Chen et al. Journal of Cardiovascular Magnetic Resonance 2015, 17(Suppl 1):O40
http://www.jcmr-online.com/content/17/S1/O40

Journal of Cardiovascular Magnetic Resonance

ORAL PRESENTATION | Open Access

Prospectively accelerated first-pass myocardial perfusion imaging in patients using motion-compensated compressed sensing exploiting regional low-rank sparsity

Xiao Chen*, Michael Salerno, Christopher M Kramer, Bhairav B Mehta, Yang Yang, Peter Shaw, Frederick H Epstein

From 18th Annual SCMR Scientific Sessions
Nice, France. 4-7 February 2015

Background

First-pass perfusion CMR utilizes accelerated imaging to achieve high spatial resolution and coverage within a small acquisition window. Several compressed sensing (CS) methods have been proposed to accelerate perfusion imaging[1-3]. However, patient motion due to imperfect breathholding and other factors leads to degraded quality of CS-reconstructed images. We recently demonstrated a CS method (Block LOw-rank Sparsity with Motion guidance, BLOSM[4]) that exploits regional low-rank sparsity and compensates for the effects of motion, and the dvantages of BLOSM were demonstrated using retrospectively-undersampled first-pass data[4]. In the present study, prospectively-accelerated first-pass data were collected from patients undergoing clinically ordered CMR studies, and we compared image quality for images reconstructed using BLOSM and the k-t SLR method[2], a reference CS method that exploits global low-rank sparsity.

Methods

Multislice 2D saturation-recovery first-pass gadolinium-enhanced data were collected from 10 patients on a 1.5T Avanto scanner using the standard body phased-array RF coil. For each patient, 3 short-axis slices were acquired per heartbeat for 50-70 heartbeats. A variable-density ky-t undersampling pattern following the poisson disk distribution was implemented to achieve an appropriate sampling pattern for CS reconstruction . With rate-4 acceleration, the acquisition window for one slice was 96 ms. Other parameters included: Cartesian trajectory, spatial resolution=1.8-2.1×1.8-2.1mm^2, slice thickness=8mm, repetition time=2.4 ms, and saturation recovery time=100ms. The undersampled data were reconstructed using BLOSM and k-t SLR. Multi-coil data were combined using SENSE, with sensitivity maps calculated from temporally-averaged undersampled data. For a fair comparison, both BLOSM and k-t SLR were implemented using the same optimization algorithm and the reconstruction parameters were optimized for each method. Two cardiologists scored the overall image quality (scale of 1-5, where 1 is the best).

Results

Figure 1 shows example BLOSM and k-t SLR reconstructed images from one slice at multiple time points. This example demonstrates that with prominent respiratory motion (see the x-t profiles in (D) and (H)), BLOSM (A-D) provides consistently good image quality, while k-t SLR (E-H) shows blurring (E,F). Figure 2 shows BLOSM results from three slices from a patient with a perfusion defect and prominent respiratory motion (D), along with a corresponding LGE image showing scar (E). Image quality scores were better for BLOSM (2.1±0.8 for BLOSM vs 2.9±0.7 for k-t SLR, p<0.01).

Conclusions

High-quality prospectively-accelerated CS-reconstructed first-pass perfusion imaging was achieved in heart-disease patients using BLOSM, even when substantial respiratory motion occurred. These findings support the use of regional low-rank sparsity with motion compensation.

University of Virginia, Charlottesville, VA, USA

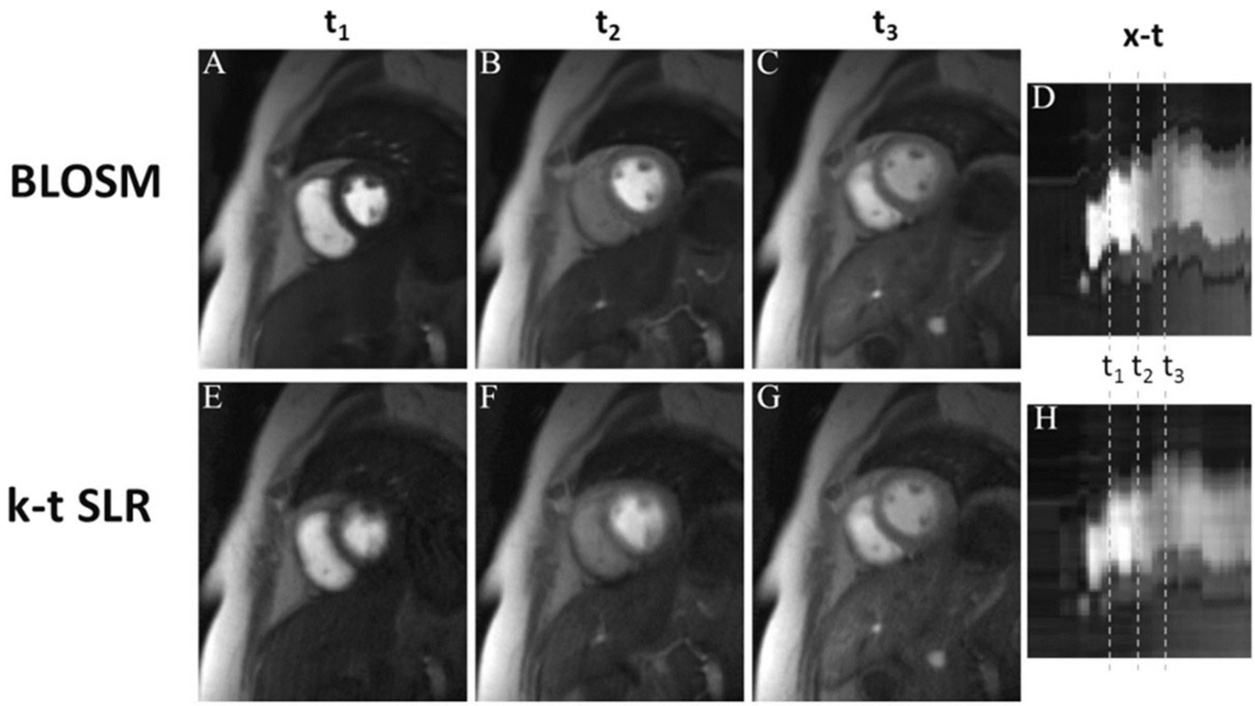

Figure 1 Example reconstruction results of one slice using BLOSM (A-D) and k-t SLR (F-I) from one patient at multiple time points. Images at three different time points (t_1,t_2,t_3) and the corresponding spatial-temporal (x-t) profiles are shown in separate columns. The x-t profiles show that substantial respiratory motion occurred during the scan. BLOSM images demonstrate good motion compensation (A-C) whereas k-t SLR images suffered from blurring when motion occurred (t_1, t_2).

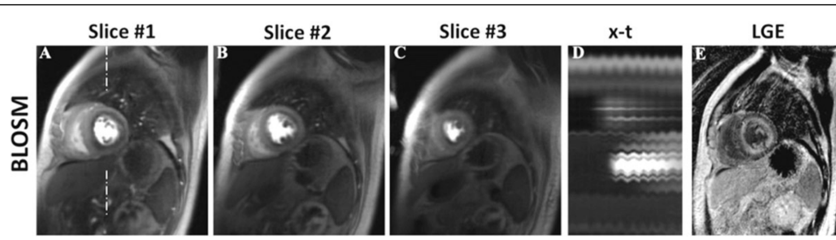

Figure 2 Example BLOSM reconstruction results from one patient with amyloidosis. Multi-slice images from one time point are shown (A-C), along with the x-t profile (D) and a corresponding LGE image (I). A subendocardial perfusion defect is clearly depicted by BLOSM, even in the presence of respiratory motion during the scan, as illustrated in the x-t profile. The subendocardial perfusion defect location matched closely with enhancement on the LGE image.

Funding

This work was supported by NIH grants R01 EB 001763, R01 HL 115225, K23 HL112910, American Heart Association Predoctoral Award 12PRE12040059 and Siemens Medical Solutions.

Published: 3 February 2015

References

1. Otazo, *et al*: *MRM* 2010.
2. Lingala, *et al*: *IEEETMI* 2011.
3. Akcakaya, *et al*: *MRM* 2013.
4. Chen, *et al*: *MRM* 2013.

doi:10.1186/1532-429X-17-S1-O40
Cite this article as: Chen *et al.*: **Prospectively accelerated first-pass myocardial perfusion imaging in patients using motion-compensated compressed sensing exploiting regional low-rank sparsity.** *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1):O40.