Repeated Measures Performance of Volumetric Whole Brain Echo Planar Spectroscopic Imaging

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Introduction

There is considerable current interest in using newly developed "echo planar" spectroscopic imaging techniques for quantitative studies of brain metabolite levels in clinical populations and for fundamental studies of normal brain metabolism. These new approaches to spectroscopic imaging have the advantages of considerably shorter data acquisition times, the potential to acquire 3-dimensional spectroscopic imaging data, and the ability to easily obtain a water reference data set. However because gradient switching occurs during the spectroscopic data acquisition, there is concern about reproducibility, signal-to-noise ratio and statistical precision. In this work we performed a repeated measures study of normal human brain, which provides an empirical assessment of these factors.

24 EPSI Studies - 5 Normal Subjects

		Mean	SD	COV
Left Thalamus	NAA	6.06	1.37	0.23
	Ch	1.04	0.25	0.25
	Cr	3.33	1.26	0.38
Left Frontal White Matter	NAA	7.90	1.30	0.16
	Ch	1.08	0.23	0.22
	Cr	4.36	0.75	0.17
Midline Posterior Cingulate	NAA	7.19	1.45	0.20
	Ch	1.14	0.20	0.18
	Cr	4.08	0.91	0.22

Table 1

Materials & Methods

Volumetric Echo Planar Spectroscopic Imaging (EPSI) with TE = 70 ms was used to study 5 normal human subjects (S1-S5) aged 19-27. A total of 24 data sets were acquired (5 studies of S1-S4, 4 studies of S5). Studies were performed with a 1.5 T MRI unit using a single receive channel. The nominal acquisition voxel size was 4.4 x 4.4 x 5.6 mm^3. Signal processing included filtering that produced a final voxel size of approximately 2 ml^3. Data were processed using an integrated set of software tools (MIDAS) that automate MRSI and MRI data co-processing including spectral fitting. The MIDAS system was used to manually select four anatomically defined spectroscopic imaging voxels (Left Thalamus (LTh), Left Frontal White Matter (LFWM), Midline Anterior Cingulate (MAC) and Midline Posterior Cingulate (MPC)) from each of the studies and then to extract the water-referenced signal areas of NAA, Cholines (Ch) and Creatines (Cr) in these regions.

		NAA COV	Ch COV
Left Thalamus	Total	.227	.246
	S1	.205	.299
	S2	.165	.328
	S3	.295	.033
	S4	.057	.227
	S5	.190	.309
Left Frontal White Matter	Total	.164	.216
	S1	.166	.155
	S2	.209	.313
	S3	.170	.230
	S4	.146	.153
	S5	.072	.085
Midline Posterior Cingulate	Total	.202	.177
	S1	.208	.158
	S2	.163	.087
	S3	.268	.203
	S4	.132	.261
	S5	.199	.191

Table 2

Results

The acquisition/processing package uniformly failed to obtain adequate data quality for spectral fitting in the MAC due to the static magnetic field gradients in this brain region. Fig 1 provides a plot of means and standard deviations (SDs) for the remainder of the data. Table 1 reports the means, SDs and the coefficient of variation (COV) (i.e. SD/Mean ratio) from all studies. Table 2 reports the COVs of NAA and Ch in the various brain locations for the subjects. The figure and tables illustrate that COVs ranging from 0.03 to 0.33 (mean COV = 0.19 $\pm$ 0.07) are characteristic of single voxels in 1.5 T single channel volumetric EPSI data. Single subject COVs were not significantly smaller than between-subject COVs indicating that differences between individuals in metabolite levels are smaller than the measurement precision. However, the repeated measures design allowed several between-individual differences in metabolite levels to be identified using ANOVA.

Conclusion

This study demonstrated that the combination of 1.5 T volumetric EPSI and automated MIDAS signal processing is capable of making single voxel metabolite assessment with a precision (i.e COV) of about 19%.

ACKNOWLEDGEMENT

Supported by NIH Biomedical Research Partnership grant, R01EB0822.

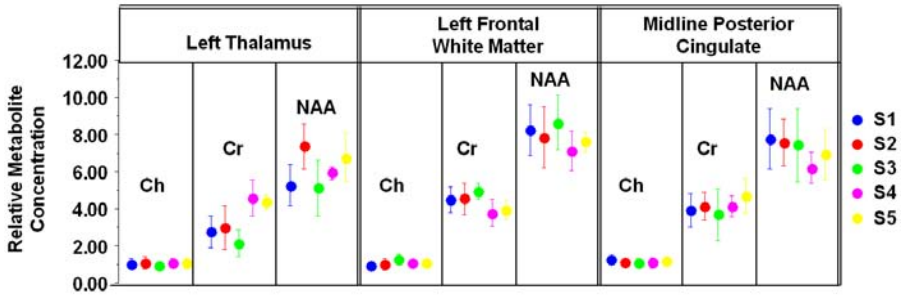

Figure 1