Short TE Volumetric Spiral 1H MR Spectroscopic Imaging of the Human Brain at 3T using semi-LASER

M. Tachrount[1,2], L. Lamalle[3], J. Warnking[1,2], and C. Segebarth[1,2]

[1]U836 - Equipe 5, INSERM, Grenoble, France, [2]GIN, Universite Joseph Fourier, Grenoble, France, [3]IFR n°1, INSERM, Grenoble, France

Introduction

Proton MR chemical shift imaging (CSI) of brain metabolites can identify biomarkers relevant to healthy or metabolic cerebral metabolism. At short TE, strongly J-coupled and short T_2 metabolites can be detected. High field offers higher SNR and improved spectral resolution with the disadvantage of increased B1 and B0 heterogeneities as well as chemical shift displacement error (CSDE). The semi-LASER (Localisation with Adiabatic SElective Refocusing) sequence reduces CSDE and B1 heterogeneity effects with improved slice selection profiles [1]. Phase encoding CSI [2] has long acquisition time which depends on spatial resolution. Spiral Spectroscopic Imaging (SSI) by simultaneous spatial and spectral encodings reduces minimum acquisition time [3]. It thus becomes possible to acquire additional data such as a spatial dimension and/or a second spectral dimension. We present here volumetric SSI of the human brain with a 32 ms TE using slice selective adiabatic refocusing pulses.

Subjects and Methods

A 3T Bruker MedSpec S300 was used. Maximum gradient strength and slew rate were 41mT/m and 127mT/m/s, respectively. A 70x70x40 mm^3 voxel of interest (VOI) was selected with a combination of conventional slice selective excitation (Hermitian with a bandwidth factor of 5400 Hz.ms) and two pairs of slice selective adiabatic refocusing pulses (Hyperbolic Secant with a bandwidth factor of 13367 Hz.ms). The carrier frequency was positioned between water and lipids resonance frequencies ($f_0 \approx 2.78$ ppm). Spatial-spectral encoding was designed [4] to encode a 24x24x8 cm^3 FOV, with 8 phase encoding steps along the slice axis. 256 spiral lobes (~415ms) were applied for readout. The reconstructed matrix was 24x24x8. The reconstructed spectral bandwidth (~1235Hz) and resolution (2.41Hz/pt) were obtained by applying four spatial and two spectral interleaves. TE/TR/TA were 32ms/2000ms/21min20s. The spiral trajectories were measured using the approach proposed by Zhang et al.[5], and used in the 2D-spatial, 1D-spectral gridding reconstruction (Kaiser-Bessel kernel[6]). Two outer volume suppression modules (OVS), including 6 hyperbolic secant pulses each, were inserted in the WET [7] 4th delay to ensure OVS and Water Suppression. An unsuppressed water data set provided phase and frequency information used in the reconstruction of metabolite spectra.

Results

Figure 1 displays the grid of spectra from a central slice of the VOI. Selection profiles markedly sharper than with conventional RF pulses [8] were obtained. With the carrier frequency centred between water and lipids resonances, the maximum in plane CSDE was about 9%. We observed good saturation of extracranial lipids. Using the measured trajectory for data reconstruction suppressed artefacts associated with gradient hardware imperfections. In addition to NAA, Cr, and Cho strong coupled metabolites like myo-Inositol and glutamate/glutamine were detected.

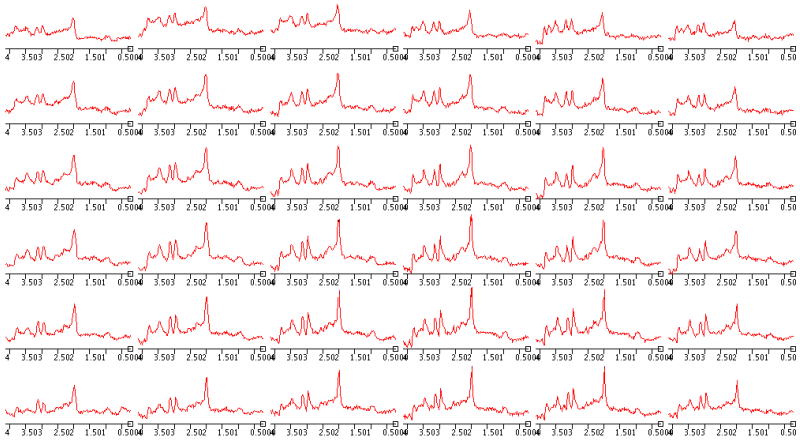

Fig. 1 Grid of water suppressed spectra from a central slice of the VOI

Conclusion

We have demonstrated in vivo short TE volumetric SSI acquisition at 3T using selective adiabatic refocusing pulses in a total acquisition time compatible with clinical examination. Metabolite quantification [9] would render this technique a valuable tool for clinical diagnostics.

References

[1] Scheenen et al. MRM 2008 ; [2] Maudsley et al. JMR, 1983 ; [3] Adalsteinsson et al. MRM, 1998 ; [3] Bottomley Ann.NY.Acad.Sci., 1987 ; [4] Glover MRM, 1999 ; [5] Zhang et al. MRM, 1998 ; [6] Jackson et al. IEEE.Trans.Med.Img. 1991; [7] Ogg et al. JMR-B, 1994 ; [8] Tachrount et al. ESMRMB 2008; [9] Gottschalk et al. NMR.Biomed. 2007