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Myocardial delayed enhancement using parallel imaging with an overlapping partial-Fourier acquisition and variable k-space segmentation

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Introduction

Myocardial delayed enhancement (E) using T_1-weighted inversion-recovery gradient-echo imaging has become the gold standard for assessing myocardial viability. One drawback of the technique is the requirement for multiple long breath holds in order to cover the entire heart. Such an acquisition can be difficult for the patient and may cause degraded image quality. Partial Fourier and parallel imaging can be used to reduce scan time; however, both approaches noticeably reduce the already low signal-to-noise ratio (SNR) and can potentially introducing additional artifacts.

Purpose

The goal of this work was to decrease the acquisition time of E while attempting to minimize the negative impact of scan reduction techniques.

Methods

The pulse sequence uses a modified partial Fourier technique as well as parallel imaging. Two partial-Fourier-like acquisitions (a.k.a. 2NEX-½NEX) are performed, each sampling slightly more than half of k-space, from the top and bottom, respectively. The low spatial frequency views from each acquisition overlap, resulting in two signal averages (NEX) at the center of k-space. Further, 2x-accelerated parallel imaging using Autocalibrated Reconstruction in Cartesian coordinates (ARC) (1) was performed in outer k-space. The fully oversampled central k-space is used by ARC as the autocalibration region, thereby eliminating aliasing from the low-spatial-frequency, high-energy data. To achieve central oversampling and peripheral undersampling, variably-spaced phase encoding was used in each imaging segment (Figure 1).

E imaging was performed on one patient, with and without ARC. Each slice required four heartbeats. Using one dummy heartbeat, three slices were acquired in a 13-heartbeat breath hold. Views per segment (VPS) with and without ARC were 23 and 36, respectively, resulting in temporal resolutions of 110 and 173 msec.

Results

E images of three slices are shown in Figure 2. The ARC images are sharper due to the higher temporal resolution but are somewhat noisier, as expected.

Conclusion

E is often performed as a fully sampled 2NEX scan. Overlapping partial-Fourier reduces both the number of k_y lines and SNR, although it maintains 2NEX at the center of k-space. Adding ARC with variable segmentation also maintains central 2NEX but further reduces data acquisition, giving better temporal resolution and reduced blurring. The oversampled center partially preserves SNR and provides more robust reconstruction than other parallel imaging methods. However, SNR is somewhat reduced overall. Nevertheless, slightly increasing the scan time beyond four heartbeats may mitigate the SNR loss and/or allow higher spatial resolution by increasing VPS.

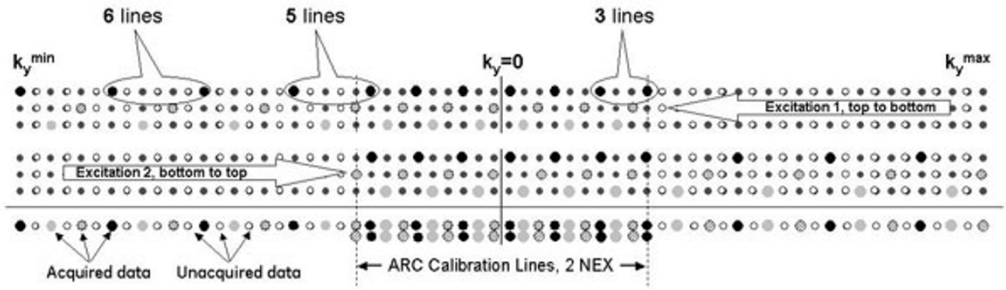

Figure 1
Phase-encoding strategy. k_y is shown left/righ. Acquired and unacquired k_y lines are depicted by the small filled and unfilled dots, respectively. The data shot in which each k_y line is acquired as shown as ●, and... . Two partial- Fourier excitations are acquired per shot. The regions of variable segmentation are illustrated in one shot where the phase-encoding skips 3, 4, or 6 k_y lines during the segment. Final k-space data is shown at the bottom of the figure.

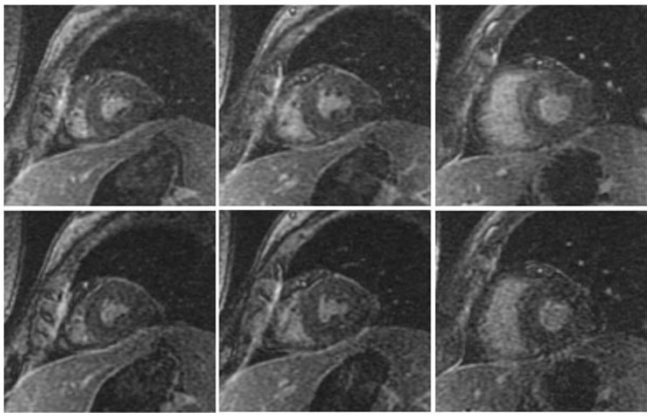

Figure 2
MDE images of three slices acquired in a single 13-heartbeat breath hold: without ARC (top row) and with ARC (bottom row). The ARC images exhibit less blurring because of the smaller VPS.

References

1. Brau : *MRM* 2008, **59:**382.