T2-weighted imaging of the left atrium acutely after pulmonary vein isolation demonstrates wall thickening and edema.

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Introduction: Pulmonary vein isolation (PVI) by RF ablation of the left atrium (LA) is increasingly employed to treat atrial fibrillation (AF). However, the success rate for preventing AF recurrence is only 65-85%. A post-procedural or real-time evaluation of the ablation lesions to confirm their optimal placement would be desireable. MRI can contribute by visualizing the ablations. Our group and others have recently demonstrated that RF ablation lesions can be evaluated by MRI after healing (>30 days post PVI), and the locations and contiguity of the lesions correlate with AF recurrence (1,2). However, the appearance of lesions acutely after PVI is less well understood, and has been the focus of recent electron beam tomography and MRI studies (3,4). We sought to investigate the ability of T2-weighted images to show edema of the LA in a group of patients 1 day post RF ablation.

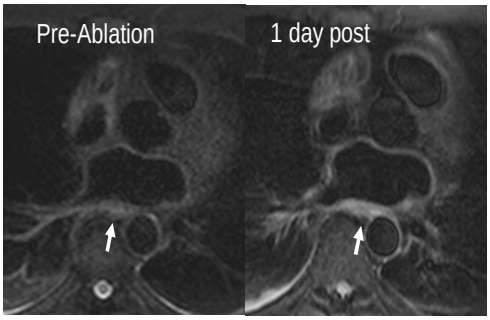

Figure 1: Pre RF ablation and 1 day post RF ablation T2-weighted black blood FSE images of the left atrium (LA). Arrows point to thickened and "bright" posterior LA wall/RF ablation site site.

Methods: Five subjects with a history of AF were studied 1 day following RF ablation. Two healthy adult subjects served as controls. Two black blood fat-suppressed 2D fast spin echo sequences were used. A black blood **T2-weighted STIR** (short TI inversion recovery) sequence had the following parameters: 1.6 x 2.4 x 5 mm, 300mm FOV, 2RR between inversions, 180ms STIR delay, 20mm reinversion pulse, 822ms black blood delay, echo train length 31, linear order, echo spacing 3.6ms, 2 averages, free-breathing, ECG-gating to mid-diastole. A **T2-weighted fat saturation** sequence was used with similar parameters except: a spectrally selection 90º pulse (and careful shimming) instead of STIR, echo train length of 16, free-breathing or breath-held, spatial resolution of 1.4 x 1.4 x 5 mm, 529ms black blood delay. We studied three aspects of the T2-weighted method. Breath-holding was compared to the clinically more feasible free-breathing scan (with 2 averages). Fat-suppression using fat-saturation (90º fat-selective pulse) was compared to the STIR technique. Finally we studied the signal evolution using TEs between 40 and 80ms, measuring the signals of the LA wall and left ventricular (LV) myocardium, and calculating the ratio.

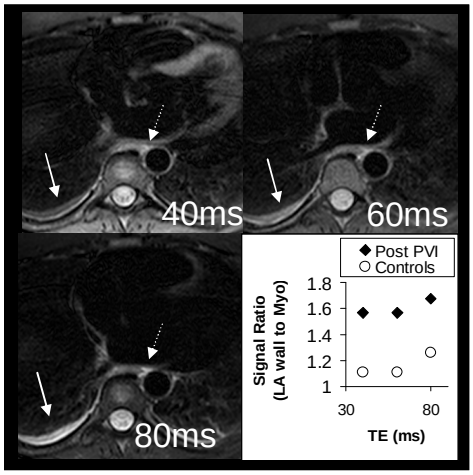

Figure 3: Images 1-day post RF ablation showing the effect of increasing TE. Note that the pleural effusion (arrow) and a hot-spot of the posterior wall (dashed arrow) appear with greater contrast at higher TEs. The ratio of signal in the posterior LA wall compared to LV myocardial signal is plotted for patients and controls, measured at three different TEs.

Results: Figure 1 compares the pre and 1 day post PVI images. Note the increased LA wall thickness in the 1 day post PVI image (arrow), reflecting probable edema. The ratio of LA-wall to LV myocardium signal was 1.6±0.3 in 1 day post PVI patients and 1.2±0.2 in controls, showing that the LA wall has a higher signal relative to the LV myocardium following PVI, vs. controls, likely caused by edema which leads to a higher T2. This ratio's dependence on TE is shown in Figure 2. Image quality was improved using breath-holding rather than free-breathing in 60% of scans (Figure 3), but 20% of the free-breathing images were better. The fat suppression using the spectrally selective fat-saturation pulse resulted in a LA wall to fat signal ratio of 2.6±1.8 with less uniformly suppressed fat, compared to 5.1±2.2 for STIR imaging.

Conclusions: We have studied and applied a T2-weigthed fast spin echo MRI sequence to observe edema in subjects 1 day following RF ablation for AF. Preliminary data suggests edema of the LA wall, as evidenced by the wall-thickening and increased signal ratio in the RF ablation patients (Figs. 1& 2). Breath-holding acquisition image quality appeared superior to free-breathing multi-averaged images. Fat-saturation, compared to STIR imaging, provides adequate although imperfect suppression of fat. This study is an important step in characterizing acute changes after PVI using MRI, potentially allowing assessment of lesions in near real-time.

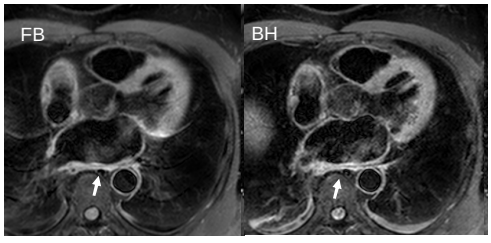

Figure 2: Comparison of free-breathing (FB) and breath-hold (BH) MRI in a subject 1 day post RF ablation. The LA is better defined on the BH image.

1) Peters DC et al, JACC Cardiovascular Imaging, 2009.
2) McGann CJ et al, JACC 2008:52;1263-71.
3) Okada T et al, JACC 2007:49:1436-1442.
4) Yokokawa M et al, AHA 2008, 700.