3D Hyperpolarized C-13 EPI with Calibrationless Parallel Imaging

With the translation of metabolic MRI with hyperpolarized 13C agents into the clinic, imaging approaches will require large volumetric FOVs to support clinical applications. Parallel imaging techniques will be crucial to increasing volumetric scan coverage while minimizing RF requirements and temporal resolution. Calibrationless parallel imaging approaches are well-suited for this application because they eliminate the need to acquire coil profile maps or auto-calibration data. In this work, we explored the utility of a calibrationless parallel imaging method (SAKE) and corresponding sampling strategies to accelerate and undersample hyperpolarized 13C data using 3D blipped EPI acquisitions and multichannel receive coils, and demonstrated its application in a human study of [1-13C]pyruvate metabolism.
Signal to noise comparison of metabolic imaging methods on a clinical 3T MRI

MRI with hyperpolarized tracers has enabled new diagnostic applications, e.g. metabolic imaging in cancer research. However, the acquisition of the transient, hyperpolarized signal with spatial and frequency resolution requires dedicated imaging methods. Here, we compare three promising candidates for 2D MR spectroscopic imaging (MRSI): (i) multi-echo balanced steady-state free precession (me-bSSFP), (ii) echo planar spectroscopic imaging (EPSI) sequence and (iii) phase-encoded, pulseacquisition chemical-shift imaging (CSI)

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Characterization and flip angle calibration of 13C surface coils for hyperpolarization studies

The aim of the present work is to address the challenge of optimal flip angle calibration of 13C surface coils in hyperpolarization studies. To this end, we characterize the spatial profile of the flip angle and demonstrate that it allows for a simple calibration improving the signal-to-noise ratio for hyperpolarized C magnetic resonance spectroscopic imaging.

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Echo Planar Spectroscopic Imaging of Hyperpolarized 13C in a Clinical System with Reduced Chemical Shift Artifacts

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Improved Decoupling for 13C coil Arrays Using Non-Conventional Matching and Preamplifier Impedance

In this study, we describe a method to obtain improved preamplifier decoupling for receive-only coils. The method relies on the better decoupling obtained when coils are matched to an impedance higher than 50 Ω. Preamplifiers with inductive imaginary impedance and low real impedance, increase the effectiveness of the decoupling. A 2-channel 13C array of 50 mm loop coils show an increase of Q-factor of the coils from 247 to 365. The measured SNR, using two small phantoms, demonstrated a similar improvement.

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Improved reconstruction for IDEAL spiral CSI

In this study we demonstrate how reconstruction for IDEAL spiral CSI (spectroscopic imaging scheme developed for hyperpolarized dynamic metabolic MR imaging) can be improved by using regularization with a sparsity constraint. By exploiting sparsity of the spectral domain, IDEAL spiral CSI can achieve chemical shift encoding by acquisition of only few time-shifted echoes. The minimum number of echoes required to avoid noise amplification can be decreased by means of regularization enforcing spectral sparsity, hereby reducing scan time. Improvements achieved by using regularized reconstruction are demonstrated for in vivo data from a hyperpolarized cardiac study of a pig.

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Non-Cartesian Parallel Imaging Reconstruction of Undersampled IDEAL Spiral 13C CSI Data

The short-lived nature of hyperpolarization places high demands on signal acquisition. To acquire large FOVs with high spatial resolution, and to fully capture substrate uptake and metabolic conversion, fast data acquisition is crucial. Parallel imaging uses multi-channel coils to achieve reduced scan times based on spatial information inherent to each coil element. In this work, we explored the combination of non-cartesian parallel imaging reconstruction and spatially undersampled IDEAL spiral CSI1 acquisition for efficient encoding of multiple chemical shifts within a large FOV with high spatial resolution.

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