Cardiac Cine MRI at 3.0T: Initial Experience with Gadomer-17 in a Swine Model

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Introduction: 3.0T, whole body MR scanners are becoming widely available, but their role in cardiac imaging has yet to be defined. B0-inhomogenity and magnetic susceptibility effects at 3.0T heighten sensitivity to off-resonance artefacts, which can undermine the quality and reliability of SSFP cine, the current standard for functional MR imaging (1, 2). Furthermore, B1 inhomogeneity adversely impacts image contrast and SAR considerations limit the allowable flip angle and the minimum TR with SSFP. For these reasons, small flip angle, spoiled gradient echo (SGE) sequences, such as FLASH cine imaging, may have advantages over SSFP, at 3.0T, if the associated blood saturation effect can be overcome.

Purpose: To evaluate the potential of a blood-pool contrast agent (Gadomer-17, Schering AG, Berlin, Germany) in improving cardiac cine imaging at 3.0T in a swine model.

Methods: Twelve pigs underwent cardiac MR imaging, under controlled ventilation, on a 3.0T MR system (Magnetom Trio, Siemens Medical Solutions) using an eight-channel body array coil. The experimental protocol included cine imaging with segmented SSFP and T1-weighted GRE imaging in multiple planes, pre- and post-contrast. For SSFP, a TrueFISP sequence was used (TR/TE = 3.2/1.5ms; flip angle: 55°, bandwidth: 900 Hz/pixel, voxel size: 1.5 x 1.2 x 5 mm^3, GRAPPA 2). Iterative frequency offset adjustment was performed to minimize off-resonance artefact on SSFP cine. For GRE imaging, a FLASH cine sequence was used (TR/TE: 27.6/1.7 ms, flip angle: 15°, bandwidth: 610 Hz/pixel, FoV: 300 x 225, voxel size: 1.5 x 1.2 x 5 mm^3, GRAPPA 2) in short-axis, horizontal long-axis and vertical long-axis planes, during a 12 s suspension of respiration. The same sequences were repeated at several time points up to 30 minutes following injection of 0.1 mmol/kg of a blood-pool intravascular contrast agent (Gadomer-17). For quantitative analysis, SNR evaluation was performed from two separate regions of interest in the left ventricular blood-pool and mid-ventricular septum, on both pre- and post-contrast short-axis and long-axis FLASH cine images using Mean Curve software (Siemens). The temporal variation in SNR was calculated as the difference between the maximum and minimum SNR values over the cardiac cycle. Statistical comparisons were made with a paired, two-tailed Student's *t*-test. Image quality of SSFP and pre- and post-contrast FLASH images was evaluated based on a 1 to 3 scoring scale (1=poor diagnostic ability, 2=acceptable diagnostic ability, 3=excellent diagnostic ability) and a Wilcoxon 2-sample test was used for statistical comparison.

Results: Technically satisfactory results were obtained in all cases. The SNR of the blood-pool was significantly increased in post-contrast FLASH images (401 ± 229.5 *vs.* 212.6 ± 108.8, P<0.01, in long-axis images and 320.8 ± 74.7 *vs.* 244.3 ± 40.3, P<0.01, in short-axis images; Fig. 1 C, D, E and F). The temporal fluctuation in blood-pool SNR over the cardiac cycle was significantly reduced, post-Gadomer, most dramatically on long-axis FLASH cines (45.6 ± 45.3 *vs.* 159.5 ± 110.6, P<0.01 long-axis and 79.8 ± 58.3 *vs.* 150.7 ± 95, P<0.05, short-axis; Fig. 2). Image quality score was significantly higher in post-contrast *vs.* pre-contrast FLASH images (P<0.01), but similar in SSFP and pre-contrast FLASH images (P=0.242).

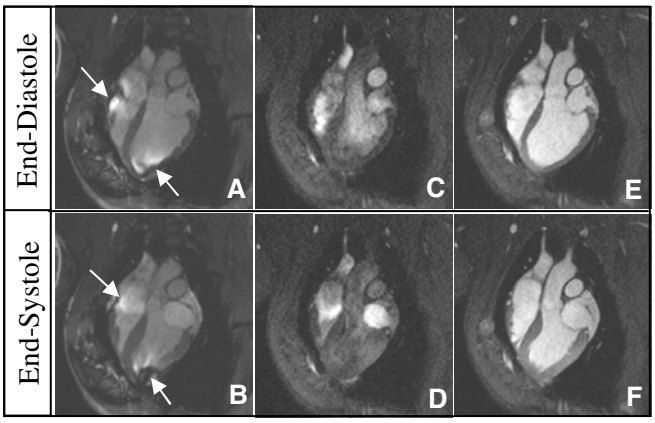

Fig. 1: Marked off-resonance artefacts (arrows) obscure SSFP images (A and B), acquired without contrast agent, in the LV outflow tract of the swine heart. Pre-contrast (C and D) and post-contrast (E and F), FLASH cine images, in the same slice position. Blood-pool signal is visibly improved in the post-contrast FLASH images.

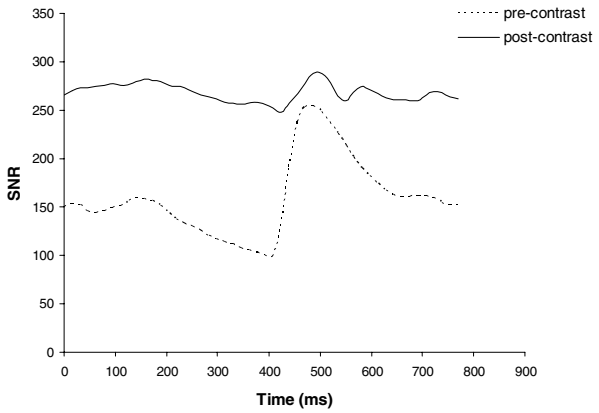

Fig. 2: Temporal variation in LV blood-pool SNR over the cardiac cycle, in pre- and post-contrast FLASH cines.

Conclusions: In combination with Gadomer-17, SGE has the potential to outperform SSFP for cardiac cine imaging at 3.0T. By eliminating saturation effects, Gadomer-17 greatly improves the spatial and temporal uniformity of the blood-pool signal and increases its intensity, with outstanding delineation of the myocardium from blood-pool.

References:

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