

A New Approach for Single breath-hold Whole Heart Coronary MRA Using Highly-Accelerated Parallel Imaging With a 32-element Coil Array

J. Xu^{1,2}, D. Kim³, R. Otazo³, S. Zuehlsdorff⁴, X. Bi⁴, B. Stoeckel¹, and D. Sodickson³

¹Siemens Medical Solutions USA Inc., New York, NY, United States, ²PolyTechnic Institute of NYU, New York, NY, United States, ³Center for Biomedical Imaging, Department of Radiology, New York University, New York, NY, United States, ⁴Siemens Medical Solutions USA Inc., Chicago, NY, United States

Introduction: Whole heart coronary MRA is typically performed with navigator gating because of the large data needed to achieve an isotropic spatial resolution on the order of 1-2 mm³ with extensive anatomic coverage (10-16 cm). Previous studies have shown that whole heart coronary MRA can be performed with either a single [1] or double [2,3] breath-hold (BH) approach using highly-accelerated parallel imaging. The single BH acquires the coil sensitivity data immediately before and after the coronary MRA data within the same cardiac cycle, which lengthens the time between the T2 preparation and fat suppression pulses to the image acquisition, whereas the double BH approach acquires coil sensitivity data in a separate BH, which may suffer from misregistration due to varying breath-hold positions between coil sensitivity and data acquisitions. We propose to acquire both the coil sensitivity and coronary MRA data in two separate cardiac phases (early systole and mid diastole, respectively) within a single BH, in order to circumvent the aforementioned problems.

Methods: RF coil sensitivity scans covered the same volume as the accelerated scans, and were obtained in short end-expiratory breath-holds prior to accelerated imaging (2 BH approach) or obtained at the early systole phase right after the ECG triggering as proposed in this study (1 BH approach). Figure 1 shows the pulse sequence diagram of the ECG-triggered and T2 prepared segmented TrueFISP (SSFP) sequence with 1BH approach used in this study. Immediately after ECG triggering is the low spatial resolution RF sensitivity scan (3D GRE sequence), and T2 preparing pulse is applied after an appropriate trigger delay time, followed by a fat suppression pulse, and the accelerated data acquisition.

Experimental studies were performed in 8 healthy volunteers (7 male and 1 female) on a 1.5T scanner (Siemens; Avanto). The relevant typical parameters are: FOV 340~360 x 340~360 mm², Matrix 256x192x60, slice thickness 1.6~2.0mm, 2D GRAPPA acceleration of 4 (PE) by 2 (PA), segment 48, TR 3ms, TE 1.4ms, T2 and fat-suppression preparation pulses were applied. Using identical parameters, we compared two cases: 1) double BH approach where the coil sensitivity and image data both acquired at mid diastole and 2) single BH approach where the coil sensitivity and image data are acquired at early systole and mid diastole, respectively.

Results: Figure 2 shows representative images that show improvement using the single BH approach. The new single BH approach produced less "pseudo-noise" artifacts than the double BH approach, owing to improved registration. The single BH approach consistently improved image quality compared with the double BH approach in most of the studies.

Discussion: We demonstrated the feasibility of performing whole heart coronary MRA in single breath hold, which offers the potential to enhance imaging efficiency and spatial resolution without apparent misregistration between external RF coil calibration scan and imaging scan. Compared with the double BH approach, the new single BH approach yielded less "pseudo-noise" artifacts, which can potentially improve the diagnostic accuracy. This approach can be used in other non-dynamic 3D imaging. Further investigations are necessary to evaluate the diagnostic accuracy of the single BH coronary whole heart MRA

Reference: [1] J. Park et. al, MRM 54:1100–1106 (2005); [2] T. Niendorf et. al, MRM 56:167–176 (2006); [3] J. Xu et. al, ISMRM 2009 Honolulu p725.

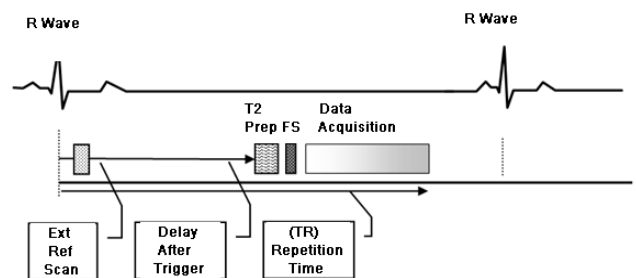


Figure 1: Single BH coronary MRA with the coil sensitivity and image data acquired at two different cardiac phases in the same cardiac cycle.

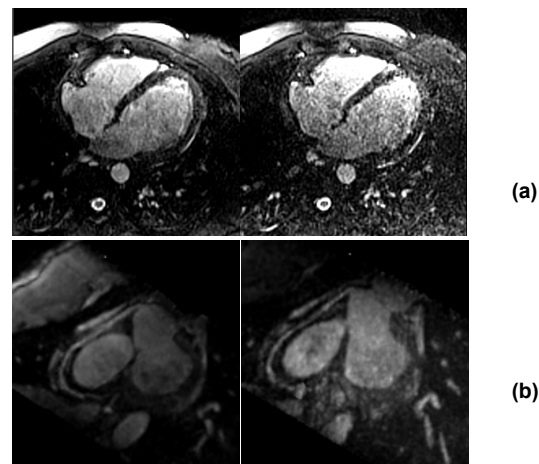


Figure 2: (a) Representative raw images from 1BH (left) and 2 BH (right) approaches; (b) LAD images from 1 BH (left) and 2 BH (right) approaches.