Free Breathing Interactive Coronary MRA Using Fat Suppressed 2D FIESTA

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Introduction

Three-dimensional MR coronary angiography using navigator echo or breathhold technique has shown great promise. However, to the patients with irregular breathing or limited ability to cooperate, an alternative approach, such as real time interactive coronary artery imaging is needed [1,2]. SNR has been a big challenge in real time acquisition. In this paper, we propose to take advantage of 2D fast imaging employing steady state acquisition (FIESTA) technique, which can offer not only good SNR of blood vessel but also very short TR for rapid imaging, to develop a free breathing interactive coronary MR imaging technique. We have demonstrated the feasibility of using ECG gated fat suppressed 2D FIESTA to localize and image coronaries interactively on a commercial clinical scanner.

Methods

All experiments were performed on a Signa 1.5 Tesla MR imager (GE Medical Systems, Milwaukee, WI, USA) equipped with TwinSpeed gradient system capable of 40mT/m at a slew rate of 150T/m/s. All images were acquired with a standard 4-element phased array cardiac coil. The initial evaluation consisted of ten normal volunteers (24~59 years old, 7 males and 3 females).

The free breathing coronary artery sequence was an ECG gated 2D FIESTA with a spectrally selective inversion pulse for fat suppression (Figure 1). The sequence was incorporated in GE's interactive imaging interface (iDrive), therefore a particular cardiac view can be interactively localized and saved into the normal database for later view or to serve as a localizer for higher resolution 3D imaging. Image parameters were 0.5NEX, 28 - 36cm FOV, 5mm slice thickness, 192 x160 Matrix, TE/TR = 1.6/4.2msec, 60 degree flip angle, ±125kHz RBW. Trigger delay (TD) is set to the mid-diastolic position [3] and can be dynamically changed with a slider bar in the user interface. A 2D coronary image can be acquired in single or double RR intervals. For the double RR interval acquisition, the even phase encoding views are acquired in one RR interval and the odd views are acquired in the other to maintain a narrow acquisition window.

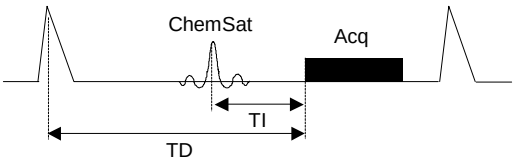

Fig. 1: the pulse sequence digram for 1RR interval.

Results

High quality RCA images were obtained from all 10 subjects. LAD can also be visualized for all 10 subjects with a little lower quality. LCX can only be visualized in 8 out of 10 subject with inferior quality. It might be due to LCX is thinner and further away from the receiver coil. Fig.2 shows a RCA image in the interactive interface. Fig.3a and Fig.3b show an example of RCA and LAD images acquired from one volunteer. Fig.4a-d, demonstrated two comparison examples of single and double RR interval acquisition. Fig.4a and Fig.4b show the RCA images for a 75 bpm heart rate volunteer. Fig.4c and Fig.4d were images acquired from another volunteer with 55 bpm heart rate. In the case of heart rate slower than 62, there is sufficient time in mid-diastolic phase to sample the data, we could use single RR interval acquisition to reduce the respiratory effect.

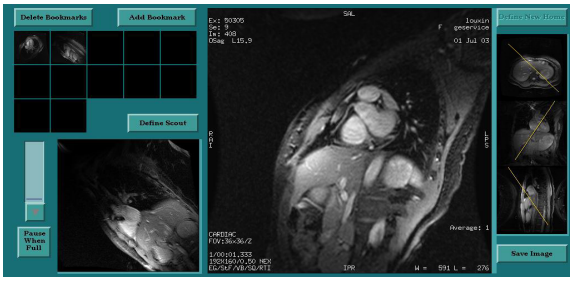

Fig. 2: A RCA image shown from the interactive MRI interface.

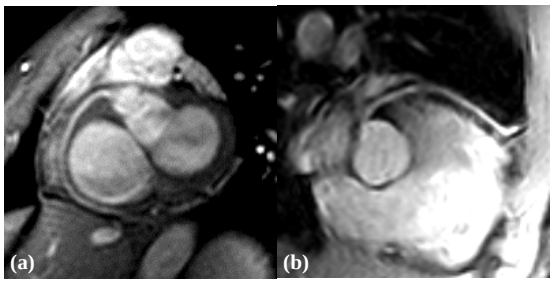

Fig. 3: (a) RCA and (b) LAD images saved from interactive scan.

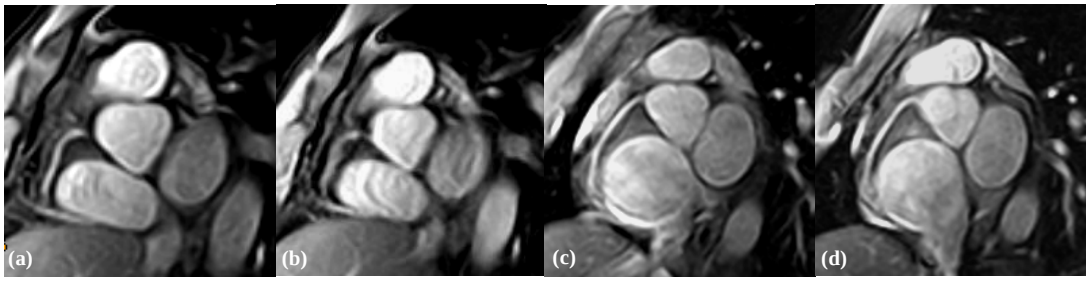

Fig. 4: RCA images obtained in (a) 2RR and (b) 1RR interval for one volunteer with 75 bpm heart rate. (c) 2RR and (d) 1RR interval for a different volunteer with 55 bpm heart rate.

Conclusion

ECG gated fat suppressed 2D FIESTA can be used for interactive free breathing coronary artery imaging. Single RR interval acquisition can be applied to the slow heart rate subjects while double RR interval acquisition should be used for the fast heart rate subjects. High quality image can be produced from right coronary arteries. The visualization of left coronary artery system might be improved with a better RF receiver and the use of small dose contrast media.

References

1. C.J. Hardy, et al, Magn Reson Med 2000; **44**:940-946
2. K.S. Nayak, et al, Magn Reson Med 2001; **46**:430-435
3. Y. Wang, et al, Radiology 2001; **218**:580-585