Accelerated Echo-Planar Correlated Spectroscopic Imaging with Sensitivity Encoding

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Introduction

Echo-Planar Spectroscopic Imaging (EPSI) is a technique that records one spatial and one spectral dimension simultaneously, allowing multivoxel spectroscopy to be aquired much faster than traditional Magnetic Resonance Spectroscopic Imaging (MRSI) [1,2]. A second indirect spectral dimension can be added in a four dimensional (4D) technique known as Echo-Planar Correlated Spectroscopic Imaging (EP-COSI) [3]. EP-COSI has the advantage of better discrimination of spectral peaks, but at the cost of increased scan time. Sensitivity Encoding (SENSE) has previously been successfully implemented with EPSI [4,5]. The purpose of this work is to investigate the feasibility of reducing the scan time of EP-COSI by applying SENSE.

Methods

An EP-COSI SENSE sequence was implemented on a Siemens 3T MRI scanner currently running on the vb17a platform (Siemens Medical Solutions, Erlangen, Germany). The calf muscles of one healthy 34 year-old and one diabetic 57 year-old volunteer were scanned with a 15 channel "transmit-receive" knee coil. Coil sensitivity maps were produced from fully sampled T_1 weighted MRI scans using the knee coil and scanner body coil. The scan parameters were as follows: TR/TE 1.5s/30ms, 512 readout gradient pairs, 64 t1 points with a t1 increment of 0.8 ms, F1/F2 bandwidth of 1250/1190Hz, FoV of 16x16cm^2, in-plane resolution of 1x1cm^2, slice thickness of 2cm, and SENSE acceleration factor of 2. Total scan time was 12 minutes and 48 seconds. The EPCOSI-SENSE data was processed offline using a custom Matlab program.

Results

Figure 1 shows the spatial distribution of the creatine 3.9ppm (Cr3.9) peak overlaid on the healthy calf MRI. Splitting of the Cr3.9 peak in the tibialis anterior muscle was observed. As expected, the Cr3.9 peak returns to a singlet in the soleus and is absent in the tibial marrow. Figure 2 and 3 show the spectra extracted from the tibialis anterior of the healthy and diabetic calf, respectively. The diabetic calf shows a splitting of the olefinic peaks.

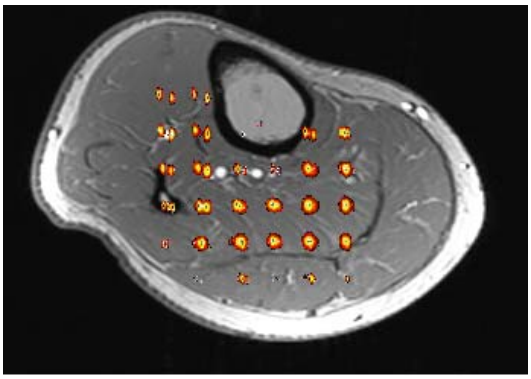

Figure 1. Distribution of Cr3.9 peak in healthy calf

Discussion

Existence of residual dipole-dipole interactions between the protons of Cr dominantly in the tibialis anterior muscle region has been previously demonstrated [3,6]. Spectral quality was sufficient to observe splitting of the creatine peak in the tibialis anterior, as well as the singlet in the soleus and the absence of creatine in the marrow, demonstrating the accuracy of localization by EP-COSI SENSE. In addition, EP-COSI SENSE was able to detect extramyocellular lipids (EMCL) and increased intramyocellular lipids (IMCL) in the diabetic subject compared to the healthy calf muscle.

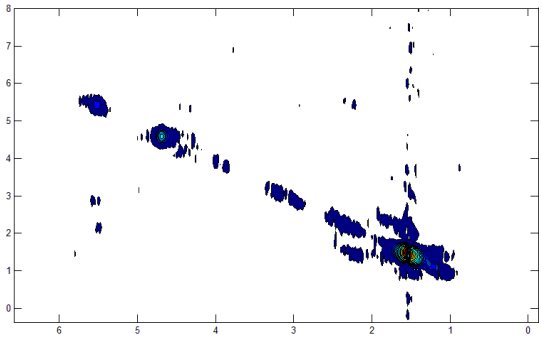

Figure 2. 2D spectrum from the healthy tibialis anterior

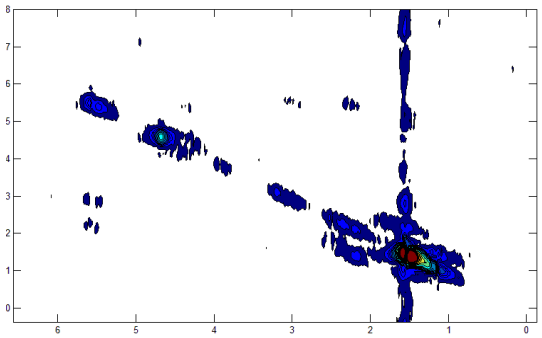

Figure 3. 2D Spectrum from the diabetic tibialis anterior

Conclusions

With an acceleration factor of 2, the EP-COSI SENSE scan was half the time of the recently implemented EP-COSI sequence [3]. The spectral quality of the SENSE data is sufficient to view details such as the creatine doublet and the two olefinic cross peaks in the diabetic calf.

References: [1] Mansfield P. Magn Reson Med 1984;1:370-386. [2] Posse S, et al. Radiology 1994;192:733-738. [3] Lipnick S, et al. Magn Reson Med 2010;64:947-956. [4] Otazo R, et al. Magn Reson Med 2007;58:1107-16. [5] Zierhut ML, et al. J Magn Reson Imaging 2009;30:473-480.. [6] Kreis R, et al. J Magn Reson B 1996; 113(2):103-18.