Correction for Off-Resonance Blurring Improves Spiral Coronary MRA

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Introduction

Coronary magnetic resonance angiography (MRA) is a promising non-invasive alternative to X-ray coronary angiography (1). Despite recent advances such as navigator echoes, a subject specific trigger delay, and the use of mid- to end-diastolic acquisition window, additional improvements in signal to noise ratio (SNR) remain desirable. Spiral 3D coronary MRA offers the advantages of improved SNR and CNR, compared to 3D T2-prepared TFE coronary MRA (2). However, inhomogeneities in the main magnetic field can produce blurring in images acquired using non-Cartesian k-space readout trajectories. This problem is more pronounced for sequences with long readout times such as spiral imaging. A solution to correct for off-resonance blurring is the use of post acquisition off-resonance correction (3).

	Spiral high res + CPR	Spiral High res	Spiral interm res + CPR	Spiral interm res	Spiral low res + CPR	Spiral low res
LAD length	68±12	66±10	67±14	65±11	70±11	64±10
LCX length	35±11	37±5	38±7	38±6	36±7	36±7
RCAlength	99±32	92±32	101±29	94±29	91±33	78±28
Vessel sharpness	0.46±0.05	0.48±0.05	0.45±0.06	0.47±0.06	0.45±0.07	0.44±0.07
Vessel diameter L	2.42±0.39	2.45±0.37	2.45±0.37	2.44±0.45	2.49±0.43	2.56±0.38
Vessel diameter R	2.94±0.38	2.86±0.36	2.93±0.47	2.92±0.49	2.88±0.50	2.89±0.47

Purpose

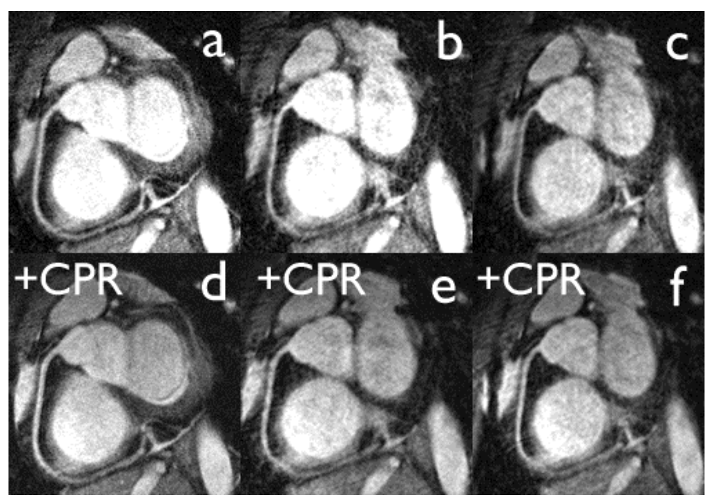
To compare off-resonance corrected 3D spiral coronary MRA with non-corrected spiral 3D MRA at several different spatial resolutions and to investigate the influence of this correction on image quality.

Materials and Methods

Free breathing, navigator gated and corrected spiral 3D coronary MRA with subject specific mid-diastolic trigger delay and acquisition window (70ms) was performed in 20 healthy adult volunteers. A T2-prep prepulse and spectral spatial excitation was used for suppression of myocardium and epicardial fat. Ten left and 10 right coronary arteries (RCA) were imaged using spiral 3D high (0.7x0.7mm in-plane), intermediate (0.84x0.84mm in-plane), and low (1.0x1.0mm in-plane) resolution coronary MRA. All imaging was done on a 1.5T clinical MR scanner (Gyroscan-NT, R9.1, Philips Medical Systems, Best, The Netherlands) using a vector ECG and a 5-element cardiac receiver coil. Imaging parameters for the stack of spiral 3D scans were: FOV = 360mm, matrix = 368, 432, 512, 42 interleaves per kz-plane, 2 interleaves per RR interval, TR = 35 ms, TE = 5.1 ms, flip angle = 45º, 90º, scan duration = 3:55min @ 70 bpm. Ten slices of 3mm thickness were acquired (zero interpolated to 20 slices of 1.5 mm). Sequences were acquired in random order. To correct for off-resonance blurring we used a B_0-field map measurement and a conjugate phase reconstruction (CPR) method (3) which took an additional 2min30s @ 70 bpm. To assess the influence of CPR on image quality we used the following end-points: mean vessel length for left main and anterior descending (LAD), circumflex (LCX) and right coronary (RCA) arteries and vessel sharpness, and mean vessel diameter for the first 20 mm of the left (left main and circumflex) and right coronary arteries. All measurements were made using custom post-processing software (4). In addition, two observers chose the best of the non-corrected and corrected images in a blinded head-to-head comparison of the spiral coronary MR angiograms.

Results

Results of the vessel length measurements as well as the findings with regard to vessel sharpness and vessel diameter are listed in the **table**. When CPR was used, the major coronary arteries could be depicted over slightly longer trajectories (*P*=N.S.). Vessel sharpness and diameter remained nearly constant, irrespective of the resolution and whether or not CPR was used. The results of the blinded head-to-head comparison were strongly in favour of off-resonance correction (*P*<0.01 for both observers). In the **figure** a representative example is shown. Images are shown of a RCA at high (a,d), intermediate (b,e) and low resolution (c,f). On the top row non-CPR corrected images are shown, on the bottom row the corresponding images are shown after CPR off-resonance de-blurring correction has been performed.



Discussion and Conclusions

Correction for off-resonance blurring using CPR is advantageous for spiral coronary MRA because it allows for a better delineation of the coronary arteries. Furthermore, a slightly longer depiction of the major coronary arteries was observed. These results warrant further studies in patients to determine the impact on diagnostic accuracy for native vessel coronary artery disease.

1. Kim et al. NEJM 2001;345:1863-1868.
2. Börnert et al. Magn Reson Med 2001;46 :789-794.
3. Man et al. Magn Reson Med 1997;37:785-792.
4. Etienne et al. Magn Reson Med 2002;48:658-66