

Prospective Navigator Cardiac Triggering for Coronary MRA

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Introduction Cardiac magnetic resonance imaging (CMRI) generally requires cardiac synchronization to compensate for heart motion using an electrocardiogram (ECG). The need of ECG increases patient set-up time for placing ECG leads and handing the connections. Additionally abnormality of patient and fetal body habitus may make it difficult to obtain accurate ECG signal. To overcome these limitations, a prospective navigator echo based cardiac triggering approach without ECG synchronization has been described by Vasanawala^[1] that uses bipolar velocity-encoding gradients for detecting cardiac phase information. In this work, we present an efficient wireless approach that uses echo peak change from 1D navigator echo.

Materials and Methods The proposed approach was applied to coronary artery imaging (CAI) with breath hold in Fig.1. Repeated echoes of TR 25 msec were acquired using 2D selective navigator pulses with 10mm in diameter that were placed on aortic arch. The FID signal was obtained with flow-compensated readout gradient to detect inflow related cardiac change. Suitable coil channels were selected and combined to derive the cardiac-related signal. The magnitude of echo peak from the FID was displayed on a real-time monitor window. Systole was detected by a rise in echo peak above a threshold. Balanced Steady State Free Precession (bSSFP) data acquisition with spectral selective inversion pulse for fat saturation (SPIR) began at diastole after a trigger delay that was determined based on cardiac motion using ECG gated 2D SSFP CINE in advance. The comparison was performed with a conventional ECG triggered approach at HDxt 1.5T (GE Healthcare, WI) using a 8-channel cardiac coil. The volunteer scan was approved by the institutional review board. The 3D SSFP imaging parameters for whole heart coronary arteries were TR/TE=3.8/1.9 msec, FA=70 deg, FOV 32x19 cm, slice thickness 3 mm, matrix size 192 x 192 x 16, parallel imaging factor of ARC 1.89, scan time 23 sec per slab.

Results The pulsatile waveform of echo peak was detected with sufficient SNR in 4 out of 8 receiver channels in Fig.2. The waveform of ECG and combined echo peaks from ch3, ch4, ch7 and ch8 was shown in Fig.3. The systolic trigger point of the echo peak waveform from ECG was delayed with 78.6 ± 40 msec. The right and left coronary arteries were successfully visualized in healthy subject (Fig.4). The navigator cardiac triggering was consistently performed every 1 R-R intervals.

Conclusion The preliminary results provide a comparable depiction of coronary arteries to ECG without the constraints of scan time, spatial resolution and image quality. Axial scan orientation prevents echo peak fluctuations due to magnetization recovery after SSFP acquisition. The proposed wireless technique can be extended to adapt for other applications such as MDE, CINE and perfusion MRI with typical short or long axis orientation to reduce total cardiac examination time.

[1] Vasanawala S, et al., Magn Reson Med, 1999, 42:82-86

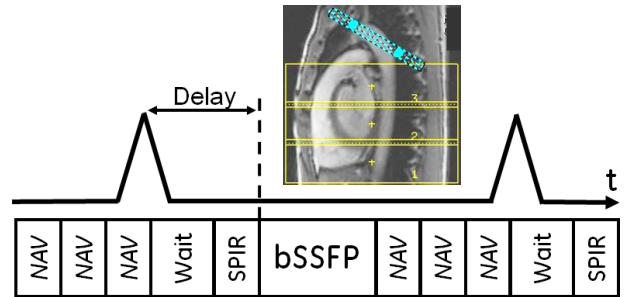


Figure 1. Prospective navigator cardiac triggering for CAI. Axial multi-slab scan plane in yellow and navigator tracker placement at aortic arch in blue are shown.

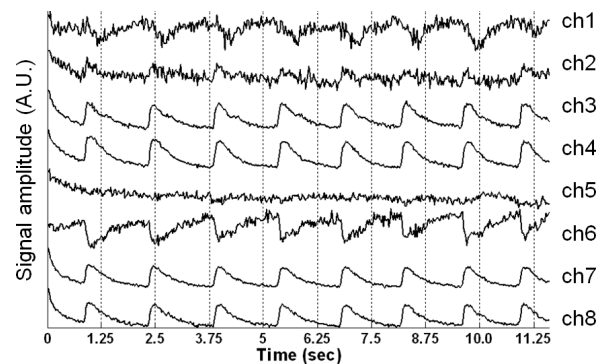


Figure 2. Representative waveform of echo peak from FID signal in all receiver channels before coil selection. Ch3, Ch4, Ch7 and Ch8 are selected in this case.

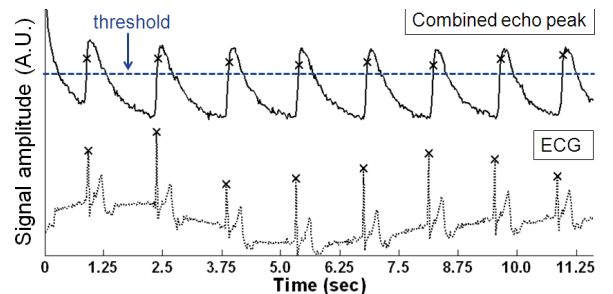


Figure 3. Representative waveform of coil combined echo peaks and ECG signal used for triggering (x = trigger positions).

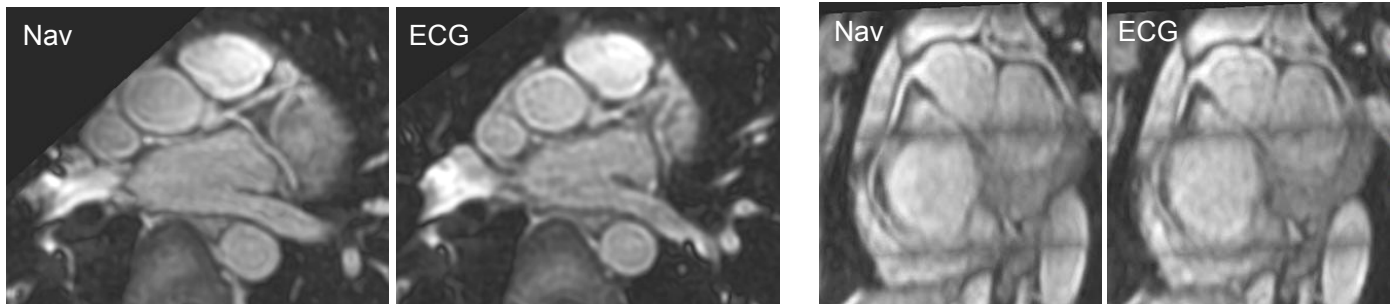


Figure 4. Coronary MRA images using different triggering approaches. Nav: Navigator echo based triggering. ECG: conventional ECG triggering.