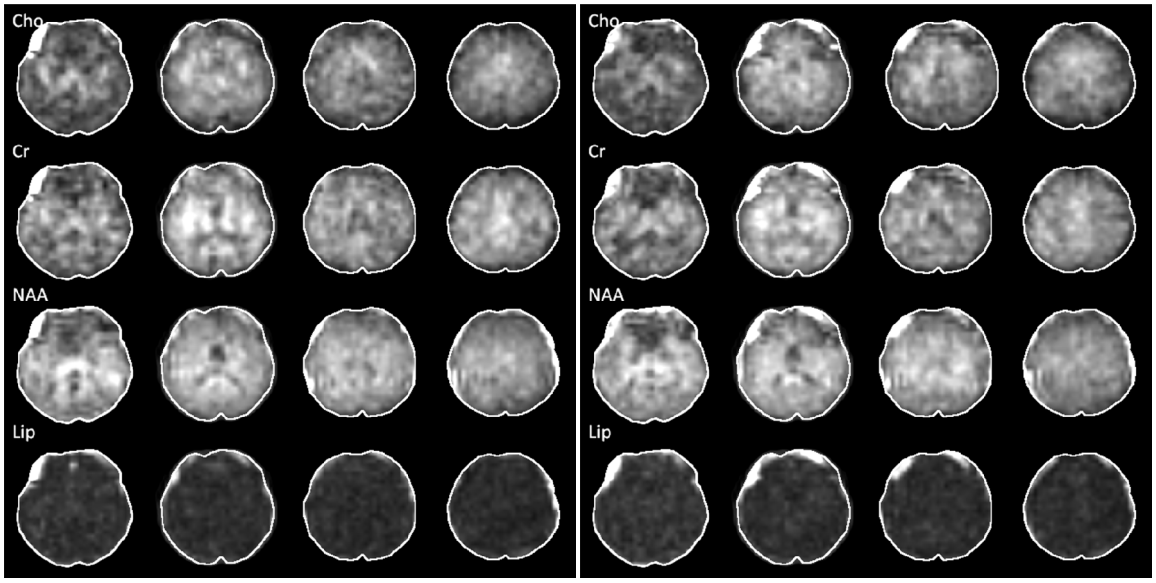
Scan Time Reduction in 3D-EPSI using Reduced Phase-Encoding

J. Wei[1], and P. B. Barker[1]
[1]Russell H Morgan Department of Radiology, The Johns Hopkins University, Baltimore, Maryland, United States

Introduction: Proton echo planar spectroscopic imaging (EPSI) [1] is one of the fastest techniques available for metabolite mapping in the human brain. Nevertheless, for whole brain coverage at high spatial resolution, scan times of the order of 25 minutes are still required for 3D EPSI (e.g. 18x50x50 matrix, 1.7s TR). While scan time reduction can be accomplished using parallel imaging techniques in combination with EPSI, this abstract describes a simpler, alternative method based on reduced (circular) k-space sampling which decreases scan time by 25% without requiring development of parallel imaging techniques.

Material and Methods: A normal volunteer was scanned on a 3T Philips Achieva system using a transmit-receive head coil. A slice-selective, spin-echo 3D EPSI sequence with dual-band water lipid suppression [2] and integrated outer-volume suppression (OVS) was implemented. Prior to data acquisition, field homogeneity was optimized up to 2nd order using a field map based routine [3]. The acquisition parameters were: FOV = 280 x 280 mm, slab thickness = 80mm, TR/TE = 1710/70 ms, voxel size = 5.6mm x 5.6mm x 10mm, image matrix = 50 x 50 x 8, spectral data points = 512, spectral bandwidth = 1661Hz, acquisition rate = 125 kHz. The readout gradient was applied in the anterior-posterior direction. Two experiments were performed; (1) with conventional rectilinear (square) k-space sampling, the scan time was 11 min 24 sec, and (2) with circular k-space sampling, scan time was 8 min 33 sec.

The spectroscopic raw data were resorted and processed according to [4] using in-house software. Metabolic images were created by numerical integration over the following frequency ranges: choline (Cho) 3.34-3.14 ppm; creatine (Cr) 3.14-2.94ppm; N-acetyl aspartate (NAA) 2.22-1.82ppm, and lipid (Lip) 1.53 to 1.13pm. The measurement of the SNR in both data sets was performed by comparing the height of the NAA peak with the root-mean-square noise level.



Results: Metabolic images of Cho, Cr, NAA and lipid are shown in Figure 1 for square sampling (left) and circular sampling (right). Despite the 25% shorter scan time with circular k-space sampling; the visual appearance of the metabolic images is virtually identical. The mean SNR of the square sampling and circular sampling were 25.884 and 23.784 respectively.

Discussion: Scan time reduction in conventional MRSI using circular-encoding and reduced FOV has been previously demonstrated by Golay et al. [5], but as far as we are aware has not been previously implemented for EPSI. Modest scan time reductions (25%) are achievable, and SNR should only be reduced in proportion to the square-root of the scan time reduction (i.e. ~86% of the fully sampled data). Circular k-space sampling also has the advantage of making the EPSI point-spread function circularly symmetric [5]. Further scan time reduction should be possible using smaller FOVs.

References: [1] Maudsley et al, NMR Biomed 19 (2006), 492-503; [2] Zhu et al, ISMRM 17(2009), 138; [3]. Schär et al, MRM 51(2004), 799-806; [4]. Hu et al, JMR B 103 (1994), 30-38; [5] Golay et al, MRM 45 (2001), 226–232
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