MOTION CORRECTED SENSITIVITY ENCODED ISOTROPIC PROJECTION RECONSTRUCTION (SNIPR) FOR WHOLE-HEART CORONARY MRA

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Target Audience: Researchers developing novel iterative reconstruction methods for coronary MRA.

Introduction: As has been shown recently, the use of 3D projection reconstruction (3DPR) and image-based motion correction with 100% acquisition efficiency [1,2] enables highly accelerated coronary MRA (CMRA) with high isotropic resolution and improved robustness to respiratory motion. However, streaking artifact from the undersampled 3DPR k-space significantly reduces the apparent signal-to-noise ratio (SNR). Moreover, affine motion correction distorts the k-space trajectory, hence introducing more streaking when a regular density compensation function is used. In this work, the SNIPR reconstruction [3], a self-calibrated sensitivity encoding scheme for 3DPR, is integrated with image-based motion correction to reduce streaking artifacts and thus improve image quality.

Methods: MR data was collected using an ECG-triggered, T2-prepared, fat-saturated bSSFP pulse sequence with 3DPR trajectory and a 12 channel receiver coil array (TR/TE=3.2ms/1.6ms, FOV=400mm^3, matrix size=384^3, flip angle=90°, readout bandwidth=900 Hz/pixel). Three datasets were collected from each subject in random order with 5800, 11500 or 20500 lines (imaging times: 2.8±0.3, 5.6±0.6 and 9.5±1.2 min). Retrospective respiratory motion correction was performed as previously described in [2]. The coil sensitivity maps were calculated with the motion corrected data using Walsh’s method [4]. SNIPR extends the generalized SENSE framework described in [5] to 3D for iterative image reconstruction. Healthy volunteer scans (N=4) were performed successfully on a clinical 1.5T scanner (MAGNETOM Avanto, Siemens AG Healthcare, Erlangen, Germany) with IRB approval and written consent. Offline reconstruction was implemented in MATLAB (MathWorks, Natick, MA). Image quality scores were assigned by an experienced reader blinded to the underlying techniques.

Table 1: Image quality score results (range: 0-4) for different reconstruction methods and undersampling factors.

	Gridding, 5800 lines	SNIPR, 5800 lines	Gridding, 12000 lines	SNIPR, 12000 lines	Gridding, 20500 lines	SNIPR, 20500 lines
Score	0.8±0.4	1.1±0.2	1.9±0.7	2.5±0.4	2.2±0.8	2.5±0.7

Results: Direct gridding shows significant streaking artifacts that increase with undersampling, while SNIPR greatly reduces the amount of streaking in all datasets and improves the apparent SNR (Fig. 1). Notably, the image qualities of 12000 and 20500 lines have no significant difference with SNIPR, although with 5800 lines there is a certain degree of blurring; this can be due to poor conditioning of the reconstruction, error in motion correction and/or in coil sensitivity maps. Subjective image quality scores are shown in Table 1.

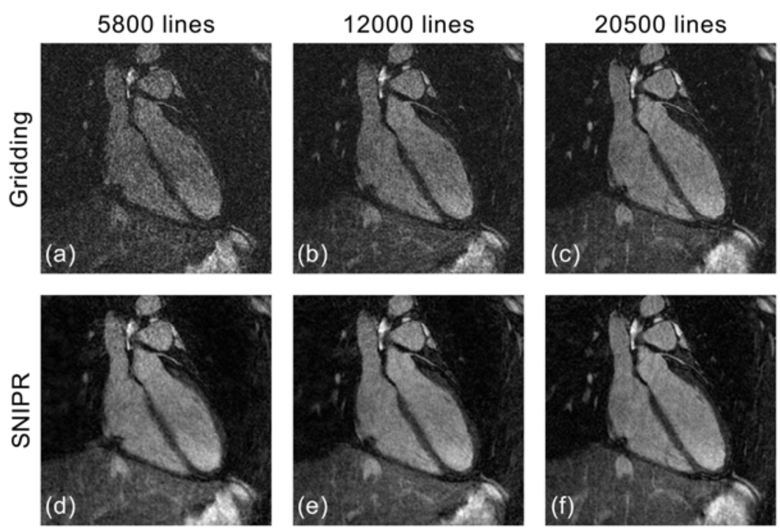

Figure 1: For various undersampling factors, SNIPR significantly reduces streaking artifact, resulting in higher apparent SNR.

Discussion and Conclusion: We have developed a self-calibrated, motion-corrected 3D non-Cartesian sensitivity encoding reconstruction for whole-heart CMRA. The proposed method greatly reduces streaking artifacts, which allows further undersampling the k-space without significant sacrifice in image quality. Current feasible scan time is below 6 min, a near 50% reduction compared with conventional navigator gated techniques [6]. This may allow more consistent image quality and less bulk motion artifacts in patient populations. Further studies are needed to characterize the noise performance of the proposed method. Also, the image quality will benefit from improvements in motion correction and coil sensitivity estimation, especially for high undersampling factors.

References: [1] Bhat et al MRM 2011;65:1269. [2] Pang et al ISMRM 20(2012). [3] Pang et al ISMRM 20(2012). [4] Walsh et al MRM 2000;43:682. [5] Pruessmann et al MRM 2001;46:638. [6] Kato et al JACC 2010;56(12):983

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