Echo Planar Spectroscopic Imaging with Peak-Enhanced 2D-Capon Analysis for Prostate Studies

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Introduction

Two-dimensional echo planar spectroscopic imaging (EPSI) may be used for clinical evaluation of the human prostate (1,2). The results of EPSI studies are typically represented as the set of magnetic resonance spectroscopy (MRS) absorption spectra that show frequency information of key metabolites. Several nonparametric techniques in addition to Fourier transformation have been proposed for the analysis of MRS data (3,4). In addition to frequency information, the damping characteristics of each metabolite can also be determined by using two-dimensional Capon analysis. This damping information may be used in conjunction with the frequency information to more easily identify metabolites, especially those whose peaks overlap. We propose using peak-enhanced 2D-Capon analysis for spectral analysis of prostate metabolites.

Methods

Data were collected using a 3.0 T General Electric (GE) Signa scanner (GE Healthcare, Waukesha, WI, USA) equipped with a high bandwidth (1.0 MHz) data acquisition subsystem and a TwinSpeed gradient coil capable of 40 mT/m at a maximum slew rate of 150 T/m/s. A prototype EPSI pulse sequence was used with an endo-rectal coil (Medrad, Pittsburgh, PA, USA) to collect data from a GE prostate phantom that contains a solution of known concentrations of metabolites commonly found in the human prostate. Conventional single voxel PRESS (PROSE) was also used with the same coil and phantom for comparison purposes. Raw data were saved and reconstructed off-line using MATLAB.

Results

EPSI scan parameters were as follows: 2D, axial, 8x8, TR=1300ms, TE=85ms, field of view = 9cm, voxel thickness = 20mm, 1 NEX, scan time 26 seconds. Scan parameters for single voxel PROSE sequence were: 2D, axial, 1x1, TR=1300ms, TE=85ms, 8cm^3 voxel, 2 NEX, scan time 1 minute and 8 seconds. The GE prostate phantom contains the following: 50mM potassium phosphate monobasic, 33mM sodium citrate tribasic dihydrate, 4mM choline chloride, 10mM creatine monohydrate, 12 mM lithium l-lactate, 0.1% sodium azide. MATLAB code was used to compute conventional MRS absorption spectra for both single voxel and 2D EPSI scans. In addition, peak-enhanced 2D-Capon analysis(4) was performed on the same data to estimate the relative damping characteristics of each metabolite.

Discussion and Conclusion

The single voxel PROSE scan collects data from a much larger voxel and provides much greater detail in estimates of the frequency and damping components of the key metabolites: citrate, choline and creatine as shown in Fig. 1. The EPSI scan acquires data from 64 different voxels that are much smaller, yet the key metabolites can also be identified as shown in Fig 2. Using peak-enhanced 2D-Capon analysis is helpful for metabolite identification with EPSI since the damping information augments the frequency parameters associated with conventional MRS absorption spectra.

References

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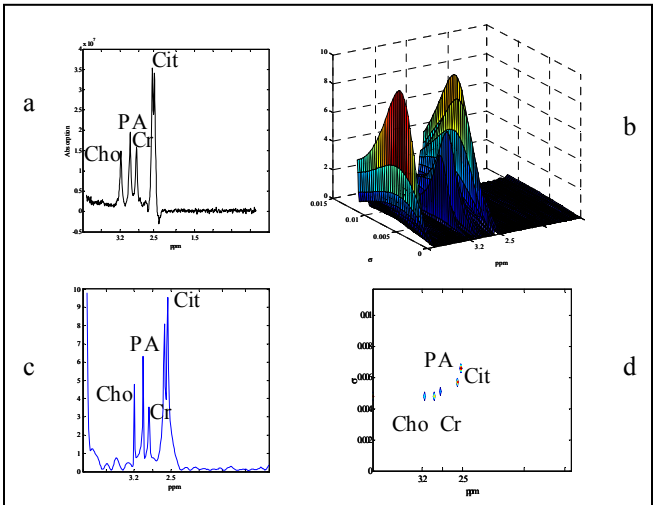

Fig. 1 - Results of single voxel PROSE analysis of prostate phantom. a) Fourier b) 2D-Capon c) 2D-Capon projection d) Peak-enhanced 2D-Capon

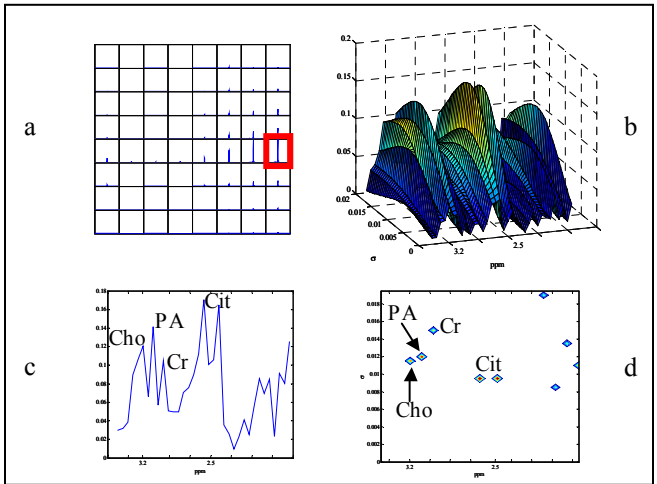

Fig. 2 - Results of EPSI PROSE analysis of prostate phantom. a) 2D-Fourier for 8x8 region; b) 2D-Capon of region highlighted in red c) 2D-Capon projection d) Peak-enhanced 2D-Capon