

## High Resolution Cine of the Heart at 3T with Free Breathing Cine-GRICS

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**TARGET AUDIENCE:** MR scientists and physicians interested in dynamic high resolution cardiac images.

**PURPOSE:** Motion compensated reconstruction algorithms enabling free breathing acquisitions have been recently applied to cine imaging [1]. The Generalized Reconstruction by Inversion of Coupled Systems (GRICS) [2] is a joint optimization problem that solves a motion compensated image reconstruction and a motion model. The problem is solved using cine-GRICS under physiological motion sensors constraints such as respiratory belts or ECG. Free breathing enables longer acquisition time that can be used to increase spatial resolution [3]. To increase resolution in a SSFP sequence at 3T, longer TR and change in flip angle are needed. Therefore, the expected benefit of higher resolution acquisition has to be demonstrated with the new sequence parameters.

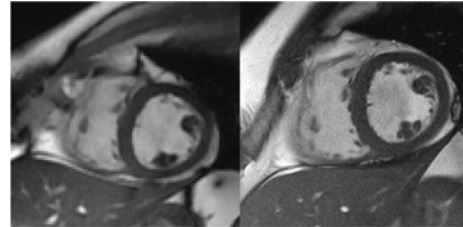


Fig 1. : Comparison of standard clinical breath hold acquisition (left) with high resolution free breathing acquisition (right).

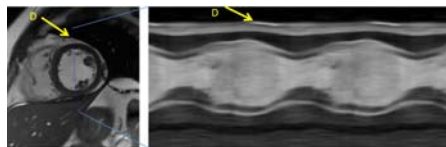


Fig 2. : Time-Motion across left ventricle with coronary vessel pointed by the arrow.

signals were also collected. For each cine loop 32 cardiac phases were reconstructed with a window width of 120ms using the cine-GRICS algorithm [1] to correct for motion. Analyses of the images have been performed to assess if small anatomical details such as valves or coronary vessels could be visualized. Standard cardiac function using Mass Analysis (Leiden Medical Center) was computed.

**RESULTS:** The  $384^2$  resolution clearly brings an increased detail level compared to the standard breathhold  $224^2$  acquisition (Fig 1.). Inflow hypersignal in the left coronary could be observed (Fig 2.). Small anatomical features like valves or trabeculations can be observed on all volunteers (Fig 3.). On short axis stacks left and right ventricles could be easily contoured (Fig 4.).

**DISCUSSION:** In one volunteer, the SA stack was incomplete due to power outage during acquisition. Breathing motion artifacts were entirely removed by the cine - GRICS

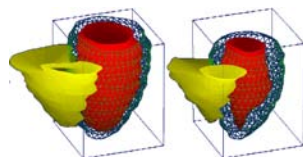


Fig 4.: Diastolic and systolic segmentation for 6<sup>th</sup> volunteer.

**METHODS:** On six volunteers (5 F, 1 M,  $40.5 \pm 17$  y,  $64 \pm 15$  kg), about 25 slices per volunteers of 2D cine-GRICS covering the whole heart have been performed on a 3T Signa HDxt MR system (GE Healthcare, Milwaukee, WI). A multi-phase balanced-SSFP sequence in free breathing (TR 5.4ms, TE 2.5ms, FOV 30cm,  $384 \times 384$  matrix,  $60^\circ$  flip angle, 5mm slice thickness, 55 temporal phases, 124s acquisition time) was used to collect the data for one cine loop. Physiological

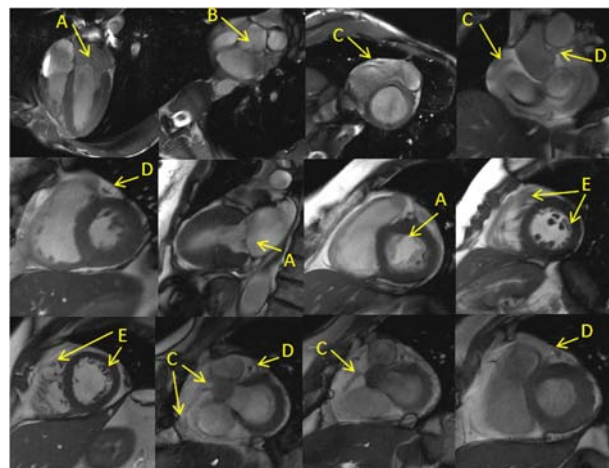


Fig 3. : Features displayed on high resolution cine-GRICS images: Mitral valve (A), Aortic valve (B), Right coronary (C), Left coronary and anterior interventricular artery (D) and Trabeculations (E).

reconstruction. Some typical flow and banding artifacts were still present. Further sequence optimizations are needed to remove remaining artifacts.

**CONCLUSION:**  $384^2$  high resolution full heart Cine stacks can be acquired in free breathing in less than one hour on a 3T system.

**REFERENCES:** [1] Vuissoz et al. JMRI 35 :340 (2012). [2] Odille et al. MRM 60:146 (2008). [3] Vuissoz et al. ISMRM Stockholm 5016 (2010).