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

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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 = 350×270 mm^2, matrix = 106×192, 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 mm^2, segments/heartbeat = 32-42, matrix = 200×256, GRAPPA factor = 2, inversion prepulse delay = 200 ms, voxel size = 1.3×1.3×0.9 mm^3, 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 = 340×300 mm^2, matrix = 168×256, inversion prepulse delay was determined by a previous TI-scout scan. 3D coronary MRA was reformatted using CoronaViz (Siemens, Earlangen, Germany).

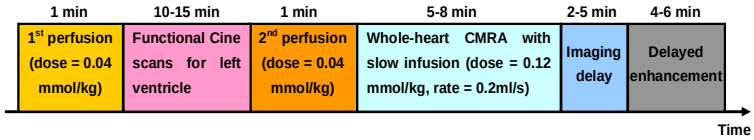

Figure 1. Schematic of the "One Stop Shop" cardiac MRI protocol.

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 Figure3. The right coronary artery and left anterior descending artery are clearly depicted.

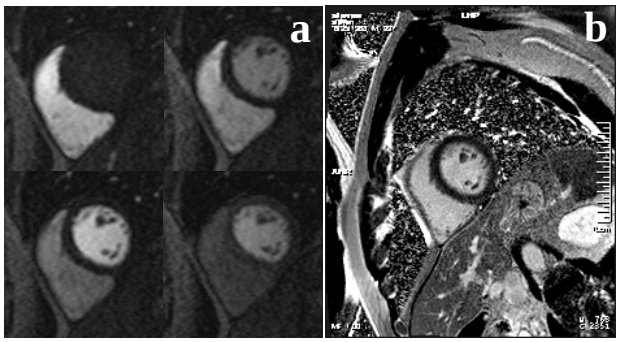

Figure 2. First-pass contrast enhanced myocardial perfusion images (a) and delayed enhanced image (b) acquired from a healthy volunteer.

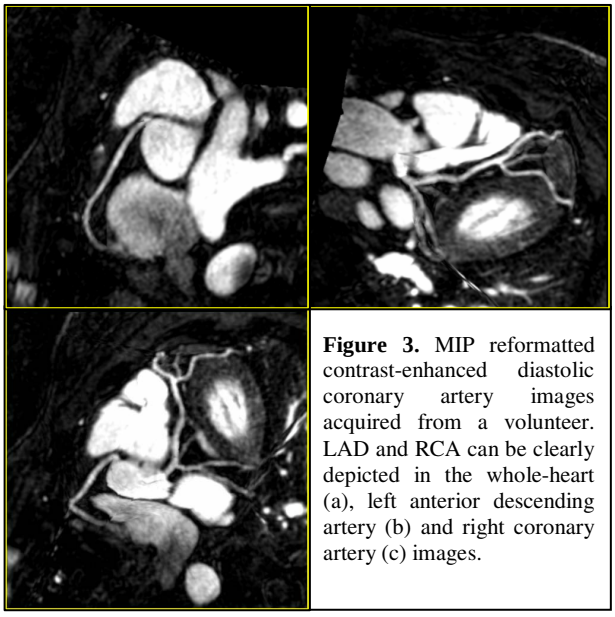

Figure 3. MIP reformatted contrast-enhanced diastolic coronary artery images acquired from a volunteer. LAD and RCA can be clearly depicted in the whole-heart (a), left anterior descending artery (b) and right coronary artery (c) images.

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:

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