Quantitative 3D spiral 1H MRSI of the brain with an 8 channel phased-array coil

M. Gu[1], D-H. Kim[2], D. Spielman[1]
[1]Stanford University, Stanford, CA, United States, [2]University of California at San Francisco, San Francisco, CA, United States

Introduction

Brain ^{1}H magnetic resonance spectroscopic imaging (MRSI) has been shown to have significant diagnostic and treatment assessment value. To obtain high-quality metabolite spectra, it is important to suppress both water and lipids. However, having a residual water signal can be valuable for phasing and quantification. For 3D in-vivo MRSI, it is also essential to use fast imaging methods to reduce scan time while maintaining good SNR. In addition, it is desirable to have robust and efficient quantification. To achieve these goals, we implemented a 3D MRSI sequence at 1.5T with dualband spectral-spatial excitation, spiral k-space readout, 8-channel phased-array acquisition, voxel-by-voxel phasing and automated quantification using LCModel [1].

Methods

A spectral-spatial 90 degree RF pulse and two identical dualband spectral-spatial 180 degree pulses were incorporated into a PRESS sequence to form a spin echo [2]. The 90 degree pulse is designed to fully excite both water and metabolites and the dualband 180 pulse is designed to fully excite metabolites that resonant from 3.2ppm (Choline) to NAA(2.02ppm), partially excite water, while suppressing lipids below 1.4ppm. During readout, spirals with 4 interleaves were played out for spatial and spectral encoding. The final imaging sequence has the following characteristics: outer volume suppression, dualband spectral-spatial PRESS RF pulse for metabolite excitation, partial water suppression and further lipid suppression, TR/TE=1500/144ms, 4 spatial interleave spiral readout gradients, 256 spirals per readout, 500 Hz spectral bandwidth, 32/32/16 matrix size, 1cc voxel, 8 NEX with phase cycling and 13 minute acquisition time at 1.5T. The signal from each of the 8 RF coils was reconstructed independently [3]. Zero and first-order phasing algorithm was then applied to every voxel with water as the reference. The phased spectrum for each voxel from each coil was then combined according to water peak values to achieve maximum SNR. [4] The combined spectrum of each voxel was passed to the LCModel software package for quantification and generating metabolite ratios [1].

Results

The dualband 180 degree RF, gradient waveforms and corresponding spectral profile are shown in Figure 1. At the time of the echo, 1% of water is excited for use as a reference. An in-vivo scan with representative spectra and their LCModel fits are shown in figure 2. As can be seen, the spectra were well phased and the standard deviation values associated with metabolite peaks indicated the reliability of the LCModel estimation and quality of spectra. For the two representative voxels, the standard deviations of the NAA, Cre, and Cho peaks are below 12%

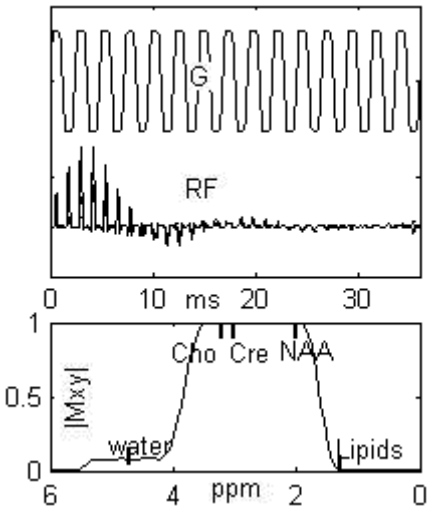

Figure 1. Dualband spectro-spatial spin echo pulse and gradient waveform and it's frequency profile.

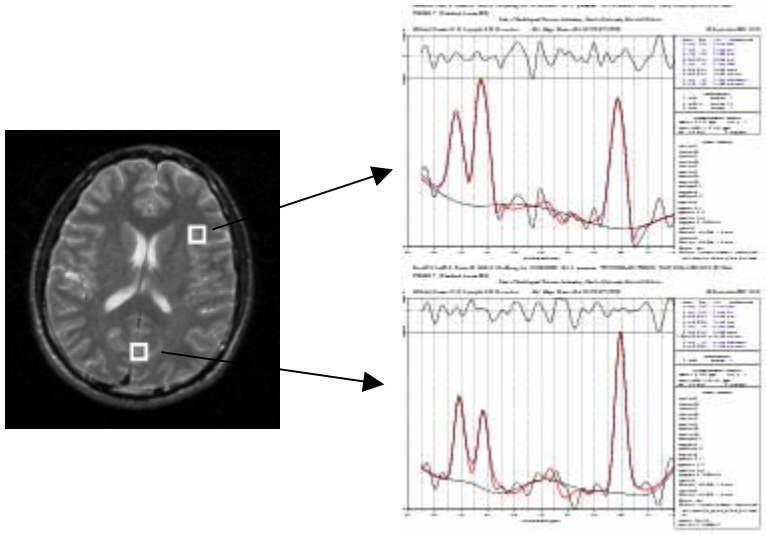

Figure 2. In vivo scan with spectra and their LC model fits from respresentative voxels.

Conclusion

A 3D MRSI sequence based on PRESS localization with outer-volume lipid suppression, dualband excitation and spiral readout has been implemented at 1.5T for brain imaging with 8 channel phased array coil acquisition. A voxel-by-voxel phasing and optimal combination algorithms were developed to produce high quality spectra. Metabolite ratios were calculated by conducting automatic quantification voxel by voxel using LCModel. To our knowledge, this is the first demonstration of human brain 1.5T ^{1}H MRS using spiral imaging and a phased-array coil.

Acknowledgements

Lucas foundation, NIH RR 09784, CA 48269

References

[1] S. Porvencher., et al., MRM 30:672-679, 1993
[2] M. Gu., et al., Proc. ISMRM 2005, 2763
[3] L. Wald, et al, MRM 34:440-445, 1995
[4] N. Maril, et al, JMRI 21:317-322, 2005