1RR Phase Sensitive Inversion Recovery Late Gadolinium Enhancement MRI

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Introduction: Late gadolinium enhancement (LGE) (1,2) is the non-invasive gold standard for detection of myocardial fibrosis. The 2RR phase-sensitive inversion recovery (PSIR) technique (3), using 2 RR intervals between inversions, is valuable for obtaining a reference scan for phase sensitive reconstruction, eliminating the acquisition of non-diagnostic images caused by a too short inversion time (TI). However, 2RR LGE has lower SNR efficiency compared to 1RR intervals, at least for lower heart-rates and short T1 tissues. For 3D LGE methods, both free-breathing and breath-hold, 1RR interval between inversions is highly desirable, since 2RR intervals prolongs scan time, which is either already limited by breath-hold duration, or already prolonged due to increased spatial resolution and respiratory compensation methods. Here we investigate a 1RR PSIR method for LGE.

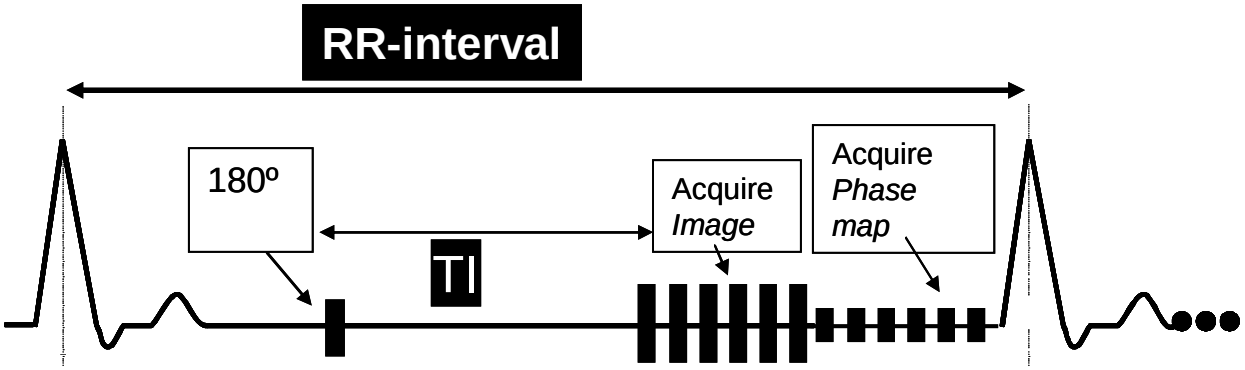

Figure 1: 1 RR phase sensitive inversion recovery sequence.

Methods: 2D LGE images were acquired in patients 10-20 minutes after injection of 0.1 or 0.2 mmol/kg Gd-DTPA. Scan parameters were: 2D gradient echo inversion recovery with TR/TE/θ/views per segment = 4.1ms/2.0ms/20º/20, 2 x 2 x 8 mm, 1RR between inversions, fat suppression, centric order. 1 RR phase sensitive inversion recovery was employed as shown in Figure 1. The figure shows a second acquisition segment, which can serve both as a phase map or a backup image, acquired directly after the 1st image acquisition segment (2nd flip 10º-20º). Because the acquisition window for the first image is long, during which time some signal regrowth occurs, the 2nd image has a longer effective TI.

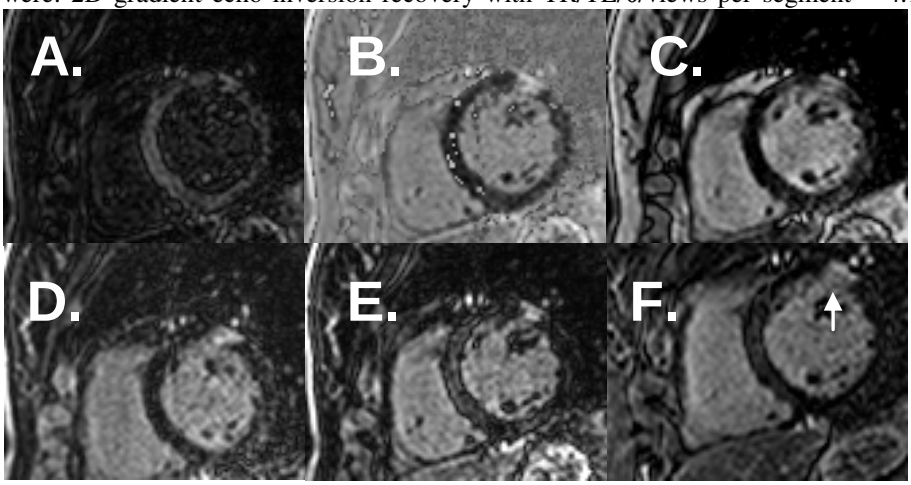

Figure 2: Patient with anterolateral scar (arrow, F), ~15 min after 0.1 mmol/kg Gd-DTPA. A-C. 1RR PSIR LGE images, with a TI set 50 ms shorter than optimal. A) 1st magnitude image, with non-diagnostic quality. B) PSIR image. C) 2nd magnitude image, where scar is visible. D) 1 RR PSIR LGE with correctly set TI, 1st magnitude image. E) IRR LGE with semi-optimally set TI. F) Clinical 2RR LGE image, arrow points to scar. In 1RR PSIR, the 2nd magnitude image functions as a "backup".

Results: Figure 2 shows example images demonstrating that the 1RR PSIR method is feasible. When the TI is too short (Fig. 2A), the 2nd magnitude image (Fig. 2C) or the PSIR image (2B) is capable of portraying the scar. When the TI is correctly set (2D), image quality is similar to 1RR LGE (2E).

Conclusion: Our preliminary study suggests that 1RR PSIR provides a second LGE image with a longer effective TI time, potentially eliminating non-diagnostic scans due to short TI. For imaging at the optimal TI, 1RR PSIR image quality is unchanged, compared to a 1RR non-PSIR acquisition. Studies are underway to employ the 1RR PSIR method for 3D LGE, for which 2RR PSIR is challenging due to increased scan time. Investigations of the dependence of image quality and SNR efficiency on heart-rate for both 1RR and 2RR PSIR are also important, to understand potential strengths and limitations of the 1RR PSIR technique.

References: 1. Kim RJ, Circulation. 1999 Nov 9;100(19):1992-2002. 2. Simonetti OP, Radiology. 2001 Jan;218(1):215-23. 3. Kellman P et al. Magn Reson Med. 2002 Feb;47(2):372-83.