Preliminary Study of Coronary MRA at 3T: Using 3D Gradient Echo Sequence in a Delayed Post-Contrast Phase

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Introduction:

Recent studies showed that free-breathing 3D coronary magnetic resonance angiography (MRA) with steady-state free-precession (SSFP) technique at 1.5T is a valuable tool for the noninvasive assessment of significant proximal to mid coronary artery disease [1]. Whereas the implementing this technique at 3T is still very challenging because SSFP is susceptible to the severer static field (B_0) and radio-frequency field (B_1) inhomogeneities. The former study already demonstrated the 3D gradient-echo (GRE) imaging sequence could be used to obtain stable coronary MRA images at 3T [2]. However, the signal-to-noise ratio (SNR) and the contrast-to-noise ratio (CNR) of GRE imaging are not as good as those of SSFP imaging. The purpose of this study was to investigate the feasibility of utilizing residue contrast from perfusion and viability scan to improve GRE acquired coronary MRA at 3T and also to develop an efficient coronary localization method.

Methods:

Pulse sequence and parameters: A 3D segmented k-space GRE imaging sequence was implemented with an interleaved center-out k-space acquisition scheme in the k_y direction and linear sequential in the k_z direction. 20 RF excitations were performed in an acquisition window of 108ms during each RR interval. VECG R-wave triggering was used to ensure the reliability of triggering in the high magnetic field. A 150^0 spectrally selective fat saturation and a T2prep pre-pulse [3] were used to suppress fat and myocardial signal. Data were acquired during free breathing using a navigator respiratory gating [4] with navigator localized at the lung-liver interface with a 5mm gating window

Coronary Imaging: 3 patients who were planed to receive perfusion and viability exam were included in the study with consent. A double dose (0.2mmol/kg) contrast was injected (A single dose for perfusion exam and another dose for viability exam) before the coronary MRA exam. The mean delay time between the first injection and the start of coronary MRA acquisition were 18±3min. All experiments were performed on a GE 3T scanner using an 8-channel torso phased array coil with scan parameters of 28x28cm FOV; 256x240 Matrix; 2mm slice thickness and later interpolated to 1mm in the image reconstruction; TE/TR/FA = 2.1/5.4ms/25^o; 488 Hz/pixel bandwidth.

Coronary Localization Strategy: Whole heart imaging has been explored by many researchers, however, the long time required for whole heart coverage is not acceptable without a powerful SENSE coil and algorithm. Our approach is a two-step target localization method. All the proximal and middle parts of right coronary artery (RCA), left main (LM) + left anterior descending (LAD) and left coronary circumflex (LCX) can be acquired from 2 target thin volumes as illustrated by fig. 1. RCA and LCX (fig. 1B) were obtained from the localization on 4-chammber plane (fig. 1A). And LM+LAD (fig. 1C) was obtained from the localization on the RCA plane (fig. 1B).

Results:

All the RCA, LAD and LCX of the 3 subjects were obtained successfully. The average total scan time was 12±3min. The average contiguous vessel length for RCA, LM+LAD and LCX were 120±32mm, 78±15mm and 31±7mm respectively. The SNR and CNR were 61±14 and 47±12 for RCA vs. 72±18 and 53±15 for LM+LAD. Fig. 2. shows an example of post contrast RCA (fig. 2A) and LM+LAD (fig. 2B) images obtained from two-step target localization method. Fig. 2C shows a RCA image without contrast agent as a reference. The post contrast SNR and CNR of RCA were about 2.1 and 2.3 times of pre contrast SNR and CNR.

Conclusion:

The preliminary result showed that it is promising to utilize residue contrast from perfusion and viability study to improve the coronary image quality at 3T although further investigation needs to be performed. Two-step target thin volume localization can get us all the proximal to middle part of main coronary artery efficiently.

Reference

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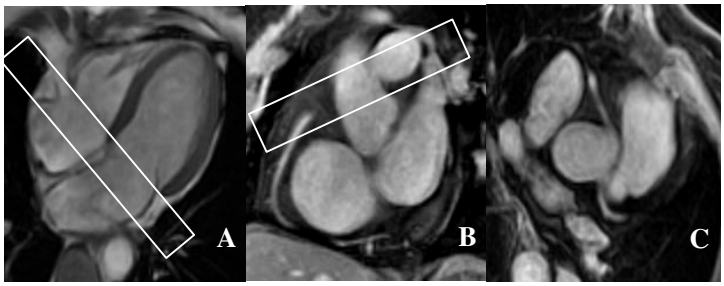

Fig. 1. Two-step target localization method for coronary MRA imaging. RCA and LCX (B) is acquired from the localization on 4-chammber plane (A) and LM+LAD (C) is acquired from the localization on RCA plane (B)

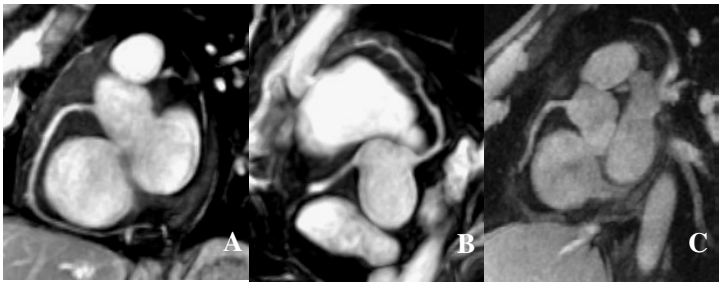

Fig. 2. Representation images obtained from two-step target localization method on 3T. A and B were from one subject with contrast agent. C was from another subject without contrast agent.