Liver Imaging Using T2-Weighted BLADE with Parallel Imaging and Through-Plane Motion Correction at 3T

A. Priatna[1], D. Cohen[2], J. Liu[2], W. Chong[2], X. He[3], and V. Narra[2]

[1]MR Research and Development, Siemens Medical Solutions, Inc, St Louis, MO, United States, [2]Radiology, Washington University, St Louis, MO, United States, [3]BMRL Laboratory, Washington University, St Louis, MO, United States

Introduction

Magnetic resonance imaging techniques have been routinely used for detecting liver metastases at 1.5T and 3T systems. The sequences that have been used for this purpose include T2-weighted acquisitions such as T2-weighted turbo spin echo (TSE) sequence. However, the scan time to acquire the T2-weighted TSE of the entire liver is long, thus it can not be done within a single breath-hold period, which can result in respiratory motion artifacts. It has been known that a special k-space trajectory such as propeller [1] or BLADE can reduce motion artifacts. This trajectory has been used mostly for neurological imaging, especially for correcting the translational and rotational motions, or in-plane motion. Liver imaging is also affected by the in-plane motion, i.e., anterior-posterior chest motion due to respiration. Therefore, BLADE trajectory is also potential to be used for liver imaging. In addition to the in-plane motion, liver imaging is also affected by through-plane diaphragm motion, thus it is also prone to artifacts caused by this diaphragm motion. The diaphragm through-plane motion artifacts can be corrected using a prospective motion correction with navigator echo (PACE) that detects the diaphragm movement. Parallel imaging has also been known to speed up the acquisition but reduces the signal to noise to ratio (SNR). The loss of SNR can be compensated using a 3T system which is known to give higher SNR than the 1.5T systems. Using GRAPPA parallel imaging [2], we evaluate the T2-weighted TSE acquisition of the entire liver with BLADE and PACE at 3T system.

Method

A two-dimensional T2-weighted Turbo Spin Echo sequence with BLADE k-space trajectory, PACE (Prospective Acquisition CorrEction) and iPAT (or GRAPPA) parallel imaging is used for the whole liver acquisition on a Trio 3T system with Total Imaging Matrix (Siemens Medical Solutions, USA, Inc, Malvern, PA). A six channel body matrix coil is used for the anterior receiver and a spine coil is used for the posterior. The PACE navigator is placed on the diaphragm-liver boundary to detect the diaphragm motion and through-plane motion correction. The two-dimensional slices are placed to cover the whole liver in transversal direction. The acquisition parameters are: TR/TE = 3390 ms/ 149 ms, FOV = 360 mm, Thickness = 5 mm, Matrix size = 320x320, # slices = 16, Refocusing flip angle = 140, iPAT acceleration factor = 2, BW = 363 Hz/pixel, echo spacing = 8.26, Turbo factor = 35. The acquisition is acquired at the end of end expiration within 2 mm navigator acceptance window. The following acquisitions are performed at 3T on five volunteers: (1) T2-weighted TSE with Cartesian trajectory with PACE and iPAT factor of 2, (2) T2-weighted TSE with BLADE trajectory and iPAT factor of 2 but without PACE navigator, (3) T2-weighted TSE with BLADE trajectory and iPAT factor of 2 with PACE.

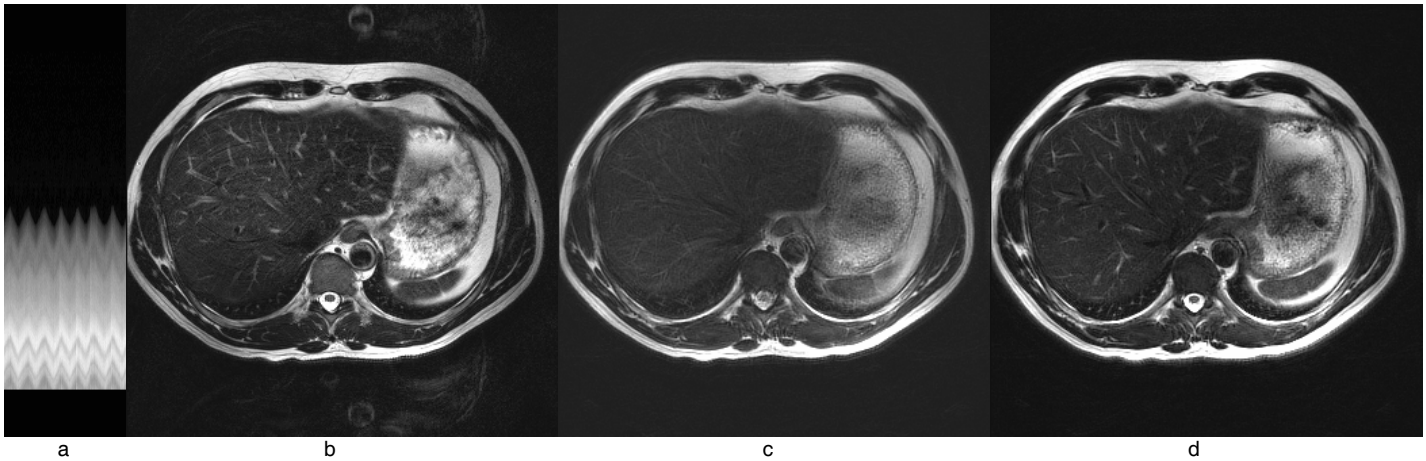

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Figure1. Images from 3T systems: (a) Diaphragm movement from PACE navigator. (b) T2-weighted TSE with Cartesian trajectory with PACE and iPAT shows in-plane motion artifacts. (c) T2-weighted TSE BLADE with iPAT but without PACE navigator shows blurriness caused by diaphragm through-plane motion. (d) T2-weighted TSE BLADE with iPAT and PACE shows no artifacts.

Results and Discussion

The results show that the diaphragm motion and correction with PACE is reliably detected with Cartesian and BLADE trajectories (figure 1a). The Cartesian T2-weighted images with iPAT and PACE shows in-plane motion artifacts as shown in figure 1b. As shown in figure 1c, BLADE images without PACE shows no in-plane motion artifacts as compared to the Cartesian trajectory. This shows that the BLADE trajectory necessary for correcting the in-plane motion artifacts caused by the anterior-posterior chest motion. However, these images show blurriness due to the diaphragm through-plane motion. With additional through-plane motion correction with PACE, the T2 weighted images of BLADE are the most artifacts free. As clearly seen in the sharp images from figure 1d, no in-plane motion artifacts or blurring is observed in the images. On all images, no artifacts associated with iPAT parallel imaging is observed, this includes acquisition with BLADE trajectories. The SNR and the image quality of BLADE images with iPAT at 3T are still very good. In addition, iPAT parallel imaging also allows the BLADE acquisition to be acquired at high spatial resolution within a reasonable scan time. In conclusion, artifact-free T2-weighted TSE of the entire liver can be acquired at 3T system using iPAT parallel imaging with BLADE trajectory and PACE that correct both in-plane and through-plane motion. This acquisition should be used for liver clinical studies at 3T.

References

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