Three-Dimensional Two-Point Dixon Acquisition with Projections Onto Convex Sets (POCS) for Abdominal Imaging

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Introduction

Abdominal imaging requires short scan times for breath holding, particularly in ill patients. Three-dimensional two-point Dixon technique has been routinely used for liver imaging to provide opposed and inphase images, as well as fat only and water only images. To cover the abdomen or pelvis, typical imaging for this technique requires approximately 20 seconds. In ill patients, breath hold times must be minimized to avoid artifacts and maintain patient comfort. Phase partial Fourier and strong echo asymmetry are often employed to reduce the scan time. However, echo asymmetry and phase partial Fourier with zero filling result in blurring artifacts in the in-plane view. This abstract describes the use of phase correction with projection onto convex sets (POCS) [1] to the three dimensional two-point Dixon sequence in order to reduce blurring artifact and improve image quality at short scan times.

Method

Three-dimensional two-point Dixon sequence was acquired on a 3.0 T MAGNETOM Trio (Siemens Healthcare, Erlangen, Germany) with Total Imaging Matrix six element body matrix coil and six to nine elements of the spine matrix coil. 7/8 partial Fourier was used in the phase direction. Strong echo asymmetry was also used. POCS was applied in the phase-encoding and readout directions. Additional parameters included 320 base resolution, TE1/TE2 = 2.45/3.67 ms, TR = 5.27 ms, FOV = 300-380 mm, phase FOV = 75%, partition thickness = 3 mm, slices per slab = 56-72, slice resolution = 64-67%, flip angle = 10^{o}, bandwidth = 360-390 Hz/pixel, and iPAT parallel imaging (GRAPPA) with acceleration factor = 2 in the phase encoding direction. For comparison, similar parameters was run with no phase partial Fourier and strong echo asymmetry. Two subjects were scanned for the study.

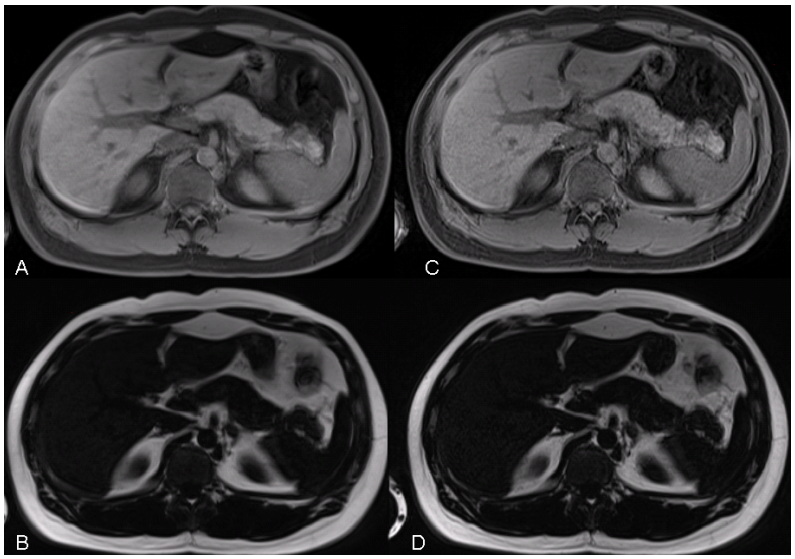

Figure 1. (A) and (B) are the water only and fat only images, respectively) from the three-dimensional two-point Dixon protocol with no phase partial Fourier and strong echo asymmetry. (C) and (D) are the water only and fat only images, respectively, from three-dimensional two-point Dixon acquired with 7/8 phase partial Fourier and strong echo asymmetry with POCS applied in the phase-encoding and readout directions. Scanning time in (C/D) was 3 seconds shorter than (A/B). The images on (C/D) images also demonstrates excellent image sharpness compared to (A/B).

Results and Discussion

Addition of the phase partial Fourier results in a significant scan time reduction on the three-dimensional two-point Dixon acquisition With current gradient systems, addition of phase partial Fourier allows the two-point Dixon acquisition at 320 base resolution in less than 17 seconds, increasing the likelihood of successful breath-holding and artifact-free imaging. POCS phase correction prevents partial Fourier blurring and yields a net improvement in image quality over standard zero-filling. As seen in Figure 1, images with POCS phase correction in the phase and readout direction shows increased sharpness than the standard acquisition. From previous literature [1], POCS reduces the SNR and may cause ringing in gradient echo imaging, but neither was seen in this case. Furthermore, combination of POCS and iPAT parallel imaging in the same phase encoding direction does not cause artifacts. In conclusion, POCS in combination with the above parameters on the three-dimensional two-point Dixon technique shows excellent image quality despite reduced scan times.

References

1. Liang ZP, et al. Rev. Magn Reson Med. 1992 4 :67.