Short echo time in vivo prostate MRSI

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INTRODUCTION:

The effective suppression of periprostatic lipid signals to reduce contaminating artifacts is vital for obtaining good spectroscopic data from in vivo prostate MRSI for long and short echo time acquisitions. In a recent review article, Casciani et al [1, 2] discusses problems associated with inadequate spatial coverage and choosing an appropiate region of interest (ROI) around the prostate. Furthermore Casciani et al highlights a principal tradeoff between choosing an appropiate ROI, and spectral quality [1]. To facilitate optimal coverage of the prostate, we previously presented a suppression technique, called conformal voxel MRS (CV-MRS) [3], which automatically optimizes the placement of spatial saturation planes to adapt the excitation volume to the shape of the prostate, thus reducing lipid contamination in prostate MRSI . Previous results showed very effective lipid suppression over all subjects[4]. By eliminating the lipid artifacts we are able to considerably increase the amount of available signal by reducing our echo time to 40ms. To provide further lipid suppression we use the spatial spectral 90° RF excitation pulse. Together, the CV-MRS technique, spatial-spectral excitation, and short TE, has resulted in improved in vivo prostate MRSI throughout the prostate.

METHODS:

Seventeen subjects, in an ongoing study, were scanned on a General Electric 1.5T Signa MR scanner equipped with Echospeed gradients. A standard endorectal coil (Medrad Inc.) in combination with a torso phased-array coil was used. The first acquisition utilized manual placement of the spatial saturation planes, which were followed by the standard PRESS excitation with TE/TR =130/1100ms. The second acquisition employed the optimized CV-MRS technique followed by the standard PRESS excitation with TE/TR =130/1100ms. A third acquisition employed the optimized CV-MRS technique coupled with spatial-spectral PRESS excitation with TE/TR =40ms/1100ms. Each 3D MRSI acquisition used a 16x8x8 phase encode matrix, with a voxel size of 0.42 cm^3. Analysis of the spectra was achieved using dedicated spectral fitting software (LCModel[1]) which simulates the key prostate metabolites (i.e. citrate, choline, etc.) at long and short TE's.

RESULTS:

A continuous improvement in data collection was observed when obtaining data from consecutive acquisitions. Figure 1 (A-C) illustrates spectra and LCModel fits obtained from the same voxels from all three acquisitions. Previous work revealed the efficacy of the CV-MRS technique [5]. Comparing the spectra obtained at TE=130ms to that obtained at TE=40ms, we observe the full citrate multiplet structure, and significant improvement in SNR which correlated with quantum mechanical simulation [6, 7]. We are observing, for the first time, spectroscopic imaging data that clearly resolves the citrate multiplet structure at a field strength of 1.5T. In addition we are also detecting several other short TE metabolites, such as taurine, inositol, and glutamate/glutamine (Figure 1 E-G).

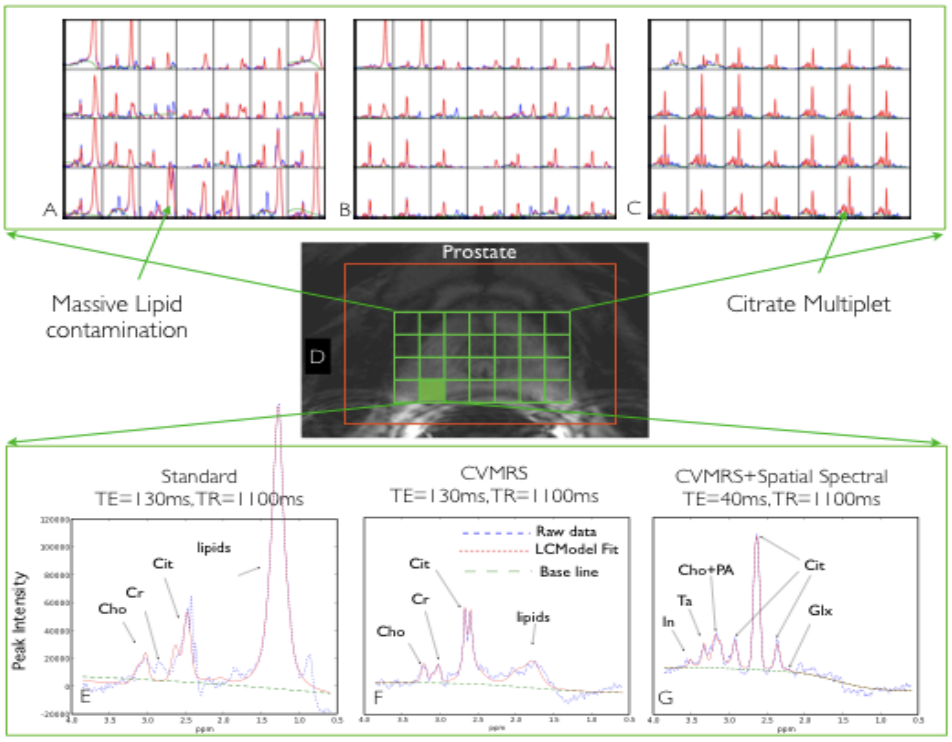

Figure 2 In vivo MRSI data was collected from 62 year old healthy volunteer using all three techniques:(A) the spectra acquired using standard techniques over the entire inferior aspect of the prostate (D). Voxels acquired suffer from massive lipid contamination. (B) Spectra acquired using the CV-MRS technique, showing dramatically reduced lipid contamination . Zooming into a single voxel (E-G), the progressive improvement of spectra quality using each technique is illustrated. In (G) the citrate multiplet is visualized with improved SNR.

DISCUSSION AND CONCLUSION:

Our initial in vivo work , show improved lipid suppression and an average lipid reduction of 60±18% over the entire prostate volume [5]. This significant improvement has led to an improved baseline and easily visualized spectra throughout the prostate. Signal bleeding from peripheral voxels containing high amounts of periprostatic lipids can clearly be a problem as illustrated in Figure 1 E. The effect of optimally suppressing peripheral lipid results in superior fitting and identification of metabolite peaks as seen in Figure 1 F. By effectively nulling contaminating lipids, short TE acquisitions are made possible. As seen in Figure 1 G, the citrate multiplet structure can be clearly visualized with large improvement in SNR. As well, other short TE metabolite such inositol, taurine, and glutamate/glutmine are also detected. By comparing each technique against a standardized benchmark test we have demonstrated that using the CV-MRS technique significantly improves the diagnostic quality of spectra throughout the prostate. Furthermore, by reducing our TE to 40ms and utilizing a spatial-spectral 90° RF excitation pulse, we have dramatically improved citrate detection, and detected short TE metabolites. In summary, an optimized in vivo prostate MRSI technique has been developed which has the potential to improve prostate cancer diagnosis.

References:

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[1] LCModel Version 6.2, developed Stephen Provencher, Ph.D, copyright 2009.