Proton MR spectroscopy of the hippocampus at 3.0 Tesla

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Introduction: The mesial temporal lobe (MTL) is an anatomical region near to sharp interfaces between soft tissue and air filled spaces or bone. Therefore, the quality of proton MR spectra from this area is often compromised by susceptibility broadening of the metabolite lines already at 1.5 T . Moreover, rather large MRS volumes are needed to acquire MTL spectra with sufficient SNR, and thus hippocampal pathology may partly be masked by averaging over diseased and unaffected tissue. As susceptibility scales with field strength, MRS of voxels located in the MTL might be even more demanding at 3.0 T . On the other hand, the signal gain expected at higher field strength should allow a reduction of voxel size which could decrease the influence of the susceptibility gradients on spectral quality as well as of partial volume effects on the determination of metabolite concentrations. The purpose of our study was to prove at 3.0 T the feasibility of accurate relative and absolute quantification in small VOI (<8ml) centered on the hippocampus to provide normal values of the metabolite concentrations for comparison to pathological alterations in MTL diseases.

Methods: The study was performed at 3.0 T on a clinical whole body MR system (Gyroscan Intera 3.0T, Philips Medical Systems) equipped with 30mT/m gradients. After linear order shimming, PRESS-localized ^{1}H single-voxel spectra (TR/TE 2000/30 ms and 2000/140 ms, water suppression by dual inversion prepulses) from the MTL in 16 healthy volunteers (12m/4f, mean age 37±18 y) were acquired with a transmit/receive birdcage head coil suited for MRS and MRI (Fig. 1). In 13 of the subjects, absolute metabolite concentrations of N-acetyl aspartate (NAA), of total creatine (tCr), of choline compounds (Cho), and of myo-inositol (Ins) in the hippocampus were determined by relating NAA to the internal water signal in non-suppressed acquisitions and correcting for CSF contents by bi-exponential T2 relaxometry. MR spectra were taken from up to 3 different voxel sizes per subject ranging between 4.2 and 16 cm^3, thus allowing intra-individual comparison of signal/noise ratios (SNR), linewidths and regional metabolite concentrations. Additionally, in 6 cases metabolite ^{1}H relaxation times T2 of NAA, tCr, and Cho in the MTL at 3.0 T were measured by mono-exponential fit to a series of 5 spectra with TR/TE 3000/50-400 ms .

Results: Spectral linewidths measured in the MTL at 3.0 T showed only a weak trend to decrease in smaller voxels; mean value for the Cho resonance at TE 30 ms was 9.2 ± 1.9 Hz (averaged over all volume sizes). Therefore, almost constant SNR per unit volume was observed. Intra-individual comparison of measurements at 3.0 T and at 1.5 T yielded about 70% higher SNR at 3.0 T . Hippocampal spectra from volumes <5ml could thus be obtained with sufficient quality at 3.0 T within 4.5min (128 signal averages) acquisition time. While for tCr, Cho, and Ins no correlation between measured concentration and MRS volume size was found, NAA/tCr and [NAA] were significantly lower in smaller voxels predominantly containing hippocampal tissue (Table 1), in accordance to results from MRS and MRSI at 1.5 T [1,2] and at 2.0 T [3].

Discussion: The SNR increase observed in proton MR spectra of the hippocampus at 3.0 T allows MRS acquisitions in considerably smaller VOI than at 1.5 T without prolongation of measurement time. In this way, partial volume averaging over surrounding MTL tissue can be reduced at higher field strength, yielding more reliable values particularly for the hippocampal NAA concentration. Our results indicate, that accurate meta-bolite quantification in MTL structures is feasible by single-voxel MRS at 3.0 T in a clinical setting. It remains to be shown, whether this finding can be reproduced in patient studies, e.g. studies of temporal lobe epilepsy or of MTL degeneration. A substantial decrease of spectral linewidths by higher order shimming might further improve the quality of MR spectra from the hippocampus at 3.0 T and of metabolite quantification.

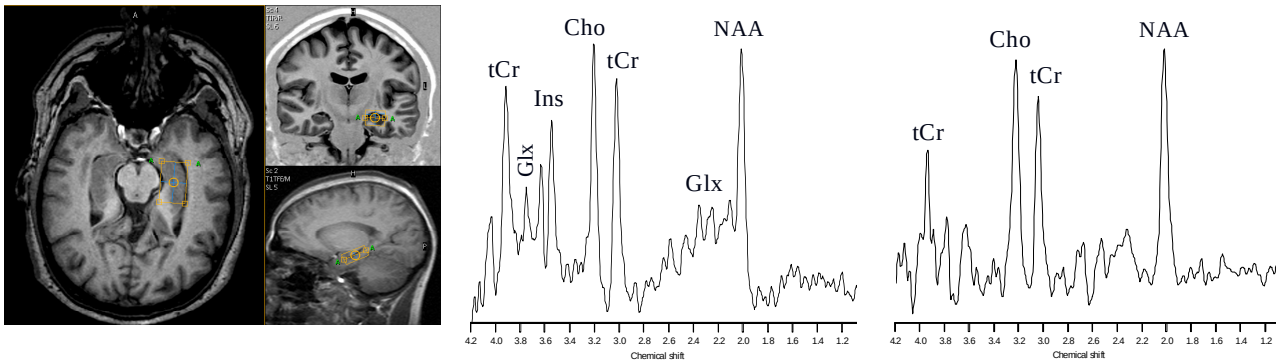

Fig. 1 : a) Display of VOI 28x17x13mm (6.2ml) **b)** ^{1}H spectrum with **TE 30ms**, 128 averages **c)** ^{1}H spectrum with **TE 140ms**, 128 averages

Table 1 : Metabolite concentrations (mM)and relaxation times T2 (ms) in MTL tissue measured by ^{1}H-MRS at 3.0 T (SD = standard deviation, p-values from comparison (unpaired t-test) of results for small and for large VOI)

	n	*NAA*	*tCr*	*Cho*	*Ins*	*NAA/tCr*	*Cho/tCr*	*Ins/tCr*
VOI < 6.3ml : **[Metab.] (mM)**	9	**9.4**	**9.8**	**2.7**	**6.5**	**1.43**	**1.34**	**0.80**
SD		1.7	2.3	0.3	1.3	0.15	0.18	0.16
p		*0.039*	*n.s.*	*n.s.*	*n.s.*	*0.010*	*n.s.*	*n.s.*
VOI > 7.5ml : **[Metab.] (mM)**	17	**11.1**	**9.7**	**3.0**	**6.3**	**1.70**	**1.44**	**0.76**
SD		1.4	1.9	0.6	1.8	0.25	0.25	0.13
T2 (ms)	6	**274**	**162**	**275**		(TE=140ms)		(TE=30ms)
SD		36	14	33				

References

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