Journal of Cardiovascular Magnetic Resonance

Oral presentation

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Navigator guided high-resolution single-shot black-blood (BB) TSE images using zoom and sensitivity encoding (sense) on a 32 channel RF system

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from 13th Annual SCMR Scientific Sessions
Phoenix, AZ, USA. 21-24 January 2010

Published: 21 January 2010

Journal of Cardiovascular Magnetic Resonance 2010, **12**(Suppl 1):O73 doi:10.1186/1532-429X-12-S1-O73

This abstract is available from: http://jcmr-online.com/content/12/S1/O73

Introduction

Although time consuming, double-inversion recovery prepared black-blood TSE imaging (BBI) techniques form the back bone of tissue characterization in cardiac MRI. While SSH-BBI is feasible, to-date, the spatial resolution of such SSH-BBI is intrinsically limited by the T2 decay induced blurring associated with the length of the readout duration. We hypothesize that by restricting the cranio-caudal FOV to the heart using the ZOOM technique (which applies the 90 and 180 degree RF pulses orthogonal to each other), and by applying SENSE in the FH/RL direction with a 32 channel coil, it is feasible to obtain high-resolution single-shot BBI.

Purpose

The purpose of this work is to test the feasibility of this hypothesis in a clinical setting.

Methods

All imaging was done on 1.5 T Philips scanner with 32 RF channels and VCG gating in 7 subjects(6 M, age: 36 ± 6 yrs). The baseline SSH-BBI sequence (Base) had a TSE readout duration of 436 ms. This readout duration was decreased to 260 ms by applying SENSE (factor = 2), and further to 164 ms by restricting the FOV by 50% in the FH/RL direction using ZOOM, and by using SENSE in the FH/RL direction (by a factor = 2). The following acquisition parameters were kept constant across all three sequences: acquired voxel size 1.5 × 2.0 × 8.0 mm3; TR/EffTE: Infinity/80 ms; bandwidth per pixel: 500-520 Hz. Only the half-scan parameter was adjusted to yield the same EffTE for all three sequences. A respiratory navigator positioned at the level of the diaphragm triggered each slice acquisition eliminating the need for breath-holding.

Results

Some representative images from the three imaging techniques are shown in Figure 1. Note the higher spatial resolution of the ZOOM+SENSE SSH technique compared to the conventional SSH approach. The shorter readout duration of ZOOM+SENSE further reduces blurring during readout, and images can be obtained during free breathing. While both SENSE and ZOOM reduce the number of phase encoding steps required to make an image without compromising spatial resolution, ZOOM provides some additional benefits compared to SENSE. Unlike SENSE, the incorporation of ZOOM does not entail a reduction in SNR, and it also facilitates the use of SENSE in the FH/RL direction (without foldover issues) that takes advantage of the multiple coil elements in the FH/RL direction on a 32 channel coil.

Conclusion

High resolution SSH-BB TSE images can be obtained during free breathing with minimal blurring by a combination of SENSE and ZOOM imaging techniques.

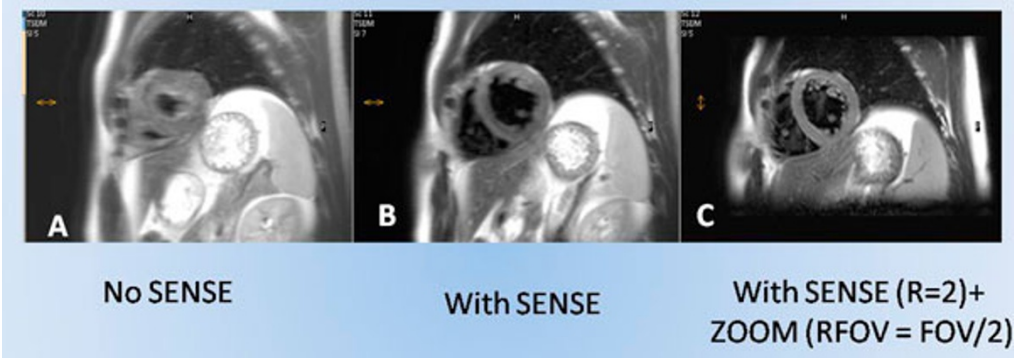

Figure 1
A) Conventional SSH-BBI with TSE shot duration of 436 ms. Note the increased blurring and systolic acquisition due to the long readout; B) SSH-BBI with the applicatin of SENSE in AP direction dreduces the readout duration to 270 ms; C) SSH-BBI with SENCE (in the FH direction) and ZOOM reduces the readout duration further to 164 ms bringing a substantial improvement quality. The yellow arrows point the phase-encoding direction, and the acquired voxel size was 1.5 × 2 mm for all three acquisitions.