Single Voxel Spectroscopy in Different Regions of Human Brain at 7 T

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Introduction

Proton Magnetic Resonance Spectroscopy (^{1}H MRS) provides a noninvasive way to investigate *in vivo* neurochemical abnormalities of many brain disorders. Each observable metabolite can potentially provide unique information about brain biochemistry and be a biomarker for brain disorders which will facilitate diagnosis and treatment. Spectra of exceptional quality have been obtained and quantified previously at 7 T from human occipital lobe (1). However, for many brain disorders the neurochemical abnormalities are not expected to occur in occipital lobe, but in other brain structures. In this project, we investigate the ability to obtain high quality 7 T spectra from different brain regions.

Methods

Normal volunteers (n = 7) were studied after giving informed consent according to the procedures approved by the Institutional Review Board. MR experiments were performed using a 7-T, 90-cm horizontal bore magnet (Magnex) equipped with a Siemens console with whole body gradients. A home-built 16-element transmission line head array (2) was used for transmit and receive and transmit phase of each coil channel was controlled with individual 1 kW CPC amplifier (max ~500W at the coil port due to line loss). For each voxel, B_1^+ phase was optimized based on a previously published algorithm (3).

In vivo ^{1}H NMR spectra were acquired from four voxels positioned in different brain regions (occipital lobe (OCC), motor cortex (MC), basal ganglia (BG) and cerebellum (CER)) using a previously described LASER sequence (4) in which the AHP and first two AFP pulses were substituted with slice-selective sinc pulse. The duration of sinc pulse was 1.5 ms, and each AFP pulse in LASER was a hyperbolic secant pulse, HS1, with length of 5.12 ms and bandwidth of 3.92 kHz. The echo time was 35 ms. A repetition time of 4.5 s was used. Each FID was acquired using a spectral width of 4 kHz. FIDs were frequency and phase corrected based on NAA signal at 2.01 ppm prior to summation.

Results and Discussion

Figure 1 shows representative spectra obtained from different brain regions at 7 T using the LASER sequence. Spectra are of very good quality without any contaminations from lipids. Table 1 reports the linewidths which were observed in different brain regions of water and of total creatine signal.

Similar linewidths of water were obtained in occipital lobe and motor cortex (15 Hz) and in basal ganglia and cerebellum (19 Hz). Linewidths of total creatine were very similar in occipital lobe and motor cortex (15 Hz) and they were also very similar to the linewidths of water. Linewidth of total creatine in cerebellum was larger than in occipital lobe and motor cortex, but the linewidths of water and total creatine were very similar to each other. In the case of basal ganglia, the linewidth of total creatine was much larger than the linewidth of water.

Conclusions

It has been shown that it is possible to obtain a good quality spectroscopy data at 7 T from four different brain regions in the same study. The linewidths in basal ganglia suggest that water and total creatine are experiencing different environments.

Acknowledgements: This work was supported by NIH grants: RR08079 and P30 NS057091 and the W.M. Keck Foundation.

References: 1. Tkac, I. *et al.*, *Magn Reson Med* **46**: 451 (2001). **2.** Adriany, G. *et al.*, *Magn Reson Med* **59**:590 (2008). **3.** Metzger, G. *et al.*, *Magn Reson Med* **39**:396 (2008). **4.** Garwood, M. *et al.*, *J Magn Reson* **153**:155 (2001).

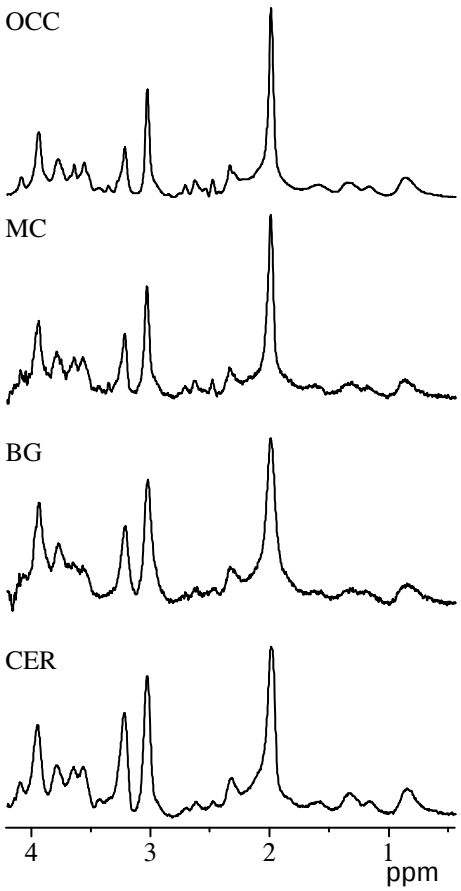

Figure 1. ^{1}H spectra obtained with LASER sequence from four voxels positioned in different brain regions (T_R = 4.5 s, T_E = 35 ms, 64 scans). The spectra are shown processed with 1 Hz line broadening.

Table 1. Linewidths of water and total creatine (creatine + phosphocreatine) in spectra measured in different brain regions.

voxel	voxel size (cm^3)	number of spectra	water	tCr (3.03 ppm)
OCC	19.7	7	15 ± 2	15 ± 3
MC	8	5	14 ± 1	15 ± 2
BG	9	6	18.5 ± 0.9	25 ± 1
CER	15.6	1	19	20