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Meeting abstract

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1095 Single coil implementation of parallel imaging: SCIPI

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Introduction

Approaches to reduce scan time using parallel imaging suffer from increased noise in regions with high g-factors, similarly, reduced field of view (FOV) approaches require subtraction of static outer regions, both serving to increase the noise level, especially over the cardiac region. Here we introduce a hybrid approach, Single Coil Implementation of Parallel Imaging (SCIPI) to reduce scan time, incorporating the advantageous properties of parallel and reduced FOV approaches.

Hypothesis

We hypothesize that for a typical cardiac images series the signal from a single coil element conforms to the criteria required for SCIPI, 1) signal is dominant for only 50% of the FOV, and 2) the signal exhibits an intensity gradient over the FOV.

Methods

The SCIPI approach was simulated using 10 cardiac cine series (256 × 256 matrix), acquired using 8-chanels and employing a steady-state free precession acquisition. For each coil element considered separately, the SCIPI approach separates the image FOV into "Dominant" signal and "Remote" signal halves. To simulate SCIPI, alternate lines of k-space were extracted, i.e. compared to the full acquisition, alternate lines were skipped, and additionally 6% of lines at the center were obtained (56% of conventional scan). The central k-space lines were used to form a low-resolution image series, and a "Rosetta-image" generated as follows: for the Dominant signal half, each pixel was set to the average intensity formed using pixels with intensities >1 standard deviation (>1SD) over the time series, and for the Remote half, intensities were set to the average formed using values <1SD. Using the Rosetta-image, a ratio map, $Image_{Ratio}$, was formed of corresponding pixels in the Dominant and Remote image halves. The alternate k-space lines generated an image, $Image_{Overlap}$, with pixels representing the sum of overlapping pixels from the Dominant and Remote image halves. Pixels were assigned to the Dominant half using the formula

$$\text{Dominant pixel intensity} = Image_{Ratio} \times Image_{Overlap} / (Image_{Ratio} + 1) \qquad (1)$$

The g-factor was calculated in each series for a region of interest (ROI) over the heart in the Dominant half image using the formula

$$\text{g-factor} = \sqrt{0.56} \times SNR_{orig}/SNR_{SCIPI} \qquad (2)$$

Where SNR_{orig} is the signal to noise ratio of the original image, SNR_{SCIPI} is the SNR of the corresponding image region in the SCIPI image, and 0.56 represents the percentage of lines contributing to the SCIPI image. Additionally, the average percentage difference was measured for the Dominant image half and for a ROI encompassing the dynamic cardiovascular features. Following application of SCIPI, Dominant half images from multiple coil elements can be combined to produce a conventional appearing image.

Results

The SCIPI approach produced excellent quality cardiac images which were virtually indistinguishable from the original, Fig 1. For regions of vascular or cardiac blood pools, the measured g-factor was 0.95 ± 0.04. The average %SNR difference was 0.84 ± 1.7% for all pixel regions in the Dominant image half and 1.7 ± 3.0% for the cardiac region.

Conclusion

The SCIPI approach to parallel imaging produces excellent image clarity, revealing even subtle valve details, with low percentage signal intensity differences compared to

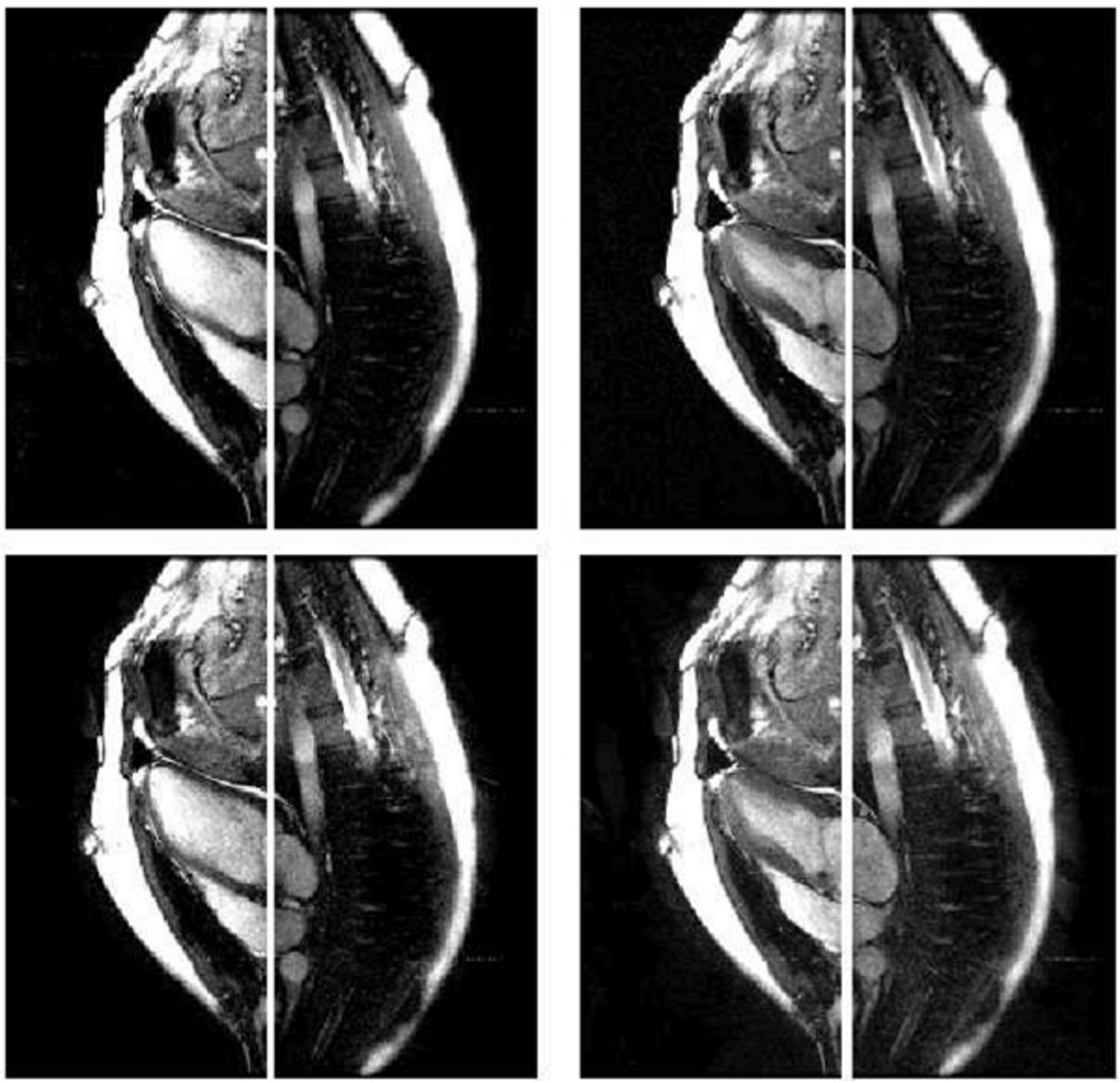

Figure 1

Top panel, original and lower panel, SCIPI images. For each panel, the left and right dominant image halves are shown (separated slightly for emphasis). Composite images correspond to end-diastole (left) and end-systole (right).

the original. The g-factor over the cardiac region was slightly less than unity, with SNR being at the theoretical maximum. These performance characteristics are attributable to three aspects of SCIPI, 1) pixel intensities are assigned based on the noise-efficient ratio operation as opposed to subtraction, 2) the ratio map is based on average intensities, biasing the distribution of higher intensities to the Dominant half and avoiding low intensity mobile features from leaving a "shadow" on the processed image, and 3) information from only one coil element is used, avoiding adverse interaction between multiple coil elements.