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High resolution delayed enhancement imaging using a spiral k-space trajectory for the detection of chronic radiofrequency ablation lesions in the left atrium

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Introduction

Delayed-enhancement (DE) in the left atrium following radiofrequency (RF) ablation has been previously shown [1]. However, current DE techniques do not reach sufficient resolution to determine if ablation lesions are transmural, a factor that can determine the success of an ablation procedure. Myocardial thickness in the left atrium can reach approximately 1 mm [2]. Therefore a delayed enhancement imaging sequence must be sub-millimetre in resolution. For this requirement, we develop a high resolution inversion recovery (IR) sequence with a spiral *k*-space trajectory. A spiral trajectory is a very efficient sampling scheme that allows for a very short acquisition window (minimising cardiac blurring) at a much reduced cost to overall imaging time compared to Cartesian.

Purpose

We demonstrate this high resolution technique by detecting chronic RF ablation scar in patients.

Methods

Two patients with chronic ablation scar underwent an MR examination on a 1.5 T Philips Achieva system with a 5-channel coil. After 25 mins following administration of 0.4 ml/kg of a Gd-DTPA contrast agent, a 3D IR-TFE scan with a Cartesian *k*-space trajectory was performed [1]. Following this scan, a M2D IR-TFE scan with a spiral *k*-space trajectory was performed (slices = 3, thickness = 5 mm,

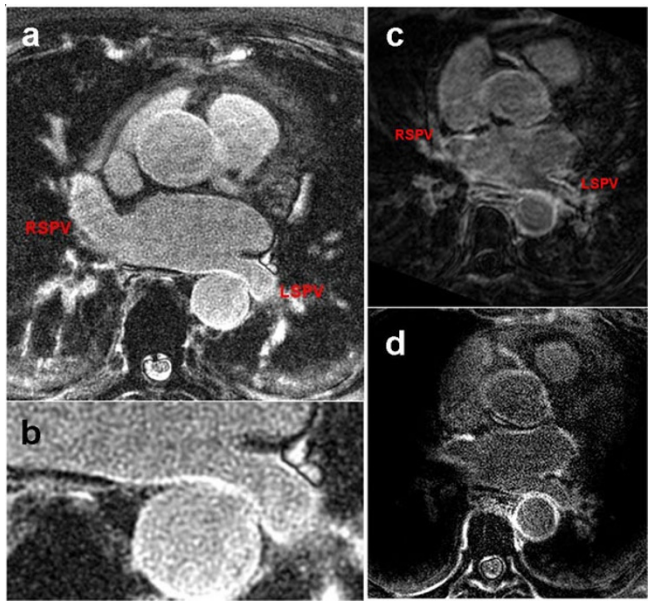

Figure 1
Patient 1 (a-b) and patient 2 (c-d). (a) shows delayed enhancement using a spiral k-space trajectory. (b) shows the area of enhancement in greater detail. (c) shows delayed enhancement using a lower resolution Cartesian k-space as compared to the higher resolution spiral k-space.

resolution = 0.7 mm^2, FOV = 270 mm^2, 1 spiral per 2RR intervals, acquisition = 20 ms per spiral, 45 spirals per slice). ECG triggering was set to atrial systole. Respiratory navigation was used. Corresponding B_0 maps were acquired to correct strong B_0 field inhomogeneities produced in spiral acquisitions.

Images were reconstructed offline and a conjugate phase reconstruction based on a Chebyshev approximation [3] was employed to correct B_0 field inhomogeneities. Images were observed by a cardiologist with expertise in MRI to assess for areas where lesions were not transmural.

Results

In both patients, the IR-spiral scan captured the LSPV and the RSPV (Fig 1). Enhancement can be seen in both patients on the posterior wall adjacent to the LSPV, and Patient 2 shows enhancement on the anterior wall adjacent to the RSPV. In patient 1, the areas of enhancement are confirmed by the Cartesian scan, although the spiral also shows enhancement in the mitral valve.

Discussions and Conclusion

This study has shown the feasibility of sub-millimetre delayed enhancement imaging of the left atrium. Current work consists of developing a technique to determine transmurality of the ablation lesions, and acquiring further patient data.

References

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2. Ho , *et al.*: *J Cardiovasc Electrophysiol* 1999, **10:**1525-33.
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