Time-efficient approximate inhomogeneity correction algorithm for 3D spiral contrast enhanced imaging of the liver

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Introduction

Contrast enhanced MRI of the liver, with peak arterial phase imaging, is an important tool for the detection and identification of liver lesions. Sliding window spiral LAVA \cite{1} has been shown to significantly improve capture of the optimal arterial phase. On the other hand, spiral imaging is prone to off-resonance and residual spiral artifacts. A time-efficient approximation algorithm is proposed for off-resonance correction in liver spiral LAVA that does not increase reconstruction time. In this abstract, the effect of this correction method on image quality is examined.

Materials and Methods

Twenty consecutive liver MR exams of patients (average age 56 +/- 17 y, 10M, 10F) using spiral LAVA were retrospectively analyzed. Since it was found in previous exams that the major spatial determinant of off-resonance patterning was the z-direction, off-resonance correction was performed by acquiring, for each coil, a single off-resonance frequency correction value per axial slice. Therefore, for each slice-encoding, an extra acquisition was performed with the spiral gradients turned off. These were performed at the end of the disdaq immediately before the start of data acquisition. After a Fourier transformation along the slice direction, a single off-resonance frequency was determined for each slice and for each coil; this frequency was then used to demodulate all spiral data in the same slice and coil. Residual spiral artifact correction was performed using PILS\cite{2}. Imaging parameters were TR/TE = 5.4-6.1ms/0.6ms, readout bandwidth $\pm$ 125kHz, 740-896 sampling points per spiral, variable density spiral (2 at the k-space center, 0.7 at the k-space edge), FOV 34-46cm, 1.3-1.8 mm square voxel size, 5-6mm slice thickness, 38-60 slices, 20-32sec scan time, 2 consecutive phases reconstructed to 5 phases using sliding window reconstruction, contrast injection: 10cc of Gadoxetate (Bayer Healthcare) in 10 patients and 0.5 ml/kg Magnevist (Bayer Healthcare) in 10 patients, using breathholding.

The raw data from each study was reconstructed into two series: with off-resonance correction, and without correction. Each series was reviewed and assigned a rating for blurring (0=no blurring; 1=mild blurring; 2=severe blurring). A Wilcoxon signed-rank test was performed to compare the average score of the two image series in order to assess the efficacy of the off-resonance correction.

Results

All MR exams were successfully reconstructed. Enhanced image quality was evident in 14 of the 20 off-resonance correction reconstructions. Image quality improvements were seen throughout the field of view, and particularly during in the arterial phase. The Wilcoxon signed-rank test indicated a significant difference between the images with and without blurriness correction ($p=0.0001$). Figure 1 shows an exemplary case where the improved visualization of the hepatic artery in the arterial phase is clearly demonstrated.

Conclusion

Liver spiral LAVA with the proposed off-resonance correction algorithm significantly improved image quality, particularly during the arterial phase.

References