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# Combination of compressed sensing and parallel imaging with respiratory motion correction for highly-accelerated cardiac perfusion MRI

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## Introduction

Cardiac perfusion MRI requires fast data acquisition to achieve an appropriate combination of temporal resolution, spatial resolution and spatial coverage for clinical studies [1]. We have recently presented a combination of compressed sensing and parallel imaging (k-t SPARSE-SENSE) to highly accelerate perfusion studies [2]. However, this method is sensitive to respiratory motion, which decreases temporal sparsity and produces temporal blurring in the reconstructed images. In this work, we present a rigid respiratory motion correction method which allows highly-accelerated first-pass cardiac perfusion MRI to be performed without strict breath-holding.

## Purpose

To develop a respiratory motion correction method for joint compressed sensing and parallel imaging acceleration of first-pass cardiac perfusion MRI.

## Methods

Free-breathing first-pass cardiac perfusion MRI with 0.1 mmol/kg of Gd-DTPA (Magnevist) was performed using a modified multi-slice TurboFLASH pulse sequence. Healthy volunteers were imaged on a whole-body 3T scanner (Siemens; Tim-Trio) using the standard 12-element body matrix coil array. The relevant imaging parameters include: FOV = 320mmx320mm, image resolution = 1.7mmx1.7mm, slice-thickness = 8mm, TE/TR = 1.3/2.5ms, repetitions=40. An acceleration factor of 8 was used to acquire 10 slices per heartbeat with temporal resolution of 60ms/slice. Data undersampling was performed using a pseudo-random ky-t pattern [2]. Fully-sampled low-resolution coil sensitivity reference data were acquired in the first heartbeat. Image reconstruction was performed in two-steps using the k-t SPARSE-SENSE algorithm [2] with temporal FFT as sparsifying transform. First, an intermediate k-t SPARSE-SENSE reconstruction is generated for respiratory motion correction. Rigid motion between frames is detected by computing the displacement of each frame from this intermediate k-t SPARSE-SENSE reconstruction with respect to the coil sensitivity reference using a crosscorrelation approach in the image domain [3]. Second, motion correction is performed by aligning all the frames in the accelerated data. The final k-t SPARSE-SENSE reconstruction is computed using the aligned accelerated data.

## Results

Rigid respiratory motion correction significantly increased sparsity in the temporal Fourier domain, which is due to better alignment among frames (Fig. 1). Fig. 2 shows k-t SPARSE-SENSE reconstruction of a representative slice from the free-breathing perfusion scan without and with motion correction. The utilization of motion correction decreased temporal blurring and presented images with higher quality.

## Conclusions

This work demonstrates feasibility of highly-accelerated first-pass cardiac perfusion MRI without strict breath-holding with rigid respiratory motion correction. Future work will explore the use of non-rigid motion correction. The proposed technique may be useful for imaging patients with impaired breath-hold capabilities.

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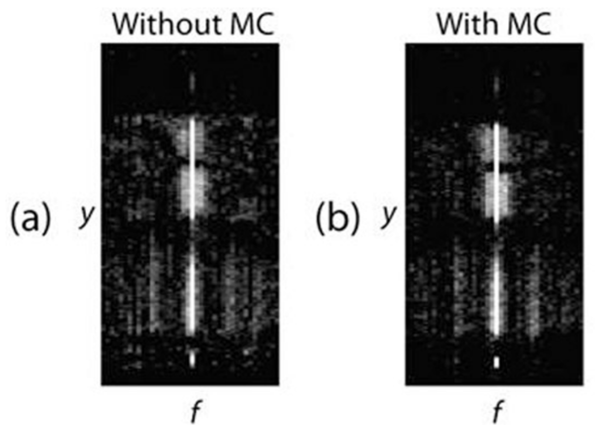


**Figure 1** Sparse y-f domain for intermediate k-t SPARSE-SENSE reconstruction with (a) no motion correct and (b) motion correction.

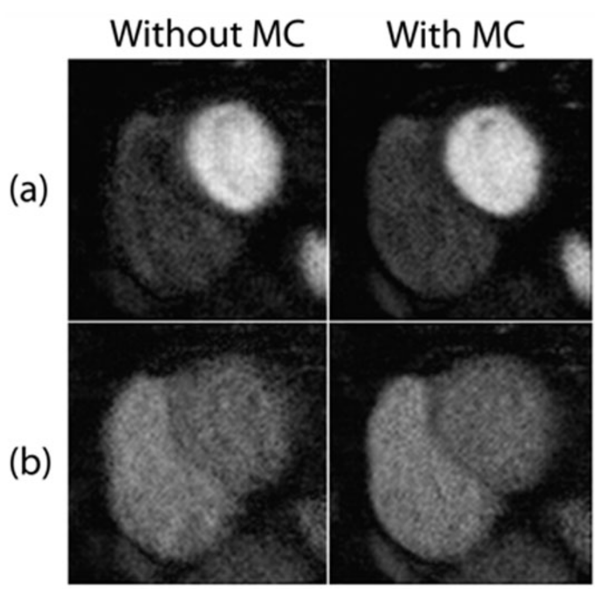


**Figure 2** k-t SPARSE-SENSE reconstruction of a representative slice without and with motion correction (MC) for (a) peak blood enhancement and (b) myocardial wall enhancement.

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