

¹⁹F/¹H Simultaneous 3D Radial Imaging of Atherosclerotic Rabbits Using Self-Navigated Respiratory Motion Compensation

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Introduction

MR molecular imaging of low doses of tracer material often requires long scan times and makes motion compensation strategies desirable. 3D radial imaging with golden section profile interleaving allows auto-navigated motion compensation [1,2]. Here, it is applied to simultaneous ¹⁹F/¹H imaging of the aorta of atherosclerotic rabbits after systemic administration of ¹⁹F-based angiogenesis-targeted nanoparticles [3]. Tracking of respiratory motion is performed on the ¹H data and correction is applied to both the ¹H and ¹⁹F images to enhance image quality and to provide the possibility of ¹⁹F quantitation of tracer concentrations.

Methods

Rabbits put on cholesterol diet to develop atherosclerosis [4] were injected intravenously with $\alpha_v\beta_3$ -targeted nanoparticles (NP) containing high concentrations of lipid-encapsulated perfluorocrownether (PFCE) [3]. Three hours post injection, the MRI exam was performed on the anesthetized and externally respiration rabbits. PFCE exhibits a single line spectrum and is imaged using simultaneous ¹⁹F/¹H MRI in order to visualize the ¹⁹F image with anatomical co-registration. 3D radial gradient echo imaging was employed for its robustness against sub-sampling and motion [5]. Angular increments (cf. Fig. 1) between readouts were derived from 2D golden section fractions [1], allowing almost isotropic coverage of *k*-space over the total scan as well as over arbitrary subsets extracted for dynamic imaging. Thus, the frame rate for dynamic imaging can be chosen retrospectively depending on available SNR and desired temporal resolution. The balance between SNR and spatial resolution can furthermore be influenced by adequate *k*-space weighting of radial samples in the gridding process of the 3D radial reconstruction. Experiments were performed on a modified clinical 3.0T whole body scanner

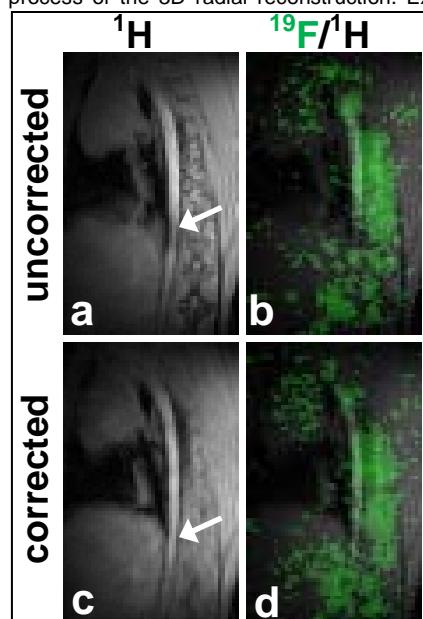


Figure 2: Comparison of uncorrected and 3D motion-corrected ¹H and ¹⁹F data. ¹H and green ¹⁹F overlay images extracted from 3D data without correction (a,b), and with rigid-body motion correction (c,d), based upon a frame duration of 1/3 s.

Conclusion

3D isotropic undersampled radial imaging using golden section profile interleaving allows flexible 3D respiratory motion compensation by self-navigation. Frame rates on the order of 3 Hz are feasible, which is sufficient to resolve rabbit or human respiratory motion. Application to simultaneous ¹⁹F/¹H imaging has been shown, but the achieved frame rates make the approach useful for compensation of respiratory motion in abdominal or cardiac ¹H imaging as well.

References

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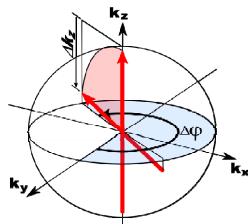


Figure 1: Golden section increments Δk_z and $\Delta \varphi$ between subsequent radial readouts.

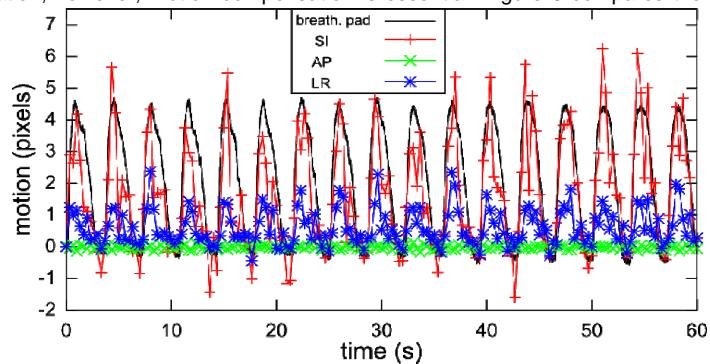


Figure 3: Comparison of a one-minute window of motion extracted from image data (color) with motion information acquired using a breathing pad (black). Red, green, and blue indicate directions SI, AP, and LR, respectively. Temporal resolution was 1/3 s.