Real time MR Coronary Angiography at 3T

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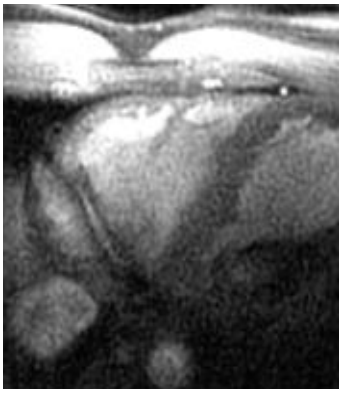
Introduction. Real time MR eliminates the need for cardiac-gating or breath-holding. Previous studies have demonstrated real time evaluation of cardiac function, visualization of cardiac flow, and localization of scan planes. MR coronary angiography (MRCA) in real time (RT), however, remains challenging. RT spiral MRCA can potentially benefit from high field imaging at 3T; however, susceptibility to off-resonance effects and RF inhomogeneity must be addressed. We, therefore, developed an optimized 3 T real-time spiral coronary imaging sequence.

Methods. Scanning was performed on a GE Signa 3T LX system capable of 40 mT/m amplitudes and 150 T/m/s slew rates with receivers supporting 4us sampling ($\pm$ 125 kHz). Body coils capable of peak B1 of 0.16 Gauss were used for RF transmission, and 5 inch-surface coils were used for signal reception. A custom-designed communication and real-time reconstruction and display framework were used to control the scanner and to view images in real time. A spectral spatial RF pulse that excites thin 3 mm slices with a sharp slice profile was designed for the MRCA application. Thin slices were achieved using a 1-3-3-1 1.2 ms sub-lobe envelope with 4 G/cm amplitude and 4.8 ms duration. Good fat suppression was achieved by suppression of the unwanted bipolar excitation at 440 Hz. The pulse sequence achieves 1.24 mm resolution over a 20 cm FOV with 4.7 mm slice thickness, every 180 ms (12 interleaves, 15 ms TR, 8.192 ms readouts). Images were reconstructed on 256x 256 matrix and displayed at 16-24 frames/ second using a sliding window. Fourteen subjects (9 men, 5 women) were recruited consecutively.

Results. All subjects completed the scan without complications. Scan times of less than 20 minutes were required to visualize the entire coronary anatomy. Coronary segments had sharp and contiguous borders. Wide anatomic coverage was also achieved. A total of 126 coronary segments were analyzed. Good to excellent image quality was seen in 79% of segments. Non-diagnostic image quality was seen in 16% of segments. These segments were mostly located in the distal LCx and distal LAD. Representative pictures of the proximal and mid RCA (a), distal RCA (b) and proximal and mid LAD (c) are shown below.

Conclusion. We have demonstrated the feasibility of real time cardiac imaging at 3T. Complete coronary evaluation can be achieved in less than 20 minutes without cardiac-gating or breath-holding. Coronary images have excellent image quality with good anatomic coverage. Further studies are needed to determine its clinical utility in the evaluation of patients with coronary artery disease.


(a)


(b)


(c)