First-pass Cardiac MRI Using UNFOLD

Purpose: To show that the reduced field-of-view technique, UNFOLD (1), is feasible and useful for first-pass contrast-enhanced cardiac MRI.

Methods: UNFOLD is a method which can be used to decrease the data acquisition time in MRI and has previously been applied to cine MRI of the heart. This technique assumes that the central half of the field of view (FOV) is dynamic while the outer half is reletively static. Because in first-pass MRI tissues both inside and outside the central FOV enhance, we acquired first-pass images using UNFOLD to demonstrate that aliasing artifacts from the outer FOV can be suppressed. After demonstrating feasibility, we explored different ways of using the decreased acquisition time through simulation and experiment. Specifically, we investigated (a) increasing the saturation-recovery time, (b) acquiring more slices per heartbeat, and (c) increasing image resolution. UNFOLD was implemented in a multi-slice saturation-recovery fast gradient-echo sequence with an echo-train readout (FGRE-ET). Normal volunteers were scanned on a 1.5T cardiac MR scanner during injections of Gd-DTPA (0.14 mmol/kg, 5 ml/sec). Image reconstruction was performed off-line.

Results: Aliasing artifacts were well-suppressed, even from enhancing tissue in the outer FOV, demonstrating feasibility of the method. Tradeoffs involving data acquisition time, saturation recovery time, signal-to-noise ratio, contrast-enhancement, and point-spread-function (PSF) artifacts agreed well between simulations and measurements. As an example demonstrating this technique, first-pass images with 2.8 x 2.8 mm in-plane resolution can be acquired in less than 100 ms (data acquisition time = 84 ms, saturation preparation time = 12 ms), enabling the acquisition of 5 slices per heartbeat for heart rates as high as 120 beats per minute.

Conclusions: UNFOLD was shown to be useful for first-pass MRI. Either an increased number of slices per heartbeat or improved image quality (e.g., higher spatial resolution, reduced motion blurring and/or PSF blurring) can be obtained using UNFOLD.