Reproducibility of short TE MRS at 3 Tesla: Comparison of hippocampal with cingulate spectra

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INTRODUCTION: Advantages of higher B0 for MRS such as increased SNR and spectral resolution are counterbalanced by T2 shortening and wider linewidths. Short TE minimizes T2 effects thereby providing optimized SNR in 3T over 1.5T (1). Reproducibility of MRS at higher B0 differs from that at 1.5T. This might be critical when assessing the subtle differences reported in mood disorders. In a previous study of MRS of the hippocampus at 1.5T NAA displayed the smallest coefficient of variation (%CV=8.8) whereas glutamate + glutamine (Glx) had the highest %CV (2). Others found better reproducibility for the NAA/(Cho+Cr) ratio (3). At 3T, physiologic variability accounted for 12% of total variability in temporal lobe NAA (4). The purpose of this study was to assess the reproducibility of MRS at 3 T using short TE single-voxel spectroscopy (SVS) in two locations relevant to the pathophysiology of mood disorders: the hippocampus and the anterior cingulate gyrus.

MATERIALS AND METHODS: A total of 12 healthy volunteers (mean age ± SD=28.4 ± 5.4; 7 females, 5 males) were scanned within 23 days; the first 8 subjects were scanned twice within 7 days. One subject was scanned 3 times within 11 days (Figure). All MR studies were performed on a Siemens Trio 3T with the standard CP head coil. Localizer TSE T2-w images were acquired in the sagittal, coronal, axial and oblique (temporal lobe) planes. Two SVS sequences with PRESS volume selection were acquired at the left hippocampus and left anterior cingulate gyrus with TR/TE=2000/30ms, 128 acquisitions, volume=2cc. Non-water suppressed spectra had 32 acquisitions. 3D MAP shimming and CHESS water suppression were automatically performed. The hippocampal VOI was positioned after criteria of Hammen et al (2). The anterior limit of the cingulate VOI coincided with that of the genu. N-acetylaspartate + N-acetylaspartyl-glutamate (tNAA), creatine (Cr), choline (Cho), myo-inositol (m-In), Glx and ratios to Cr were quantified using LCModel (5). The unsuppressed water spectrum was used for eddy current correction and for signal scaling to the basis spectrum acquired with similar parameters. Inter and intrasubject %CVs are presented. The latter were calculated for the 8 subjects with 2 scans as the SD of the difference between scan and rescan divided by the mean (6). Data were excluded if Cramer-Rao lower bound variance was ≥ 20%.

RESULTS: Mean (± SD) ratios, metabolite signals and inter and intrasubject percent %CVs are given in the tables for the left hippocampus and cingulate.

HIPPOCAMPUS	TNAA/CR	TCHO/CR	M-IN/CR	GLX/CR	TNAA	CR	TCHO	M-IN	GLX
Mean±SD	1.20±0.1	0.33±0.05	0.88±0.1	1.85±0.33	6.30±0.6	5.29±0.6	1.75±0.2	4.65±0.8	9.72±1.74
Intersubject %CV	11.15	15.61	12.66	17.81	9.56	10.34	11.53	16.38	17.86
Intrasubject %CV	19.11	15.36	16	39.89	11.56	10.81	11.77	22.77	41.85

CINGULATE	TNAA/CR	TCHO/CR	M-IN/CR	GLX/CR	TNAA	CR	TCHO	M-IN	GLX
Mean±SD	1.44±0.1	0.35±0.04	0.79±0.1	2±0.4	7.84±0.4	5.49±0.4	1.90±0.2	4.32±0.6	10.95±2
Intersubject %CV	9.22	12.69	16	18.64	5.62	7.04	10.18	14.08	17.95
Intrasubject %CV	13.05	14.44	15.34	31.96	7.49	13.14	6.26	7.5	30.49

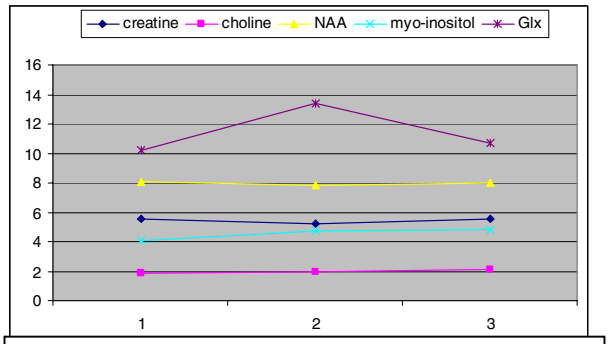

Figure: Course of cingulate metabolites for a subject with 3 scans

DISCUSION: %CVs for tNAA, Cr and Cho in 2cc voxels from the left hippocampus and cingulate at 3T fall within the range of 6% to 13%. A limitation of this study is that no tissue volume correction was done assuming that metabolite ratios are essentially atrophy corrected. However, %CVs of individual metabolites are lower than those of ratios, probably because ratios combine variability of 2 metabolites whose signals are already normalized to water. The range of %CVs depends on regional and metabolite factors. Cingulate spectra have lower %CVs for most ratios and metabolites compared to the hippocampal VOI. This may be accounted for by the higher SNR and better quality of cingulate spectra, also observed in frontal vs. temporal regions at 3T by Wellard et al. (4). The hippocampal VOI is sensitive to inhomogeneity, which is enhanced at higher B0, due to its proximity to the brain-bone interface. The reported values in the hippocampus are comparable to those from Hammen et al (2) at 1.5T and more robust than the ones found by Hsu et al. (3). As for individual metabolites, Cr and Cho are at about the same rank of variation as tNAA, in contrast with results at 1.5T that show lower CVs for tNAA (2,7). Better discrimination of Cr and Cho at 3T might explain their lower CVs. Interestingly, a lower %CV was found for m-In especially at the cingulate as compared to reports at 1.5T (2,6,7). At 3T increased spectral resolution of the 3.55 and 3.61 ppm resonances improve m-In quantitation when using the whole spectral information as does LCModel (8). These results are encouraging for MRS studies of mood disorders, where Cho and m-In changes have previously been reported (9). On the other hand, the highest variation was associated with the Glx region as also reported at 1.5T (2,4). In conclusion, MRS reproducibility at 3T is comparable to that at 1.5T, with improvements for Cho and m-In. Regional variations play a major role in the degree of reproducibility.

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