"One-Stop Shop" MRI of Coronary Heart Disease at 3T: Technical Feasibility

L. Ge1, A. Kino1, X. Bi2, X. Liu1, N. Berg1, R. Jerecic2, J. Carr1, and D. Li1

1Radiology and Biomedical Engineering, Northwestern University, Chicago, IL, United States, 2Siemens Medical Solutions, Chicago, IL, United States

Introduction:
Coronary heart disease is the leading cause of death and disability in the US [1]. Cardiac MRI is a promising tool to detect and evaluate myocardial ischemic disease [2]. Various MRI techniques have been developed, including functional cine scan, first pass myocardial perfusion (FPMP), coronary MRA, and delayed enhancement imaging. However, these techniques have not yet been applied in the same imaging session for a comprehensive examination. One of the major challenges has been the relatively long time required for whole-heart coronary MRA. A contrast-enhanced 3T coronary MRA protocol with slow infusion of MultiHance has been developed to cover the entire heart within 5 minutes [3], which makes it feasible to perform a ‘one-stop-shop’ MRI of coronary heart disease in a single study with contrast injection. In this work, we attempted to demonstrate the technical feasibility of this approach in volunteer studies. We hypothesized that residual contrast enhancement after FPMP studies plus additional slow infusion of contrast media would allow for an adequate coronary MRA.

Materials and Methods:
Four healthy volunteers were studied on a 3.0 Tesla scanner (Trio, Siemens, Erlangen, Germany). The imaging protocol is shown in Fig. 1. Two FPMP scans were first acquired (stress scan followed by a resting scan) with a 15-minute interval. Each scan was performed during a single breath hold with the injection of 0.04 mmol/kg of contrast agent, chased by 15 ml of saline solution at a rate of 4 ml/sec. Imaging parameters included: TR/TE/flip-angle = 2.06/1.03/10º, FOV = 350x270 mm², matrix = 106x192, number of slices = 3, GRAPPA factor = 2, saturation prepulse delay = 40 ms. Cine scans were performed between the two perfusion acquisitions with a FLASH sequence along the short axis covering the entire left ventricle. A whole-heart coronary MRA with additional slow infusion of contrast media (0.12 mmol/kg at 0.2ml/sec) was acquired immediately after the second perfusion study. The total contrast volume including two perfusion scans and MRA was 0.2 mmol/kg. An ECG-triggered, navigator-gated gradient-echo sequence, with the following image parameters was used: TR/TE/flip-angle = 3.1/1.4/20º, FOV = 320×250 mm², segments/heartbeat = 32-42, matrix = 200×256, GRAPPA factor = 2, inversion prepulse delay = 200 ms, voxel size = 1.3×1.3×0.9 mm³, partitions = 112. Delayed-enhanced images were acquired by Phase Sensitive Inversion Recovery (PSIR) sequences 10 minutes after the previous contrast injection for viability study. TR/TE/flip-angle = 3.8/1.6/10º, FOV = 340x300 mm², matrix = 168×256, inversion prepulse delay was determined by a previous TI-scout scan. 3D coronary MRA was reformatted using CoronaViz (Siemens, Earlangen, Germany).

Results:
The “one stop shop” cardiac MRI was successfully acquired in 4 volunteers with an average time of 43 minutes. Representative perfusion images (a) and delayed enhanced images (b) from one volunteer are shown in Figure 2. MIP reformatted images of the whole-heart coronary imaging with slow infusion are shown in Figure 3. The right coronary artery and left anterior descending artery are clearly depicted.

Conclusions and discussion:
The study demonstrated the feasibility of a comprehensive protocol “One Stop Shop” for cardiac MRI at 3T. It was possible to complete the integrated perfusion, delayed enhancement, dynamic myocardial analysis (cine MRI) and 3D whole heart coronary MRA in a single study within 45 minutes. Patient studies will follow to assess the clinical potential of the approach.

References: