7 Tesla In-vivo Short-Echo-Time Single-Voxel ^{1}H semiLASER Spectroscopy: A Test/Retest Reproducibility Study

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Target Audience: Scientists interested in measuring metabolic changes in neuropathological conditions with heightened signal-to-noise (SNR) and spectral dispersion provided at 7T.

Purpose: Metabolite levels measured by short-echo-time ^{1}H MRS may provide indicators of disease status and progression in various neuropathological conditions. The use of high magnetic fields increases SNR and spectral dispersion leading to improved metabolite quantification. The purpose of this study was to quantify the metabolite level measurement test/retest reproducibility for a short-echo-time single-voxel ^{1}H semiLASER spectroscopy protocol in human subjects at 7T.

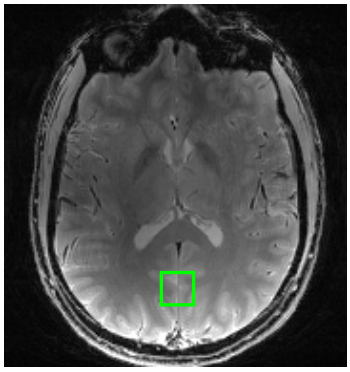

Figure 1: Axial T_2-weighted MRI image with the 2x2x2 cm^3 measurement volume in green

Methods: A 7T Agilent/Siemens MRI system with a 16-channel transmit and receive head coil (built in-house) was used to acquire single-voxel short-echo-time ^{1}H MR spectra as previously described [1], from a 2x2x2 cm^3 volume of interest in the parietal-occipital region (Figure 1) of six young healthy volunteers (mean age 28.0 ± 2.7 years). Water (8 averages), water suppressed (full - 128 averages), and water and metabolite suppressed (macromolecule - 128 averages) data were collected twice in one scan session (scan 1 and scan 2) and again twice in a second scan session one week later (scan 3 & scan 4). A conventional localization by adiabatic selective refocusing (LASER) sequence [2] was modified as described by Marjanska *et. al.* [3]. Briefly, the sequence consisted of a 2 ms slice-selective 90° excitation pulse followed by two pairs (one pair for each remaining orthogonal dimension) of slice-selective adiabatic full-passage pulses (hyperbolic secant, R10, 3.5 ms) (TR/TE = 3700/38 ms). Eight global 5 ms gaussian pulses were used for variable pulse power and optimized relaxation delays (VAPOR) water suppression [4]. Double inversion recovery [5] (two non-selective 5 ms adiabatic full-passage pulses) was used to suppress the metabolite signal when acquiring the macromolecule spectra. T_2-weighted 2D FLASH images (TR = 1000 ms, TE = 6.5 ms, α = 30°, 1x1x2 mm^3 resolution) were used for voxel placement (Figure 1). Absolute metabolite concentrations were calculated using water as an internal reference and by correcting for signal relaxation based on cerebral spinal fluid (CSF) and tissue fractions.

Results: Figure 2 shows a representative spectrum following macromolecule removal, with superimposed fit and the residual difference between the data and the fit. The average same-day percent differences are plotted in Figure 3 as both the absolute concentrations of *N*-acetylaspartate (NAA), glutamate (Glu), choline (Cho), and myo-inositol (Myo), and as the ratios of NAA/Cr, Glu/Cr, Cho/Cr, and Myo/Cr. The average 1-week percent differences of the same metabolites and ratios are plotted in Figure 4. The same-day percent differences (Figure 3) range from 3 - 7%, and the 1-week percent differences (Figure 4) range from 3 - 10%. Furthermore, differences in absolute measures (light grey bars) and differences in ratios (dark grey bars) were of similar magnitudes.

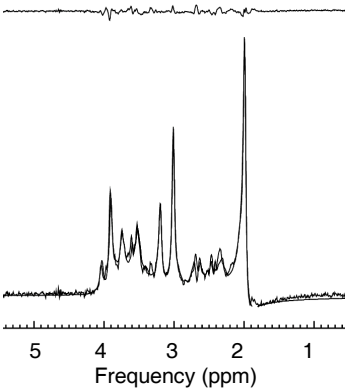

Figure 2: Representative MRS data with superimposed fit, and residual difference above

Discussion and Conclusion: The semiLASER MRS protocol produced high SNR at 7 Tesla and can be used to measure metabolite concentrations with high reproducibility, ideal for measuring metabolic changes in neuropathological conditions.

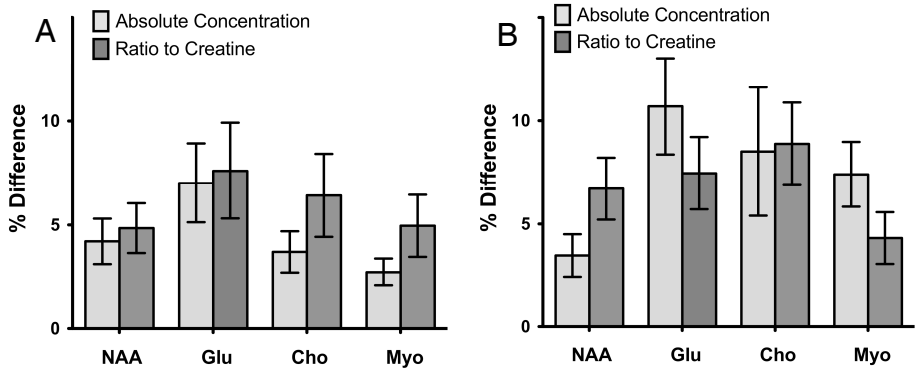

Figure 3: Average same-day (A) and 1-week (B) % differences for absolute concentrations and for ratios

References:

[1] Kassem, M. et al. Magn Reson Med 49(5):918-27 (2003)

[2] Garwood, M. et al. J Magn Reson 153:155-177 (2001)

[3] Marjanska, M. et al. Proc Intl Soc Mag Reson Med 2343 (2009)

[4] Tkac, I. et al. Magn Reson Med 41:649-656 (1999)

[5] Dixon, W. et al. Magn Reson Med 18:257-68 (1991)