

Proton MR spectroscopy in patients with amyotrophic lateral sclerosis (ALS) at 3 Tesla

W. Block¹, F. Träber¹, C. Grothe², C. Manka¹, O. Gür¹, R. Lamerichs³, J. Gieseke⁴, T. Klockgether², H. H. Schild¹

¹Department of Radiology, University of Bonn, Bonn, Germany, ²Department of Neurology, University of Bonn, Bonn, Germany, ³Philips Medical Systems, Best, Netherlands, ⁴Philips Medizin Systeme, Hamburg, Germany

Introduction:

The determination of upper motor neuron involvement plays a key role for the diagnosis of amyotrophic lateral sclerosis. Numbers of studies had shown, that proton MR spectroscopy (MRS) allows the detection of neurodegeneration in different brain diseases. Although these studies yielded highly significant differences between patient groups and healthy controls, the diagnosis for the individual case requires further improvement. The correct placement of the volume of interest (VOI) in MRS is important to reduce inclusion of non-target tissue. However, the VOI size used in spectroscopy studies at 1.5 T is often a compromise between gaining sufficient SNR and accepting such partial-volume effects. Increased SNR at high-field MR systems provides the opportunity to reduce VOI size substantially. To potentially improve specificity and sensitivity of the diagnosis of upper motor neuron involvement in ALS patients, VOI size was reduced by a factor of 2 at 3 T.

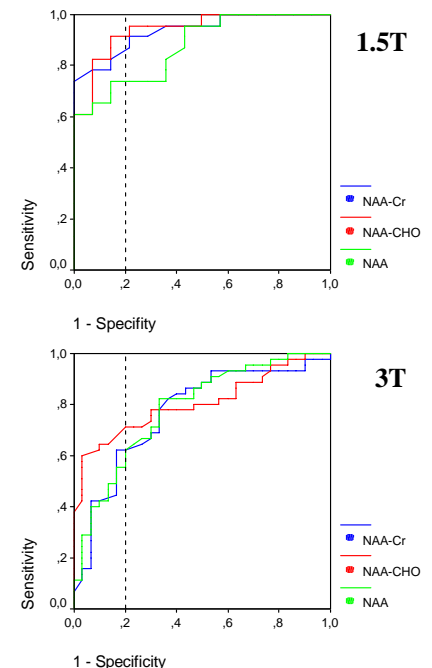
Material and methods:

Examinations were done in 25 patients with ALS and in 18 healthy controls on our clinical 3T whole-body MR system (Gyrosan Intera 3.0 T, Philips Medical Systems) with a transmit/receive head coil designed for imaging and proton spectroscopy. Single-volume proton MRS of a 15ml VOI placed anterior to the central sulcus in the motor cortex was performed by acquisition of water-suppressed PRESS spectra with TE/TR 140/2000 ms and 30/2000 ms. The VOI was angulated in a way that the upper boundaries were aligned parallel to the brain surface in the sagittal and the coronal plane. The primary motor area of the hand and upper limb within Brodmann area 4 and 6 was included. Metabolite ratios and absolute metabolite concentrations of N-acetyl-aspartate (NAA), total creatine (tCr), choline containing compounds (Cho) and myo-inositol (Ins) were calculated using the unsuppressed water signal of the VOI as an internal reference. Data were compared to findings from 47 ALS patients and 30 healthy controls previously acquired in our cross-sectional studies at 1.5T^{1,2}. Group comparisons between patients and healthy controls at 1.5T and 3T were performed using Student's unpaired t-test. Sensitivity and specificity of metabolic parameters were determined by ROC analysis.

Results:

T2 of brain tissue and CSF percentage calculated for the motor cortex VOI at 3T were significantly reduced compared to data derived from 1.5T. Group comparisons yielded a highly significant reduction in absolute and relative NAA concentration at both field strengths for motor cortex spectra of ALS patients. At 3T the absolute NAA concentrations in the patients group was decreased by approximately 20% with respect to the controls, while at 1.5T differences to controls was only about 10%. Similar findings were observed for the extent of reduction in metabolite ratios NAA/Cho and NAA/tCr at the different field strengths. At a sensitivity of 80%, ROC analysis revealed an increase in specificity for absolute NAA concentration from 62% at 1.5T to 74% at 3T, for NAA/tCr from 62% to 86% and for NAA/Cho from 71% to 91%, respectively.

	n	T2 (WM+GM)	T2 (CSF)	% (CSF)	[NAA]	[Cho]	[tCr]	[Ins]	NAA/Cho	NAA/tCr	Ins/tCr	
3T	ALS	25	63.8	635	8.89	10.05	2.05	8.61	5.25	1.66	1.56	0.73
			2.75	245	2.56	1.28	0.32	1.31	1.37	0.23	0.18	0.35
Control	18	63.2	558	8.54	12.27	2.04	8.20	4.28	2.03	1.83	0.66	
		1.58	179	1.34	1.36	0.28	1.00	1.37	0.19	0.13	0.19	
<i>p (student-t)</i>					< 0.001							
1.5T	ALS	47	77.0	950	12.42	12.42	2.14	7.09	4.88	2.00	2.66	1.02
			2.7	257	1.31	1.31	0.33	0.90	1.09	0.24	0.48	0.43
Control	30	77.9	821	11.5	13.85	2.12	7.31	4.49	2.25	2.83	0.91	
		4.5	184	6.64	1.14	0.25	0.89	1.78	0.18	0.27	0.28	
<i>p (student-t)</i>					< 0.001							



Discussion:

Similar to previous findings from our cross-sectional study at 1.5T, a significant reduction of relative and absolute NAA concentration was observed in motor cortex spectra derived from ALS patients at 3T. Comparison of spectra acquired at both field strengths with different VOI sizes showed differences due to changes in relaxation times as well as due to changes in gray and white matter content of the voxel. Determination of specificity and sensitivity from ROC analysis provided an enhanced discriminatory power between patients and control group at 3T, which might improve diagnostic capability also in the individual case.

References:

1. Block W, Karitzky J, Träber et al., Arch Neurol 55:931, 1998
2. Pohl C, Block W, Karitzky J et al., Arch Neurol 58:729, 2001