Quantification of Metabolites with Coupled Spin Systems using Single Voxel Spectroscopy: Potential Pitfalls

A. Stengel[1], T. Neumann-Haefelin[1], F. Zanella[1], H. Lanfermann[1], U. Pilatus[1]

[1]J.W. Goethe University, Frankfurt am Main, Germany

Introduction and Purpose:

Short TE single voxel spectroscopy can be used to quantify metabolites in the human brain offering the opportunity for studying the pathophysiology. In contrast to long TE (>136 ms) the short TE allows quantification of nuclei with rather complex coupling patterns like myo-inositol (mI), glutamic acid (Glu), and glutamine (Gln). Due to large overlap of Glu and Gln signals both are frequently evaluated as one signal Glx. In several studies we observed a rather large scattering of the Glx data, which is in accordance with previous reported standard deviations of approximately 17% - 39% [1]. Data scattering may be attributed to a low SNR and baseline distorsions at short TE, however, pulse imperfections and spatial interferences, which have to be considered in long TE measurements when monitoring coupled signals like Lac [2], should also occur. Here we present data from a phantom study at a TE of 30 ms, which demonstrate that the signal pattern / intensity of coupled spin systems depend on voxel size and shape.

Methods:

The SVS examinations (TE/TR 30/10000) were performed on a 1.5 T Philips Gyroscan Intera scanner using PRESS volume selection. The data were acquired with a 1000 Hz spectral width and digitized with 1024 data points. Water suppression was accomplished by selective excitation (RF pulse with 60 Hz bandwidth followed by dephasing by gradients). Phantoms containing a solution of either 30 mM Glu, 30 mM mI, or 38 mM aspartic acid (Asp) supplemented with 30 mM formic acid (sodium salt) as reference were studied. Voxel sizes were varied covering the following range: x , y, z: 10 - 50 mm; volume (xyz): 3.5 - 125.0 ml. The signal intensities were determined by integration in the frequency domain (csx2 software [3]) and divided by the voxel size.

Results:

Fig 1 shows spectra of Glu and Asp at two different voxel sizes. The arrows mark positions where the pattern is clearly changed. This variation is accompanied by significant changes in the normalized intensity of the integrated signal yielding 32% for Glu and 18% for Asp. No significant change (2%) was obtained for formic acid. The impact of the voxel dimensions on the normalized signal intensities of Glu and formic acid is shown in Fig 2. Changes are shown as function of the thickness (x) of the slice selected by the first (90°) pulse (Fig 2a) and as function of the area yz (Fig 2b). Solid circles represent voxels with x > 19 mm and y z < 626 mm^2, which exhibit significantly increased signal intensities of Glu (up to 100%). Only minor effects of voxel shape can be observed for formic acid (± 11%). Similar effects were observed for Asp (at least 18%), while mI (± 10 %) behaved like formic acid.

Discussion:

Signals from coupled spin systems can vary with voxel size and shape of the PRESS volume in single voxel spectroscopy. The effect may depend on the size of the maximum coupling constant (Asp: -17 Hz, Glu: -15 Hz, mI: 10 Hz [4]). It should also depend on timing and design of the pulse sequence.

Conclusion:

Analysis of short TE in vivo spectra using prior knowledge obtained from model spectra can be affected by the shape of the examined volume.

References:

1. Helms et al. Magn Reson Imaging 17, 1999; 2. Yablonskiy et al. MRM 39, 1998; 3. courtesy of PB Barker, JHU, Baltimore. 4. Govindaraju et al. NMR Biomed 13, 2000.

Fig 1. Variation of the signal pattern of Glu and Asp for different voxel dimensions

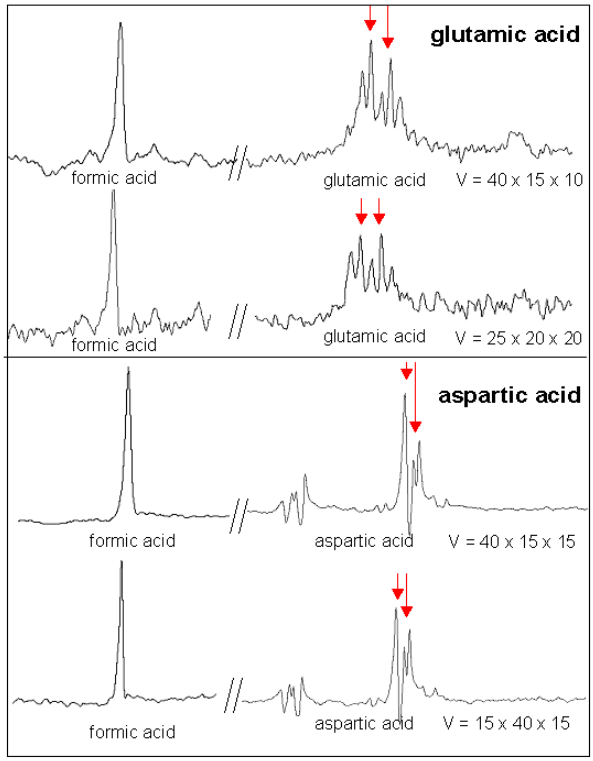

Fig 2. Normalized signal intensity of Glu plotted versus x and the area y z .

● Glu (with large variations); o Glu (normal); ▲ formic acid