IMPROVING FAT SUPPRESSION IN RADIAL CORONARY MRA USING A WEIGHTED GOLDEN RATIO ACQUISITION

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INTRODUCTION: Coronary MR angiography benefits from the favorable motion properties of radial *k*-space sampling [1-2], which allow reducing scan time by use of longer cardiac acquisition windows [3]. However, recovery of epicardial fat signal during the prolonged data acquisition window may impair image quality as radial trajectories repeatedly sample the center of *k*-space. Moreover, the effectiveness of the fat suppression may depend on the subject specific epicardial fat distribution. Here we investigate the use of a *k*-space filtered golden radial acquisition [4] to overcome this problem. The filtering is used to consider the *k*-space central data only for those radial projections with sufficient fat suppression. The golden angle approach has been chosen as it allows retrospective subject specific filter adaptation for optimal fat suppression.

METHODS: In golden ratio radial acquisitions the angular spacing between two consecutives profiles is constant and given by the golden ratio, $\theta_{GR}=111.25°$. This approach provides flexibility in the reconstruction, since the number of profiles contributing to image contrast is not fixed during the acquisition but can be adjusted to the contrast variability after the application of the fat suppression prepulse (Fig.1a). A retrospective *k*-space filter is used to weight different regions of the *k*-space according to their fat saturation levels (weights represented by different colors in Fig. 1b and c). The design of the filter includes definition of number of regions in *k*-space (e.g. *4* regions in Fig.1c), radius of each region, and number of radial profiles considered in each of them. These parameters can be determined retrospectively according to the epicardial fat recovery, provided the Nyquist criterion is satisfied in each region.

The feasibility of this approach was tested in a water-fat phantom (one bottle filled with water and one with vegetable oil). In-vivo experiments were performed in four healthy volunteers on a 1.5T Philips scanner using a 32-channel receiver coil. In all cases, the right coronary artery (RCA) was imaged with a 3D segmented balanced-SSFP sequence in a double-oblique sagittal orientation using a ‘stack of stars’ trajectory for the conventional and golden radial approaches. Relevant scan parameters include: FOV = *272×272×30mm*, matrix size = *272×272×10*, resolution = *1×1×3mm*, TR/TE/flip angle = *5.53/2.76ms/90*, T2 prep pulse (TE = *30ms*) navigator gating window = *8mm*, subject specific mid-diastolic trigger delay, fat saturation prepulse (SPIR) prior to each b-SSFP acquisition. The achieved fat suppression with the *k*-space filtered golden radial approach was compared against the conventional radial imaging sequence for different cardiac acquisition windows duration (acq.wind. = *90*, *180* and *240ms*). A filter with *4* regions (Fig.1c) was considered for the phantom experiment, whereas *4* to *6* regions were employed for the in-vivo acquisitions.

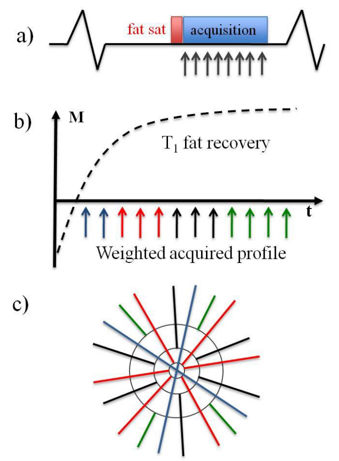


Figure 1: a) Golden-radial acquisition performed after fat-saturation prepulse. b)-c) Each profile is retrospectively weighted (colors) at different k-space regions according to their fat saturation levels.

RESULTS: *a) Water-fat phantom:* The radial and *k*-space filtered golden reconstructions for an acquisition window of *240ms* are shown in Fig.2b and c, respectively. A strong fat signal is noticeable in Fig2.b due to fat relaxation, whereas significantly improved fat suppression is observed with the proposed approach in spite of the long acquisition window (Fig2.c). For comparison a radial sampling with a short acquisition window of *90ms* and effective fat suppression is included in Fig.2a.

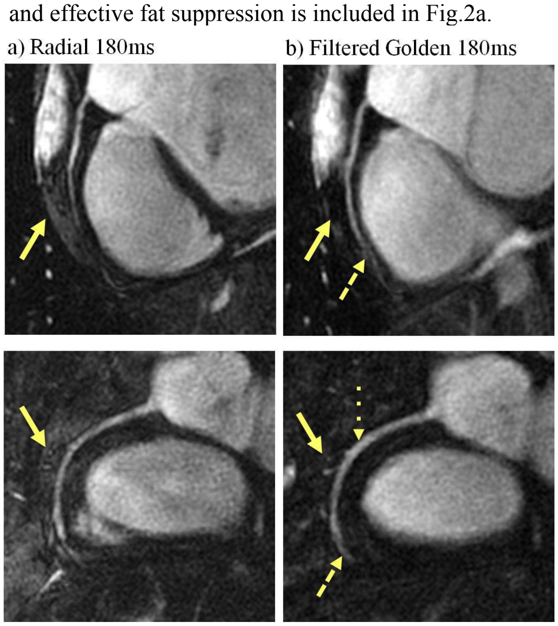
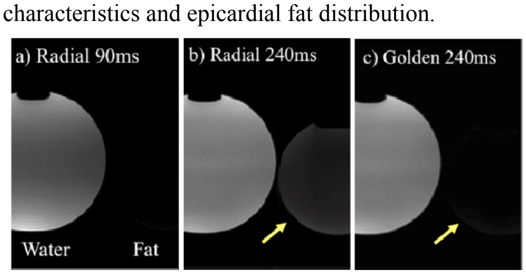


Figure 3: a) RCA radial and b) RCA k-space filtered golden radial acquisition with acquisition window of 180ms. Improved fat suppression (solid arrows) and visualization of distal RCA (dashed arrows) is shown with the k-space filtered golden approach.

b) *In-vivo experiments:* In comparison with the conventional radial approach, the *k*-space filtered golden acquisition yielded superior fat suppression over prolonged sampling periods in all volunteers. Reformatted RCA images for conventional and golden radial acquisitions are shown in Fig.3 for two volunteers (acq.wind. of *180ms,* nominal acquisition time of *2 min.*). Epicardial fat is visible in the radial acquisitions due to T1 recovery, whereas good suppression of epicardial fat is observed with the proposed approach (solid arrows in Fig.3a and Fig.3b). Better visualization of the distal RCA (dashed arrows in Fig3.b) is achieved with the *k*-space filtered golden approach due to improved fat suppression. Furthermore, reduction of water-fat shift artifacts (black rim) results in larger apparent vessel diameters for the *k*-space filtered approach (dotted arrow in Fig.3b).

CONCLUSIONS: We have shown that improved fat suppression in radial coronary MRA is achieved by using a weighted golden ratio acquisition for prolonged sampling periods (and therefore reduced scan times) after a fat saturation prepulse. This approach does not require any increase in scan time and the appropriate *k*-space filter can be designed retrospectively for each subject without any a-priori sequence modification. Future work will investigate subject specific filter characteristics and epicardial fat distribution.

Figure 2: Water-fat phantom with radial and weighted golden radial approaches for acquisition windows of 90 and 240ms. Residual fat signal is observed for the 240ms radial sampling, whereas significant improved fat suppression is shown with the filtered golden radial acquisition.



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