Journal of Cardiovascular Magnetic Resonance

Meeting abstract

1016 Increased sensitivity for detection of intra-cardiac thrombus using phase sensitive inversion recovery (PSIR) late enhancement techniques for combined myocardial scar and thrombus imaging

Weale J Peter*[1], George Lin[2], Sven Zuehlsdorff[1], Francois Christopher[2], David Tuit[2], Renate Jerecic[1] and James Carr[2]

Address: [1]Siemens Medial Solutions, Chicago, IL, USA and [2]Northwestern Memorial Hospital, Chicago, IL, USA
* Corresponding author

from 11th Annual SCMR Scientific Sessions
Los Angeles, CA, USA. 1–3 February 2008

Published: 22 October 2008

Journal of Cardiovascular Magnetic Resonance 2008, **10**(Suppl 1):A141 doi:10.1186/1532-429X-10-S1-A141

This abstract is available from: http://jcmr-online.com/content/10/S1/A141

Introduction

Late enhancement techniques have been recently used for the detection of intra-cardiac thrombus due to its characteristic appearance in DE images. For time reasons in clinical practice frequently a TI is chosen which nulls the normal myocardium and not the thrombus allowing simultaneous evaluation of myocardial scar and thrombus. This work demonstrates the pitfalls of solely magnitude based DE imaging for the simultaneous detection of intra-cardiac thrombus and shows the benefits of the PSIR technique by theoretical and clinical analysis

Methods

In Phase-Sensitive-Inversion-Recovery (PSIR) techniques the reconstructed image discriminates between positive and negative signal amplitudes. Thus PSIR reduces the need to set precise inversion times to avoid reduced or even inverted contrast between areas of hyper-enhancement and normal myocardium [1].

The same theoretical advantage can be used for the detection of intra-cardiac thrombus where the T1 is typically longer than any other cardiac structure in a contrast-enhanced scan [2,3]. It is possible that in magnitude (non-PSIR) images acquired with a TI to null normal myocardium the signal intensity from thrombus is close to that of the contrast-enhanced blood-pool of the cardiac chambers leading to contrast loss between thrombus and surrounding blood. A simulation of the signal-time-curve at different TIs was performed using typical T1-values of 600 ms (Thrombus) and 300 ms (Contrast enhanced blood) to demonstrate this effect. To verify the theoretical advantages of PSIR an evaluation of the relative contrast (CI) between thrombus (S_T) and blood pool (S_{BP}) for both magnitude and PSIR images was performed ($CI_T = (S_T - S_{BP})/S_{BP}$) in 36 patients with known intra-cardiac thrombus. These patients had undergone DE using a TI-scout followed by a PSIR technique which concurrently reconstructs the corresponding magnitude and phase sensitive images. The TI was chosen to null the myocardium. The data of the TI-Scout were used to plot the signal evolution at different TI times (Figure 2) to verify the theoretical advantages seen in the simulation (Figure 1).

Results

The recovery curves in Figure 1 clearly demonstrate the advantage of the PSIR method. At a chosen TI (in this case 300 ms) the difference between the signal amplitudes for thrombus and blood is substantially less than in the PSIR reconstruction. It is possible that for some combinations of TI, contrast-agent concentration and scan-timing that the thrombus/blood-pool contrast could be eliminated. The signal behaviour of the TI scout data in a patient with thrombus confirms the result of the simulation. The mean contrast index value was $CI_{PSIR} = 1.07$ (S.D 0.86) for the PSIR method vs $CI_{Mag} = 0.66$ (S.D 0.57) for the magnitude reconstruction. The qualitative contrast improvement is

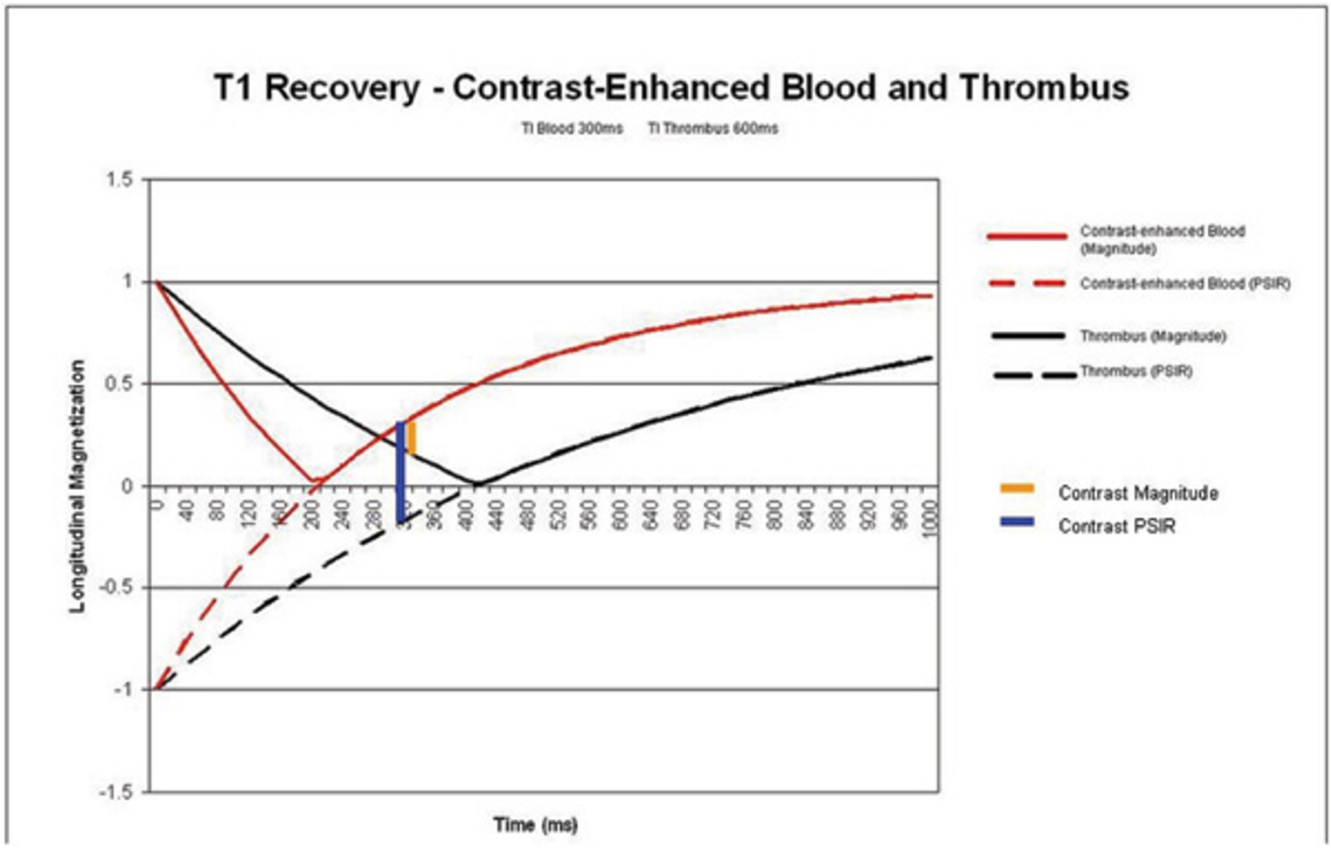

Figure 1
Simulated T1 Recovery curves for two different tissues with T1 values similar to contrast-enhanced blood and thrombus. The region between the zero crossing points of the two tissues illustrates rapidly reducing and inverting contrast in the range of T1 values commonly used in MDE imaging – this is eliminated with the use of a Phase Sensitive IR sequence which preserves true T1 contrast.

shown in a direct comparison of both reconstruction methods (Figure 3).

Conclusion

The theoretical benefits in the use of a PSIR method as a robust method to depict intra-cardiac thrombus within a single DE study are validated in-vivo. In magnitude images the contrast between thrombus and contrast-enhanced blood is compromised in the range of TI values typically used in DE to null the myocardium and small thrombi could remain undetected. Non-PSIR methods require additional scans with optimized TI times to maximize sensitivity to thrombus.

A pilot study recently described the use of DE techniques for detection of left atrial appendage thrombus [4] and reported a low sensitivity (44%) using a non-PSIR technique. The range of TI values suggests that the optimization was for myocardial nulling which results in the compromised contrast illustrated above. The use of a PSIR-technique should result in increased sensitivity in detection of LAA and other intra-cardiac thrombi without the need for an additional scan or optimization of TI-times.

References

1. Kellman P, *et al.*: *MRM* 2002, **47:**372-382.
2. Rapoport , *et al.*: *Radiology* 1987, **162:**527-530.
3. Schlosser , *et al.*: *Radiology* 2005, **236:**1041-1046.
4. Mohrs O, *et al.*: *AJR* 2006, **186:**198-205.

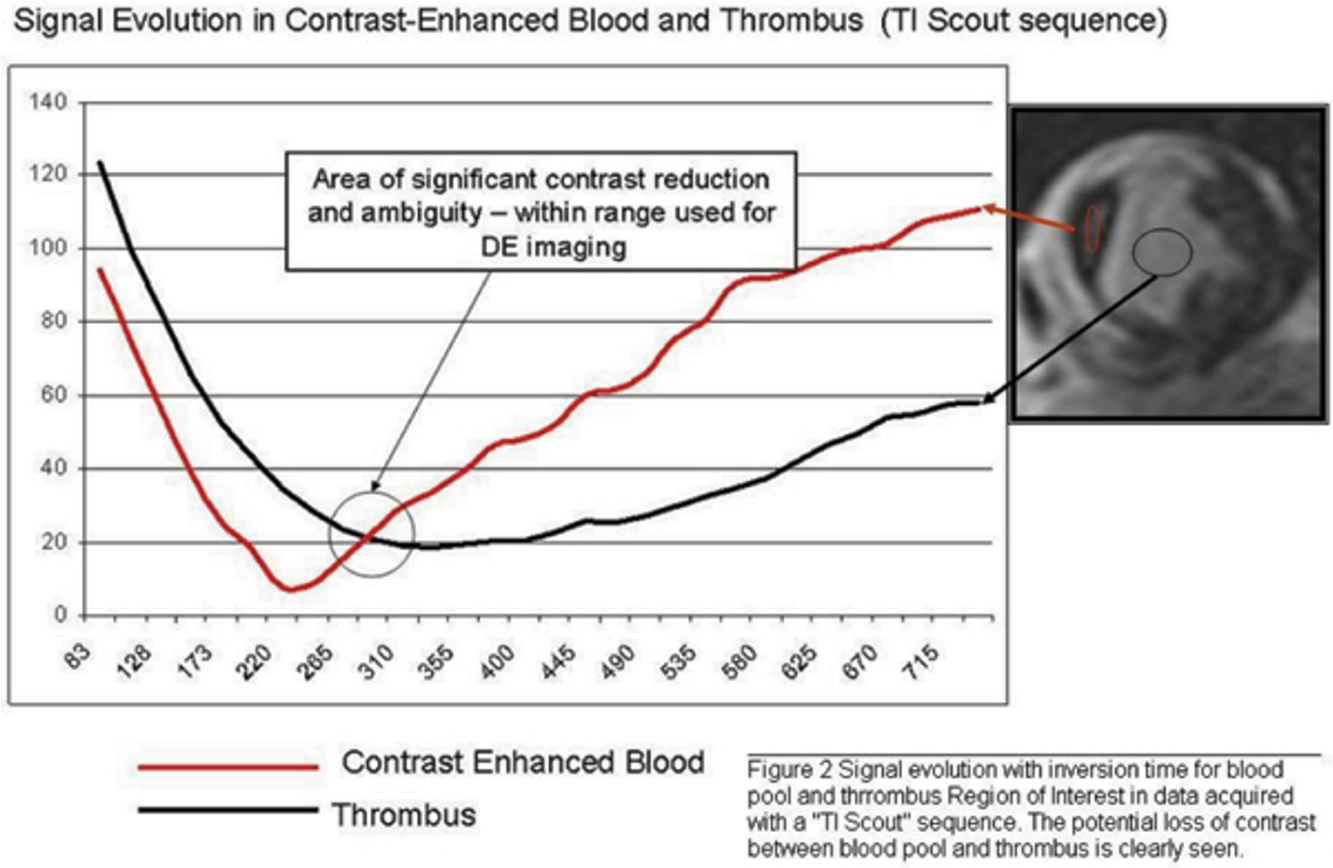

Figure 2
Signal evolution with inversion time for blood pool and thrombus Region of Interest in data acquired with a "TI Scout" sequence. The potential loss of contrast between blood pool and thrombus is clearly seen.

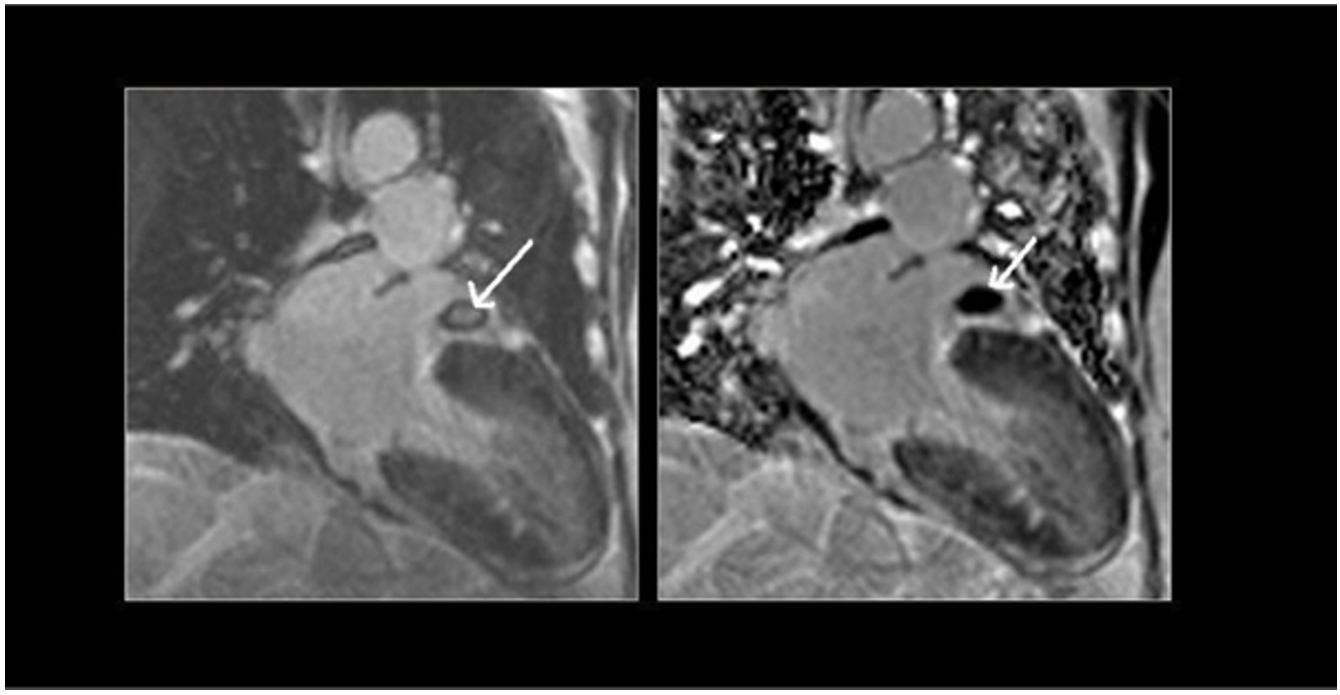

Figure 3
Magnitude (left) and PSIR (right) recontructed images of a long axis veiw of a patient with Left Atrial Appendage thrombus. The higher contrast in the PSIR is seen though the Magnitude reconstruction shows the typical "black rim" around the area in voxels on the boundary between tissues with positive and negative magnizaton (longer or shorter than the selected T1).