Feasibility of high temporal resolution compressed sensing based DCE-MRI

H. Wang1, D. Wang1, S. Bao1, and J. Hu1

1Beijing Key Lab of Medical Physics and Engineering, Peking University, Beijing, China, People's Republic of, 2Department of Radiology, Wayne State University, Detroit, MI, United States

Introduction

Dynamic contrast-enhanced (DCE) MRI has been widely used to characterize tumor vasculature. Because of the dynamic nature of DCE-MRI, higher temporal resolution translates into more accurate data for kinetic analysis. On the other hand, the heterogeneous nature of tumors requires high spatial resolution for accurate characterization. Because of their mutual importance, consistent efforts have been aimed at accomplishing both high temporal and spatial resolution DCE-MRI. Several applications of compressed sensing (CS) theory to dynamic MRI have been successfully demonstrated such as k-t SPARSE and k-t FOCUSS [1-2]. But only a few studies focus on CS-based DCE-MRI, and none on the breast. A number of practical issues have to be investigated before implementing CS-based DCE-MRI in a typical clinical setting, such as the reliability of uptake curves reconstructed from undersampled data with CS theory, and the potential impact of subject motion. The purpose of this study is to investigate the feasibility of applying CS theory to breast DCE-MRI to improve the temporal resolution while faithfully reconstructing uptake curves and minimizing potential motion related artifacts.

Methods

3D breast DCE-MRI data were acquired using T1-weighted 3D SPGR with fat suppression on a whole-body 1.5T scanner (Signa Excite, GE Medical Systems, USA). The experimental parameters were: TR/TE = 6.931/2.72ms, Flip Angle = 15°, slice thickness = 5mm, and matrix size = 512×512×21. One pre-contrast and seven post-contrast frames were obtained. Gd-DTPA (0.2mmol/kg; Magnevist, Bayer Schering Pharma AG, Berlin, Germany) contrast agent was injected into the antecubital vein with flow rate of 2 ml/s. Administration of contrast agent was followed by a 20 ml saline flush at flow rate of 2 ml/s. Undersampled 3D data were extracted from the fully sampled 3D breast DCE-MRI data (a 2D Gaussian random undersampling in kx and ky directions with full sampling in kz direction). Final DCE images f(t) were reconstructed using Reference Image based Compressed Sensing technique (RICS) [3] with the average and motion estimation and motion compensation (ME/MC) [2] approaches, respectively. SFD was used as the spatial sparse transformation in l1-norm minimization.

Results and Discussion

The uptake curve reconstruction experiment shows a high correlation between uptake curves reconstructed from fully sampled data by Fourier transform and from undersampled data by RICS, indicating high similarity between them (see Fig.1). The mean Pearson correlation coefficients for RICS with the ME/MC approach was 0.977±0.023. The comparisons of final reconstruction results between RICS with the average approach and RICS with the ME/MC approach suggested that the latter was superior to the former in reducing motion related effects as shown in Fig. 2 (indicated by the arrows). In conclusion, our preliminary results demonstrate the feasibility of RICS for faithfully reconstructing uptake curves for DCE-MRI and improving temporal resolution.

Reference