE/TR = 2.6/5.4ms, navigator window = 5-7mm, flip angle = 25°, voxel size = 1.2x1.2x4mm (reconstructed = 0.6x0.6x2mm). A delay of 100ms was applied between the navigator and image acquisition to avoid the pulmonary vein inflow artifact (4). The traditional IR-GE pre-pulse (fig. 1a.) was employed with the TI set to null normal myocardium using a preceding Look Locker scan. The dual-IR-GE sequence (fig. 1b.) employed two non-selective inversion pre-pulses separated by two time delays TI1 and TI2. These delays were optimized to achieve signal suppression in a T1 range of 250 - 1400ms according to the heart-rate. The aim of the dual-IR pre-pulse is to simultaneously suppress both normal atrial wall and blood signal whilst maintaining high signal in atrial scar.

MR Imaging: Twelve patients (10 male, age 57+/-10yrs) underwent MR imaging using a 1.5T clinical MR scanner (Philips Healthcare, Best, NL) following RF ablation for AF (median = 5; IQR = 3 months). 0.2mmol/kg of gadopentate dimeglumine (Magnevist, Bayer Schering AG, Berlin) was administered. Dual-IR-GE imaging was performed at 15, 20 and 30 minutes and compared to standard IR-GE imaging at 25 minutes.

Image Analysis: Regions of interest were manually defined in 5 slices in the blood and right superior PV scar. Blood and scar signal-to-noise (SNR) and scar-to-blood contrast-to-noise (CNR) values were measured using Osirix software.

Results & Discussion: Dual-IR images achieved superior blood suppression at an earlier time point (Fig 2). Blood SNR values were significantly reduced at all time points compared to IR images (fig. 3a.) whereas there was no significant difference in scar SNR (fig. 3b.). Scar-to-blood CNR values were significantly improved with dual-IR after 20 and 30 minutes compared to IR at 25 minutes. In conclusion, dual-IR achieves high quality LGE images earlier after contrast administration than IR-GE imaging and without the need for a Look Locker scan. It improves the visualization of scar contour definition and potentially reduces the total scan time.

References: 1) Verma A et al. Circ. 112:627-35 (2005), 2) Peters DC et al, JACC 2:308-16 (2009), 3) Peel SA et al. Proc. ISMRM 2011 E-poster 3387, 4) Moghari MH et al. MRM 66:180-186 (2011).

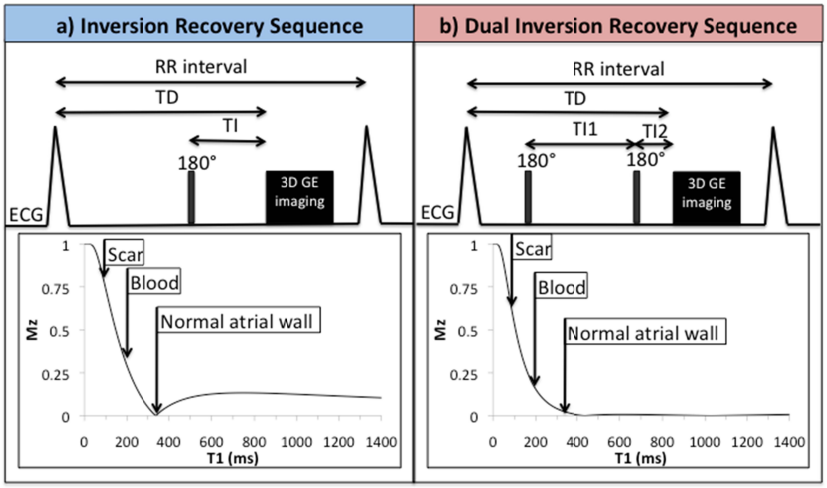

Fig. 1: IR (a) and dual-IR (b) pre-pulses with corresponding signal vs T1 plots. The IR pre-pulse only suppresses the normal atrial wall whereas the dual-IR pre-pulse suppresses both the atrial wall and blood.

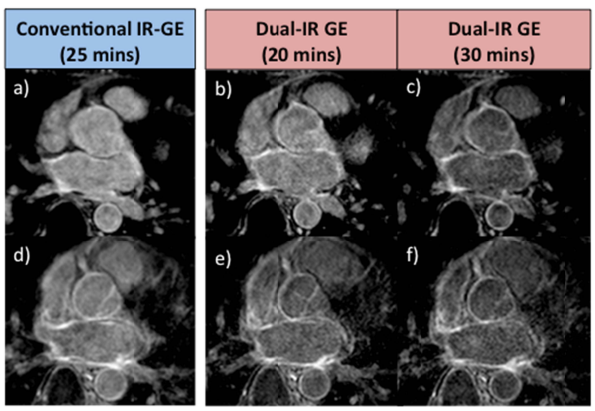

Fig. 2: LGE of atrial scar in two patients: IR imaging at 25 mins (a and d) and dual-IR imaging at 20 mins (b and e) and 30 mins (c and f). All images have identical windowing.

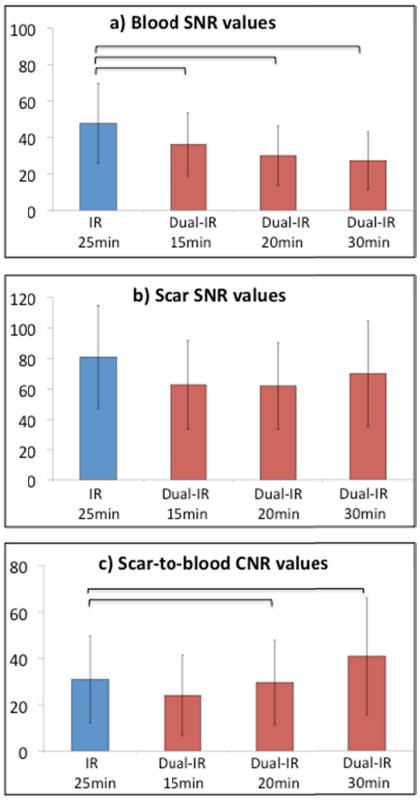

Fig. 3: a) Blood SNR, b) scar SNR and c) scar-to-blood CNR measurements for IR and dual-IR images. Horizontal bars indicate statistical significance in a paired t-test p<0.05.