Comparison of 1D and 2D MR Spectroscopy in Bipolar Depression

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Introduction: Proton magnetic resonance spectroscopy (1H-MRS) can detect subtle biochemical changes non-invasively in different brain pathologies *in vivo*. The absolute concentration of metabolites such as NAA, creatine (Cr) and choline (Ch) can be reliably quantified using the one-dimensional (1D) MR spectra (1), however, overlap of several cerebral metabolites such as, glutamate/glutamine (Glx), myo-inositol, aspartate and GABA is a major concern *in vivo*. Spatially localized versions of two-dimensional (2D) chemical shift correlated MR spectroscopic sequences can lead to increased spectral resolution, due to the added second spectral dimension (2). A major goal of this work was to assess cerebral metabolite levels in the anterior cingulate of bipolar depressed patients and healthy controls using 1D MRS and localized 2D correlated spectroscopy (L-COSY).

Methods: A GE 1.5T MRI/MRS scanner (LX 9.1 platform) was used and the spectra were recorded using a body rf coil (as transmitter) in combination with a 3" surface coil for receiving the signal of 2D MRS and a standard head transmit/receive coil for 1D MRS. A 27ml voxel was localized in the anterior cingulate and the global water suppression was achieved using a CHESS sequence. We studied a group of 23 bipolar depressed (BPDep) subjects (17M, 6F) and 12 healthy controls (HC) (7M,5F) whom provided written informed consent. **1D MRS:** TE/TR=30/3000 ms, NS=256 and LC model post processing (metabolites with >20% error from the standard LC model fit were rejected). Gray/White vs. CSF segmentation was also done using a home-developed image analysis package. NAA, Glx (Glu+Gln), Cr, Ch and mI quantified as absolute [concentration], CSF corrected [concentration] and ratios with respect to Cr. **2D L-COSY:** The parameters were: TR=2s, TE=30ms, 96 Δt_1 and 8 averages per Δt_1 . The peak volumes under several diagonal and cross peaks were calculated using Felix 2000 (Accelrys, San Diego, CA). Metabolite ratios of NAA/Cr, mI/Cr, PE/Cr, Glx/Cr, Asp/Cr, mI-Ch/Cr, Ch/Cr, GABA/Cr, Tau/Cr and Thr/Cr were computed with respect to diagonal peak of Cr.

Results and Discussion: The 1D study showed that [Glx], [Glu] and [Cr] (before and after CSF correction) were significantly increased in BPDep vs HC; however as presented in Table 1, the metabolite ratios did not differ significantly between BPDep and HC. The metabolite to creatine ratios calculated from 2D L-COSY from the same cohort are summarized in Table 2 for Ch_d, NAA_d, Thr, mI, Glx, PE, GABA, PCh, Tau and Asp. As evident in Table 2 and Table 1, the Glx elevation (7.7%) was in agreement with our own 1D MRS findings. Also, non-significantly increased Ch and mI ratios were evident in the 2D L-COSY data.

Table 1: Anterior cingulate metabolite ratios (mean±SD) obtained from 1D-MRS.

Metabolites /Cr	BPDep (n=23)	HC (n=12)	P	t
NAA	1.24±0.03	1.31±0.04	0.21	1.27
NAA+NAAG	1.27±0.03	1.33±0.04	0.34	0.98
Glx	1.41±0.05	1.28±0.07	0.13	-1.54
Gln	0.43±0.04	0.38±0.06	0.46	-0.75
Glu	0.98±0.04	0.89±0.05	0.21	-1.27
Ch	0.23±0.01	0.23±0.01	0.77	0.29
mI	0.71±0.03	0.79±0.04	0.12	1.6

Table 2: Anterior cingulate metabolite ratios (mean±SD) calculated from the 2D L-COSY spectral peak volumes.

Metabolites /Cr	BPDep (n=23)	HC (n=11)	P	t
Ch_d	1.08±0.08	1.05±0.09	0.41	-0.84
NAA_d	1.60±0.12	1.60±0.15	0.94	-0.08
Thr	0.01±0.00	0.01±0.00	0.53	-0.63
mI	0.06±0.01	0.05±0.01	0.18	-1.39
Glx	0.09±0.02	0.08±0.01	0.43	-0.80
PE	0.02±0.01	0.02±0.01	0.49	-0.70
GABA	0.04±0.02	0.03±0.01	0.17	-1.40
Tau	0.04±0.01	0.03±0.01	0.61	-0.52
Asp	0.05±0.01	0.05±0.00	0.24	-1.20

Conclusion: Even though absolute quantitation was possible, the reliability of quantifying metabolites such as Asp, GABA, PCh, PE and other weaker metabolites was not reliable using LC-Model processed 1D MR spectral data. Even though only ratios were calculated thus far, the 2D L-COSY analysis was able to show the relative metabolite levels at low concentrations (0.5-2mM) with improved reliability. Furthermore, this is the first pilot study to highlight the similarities and differences between 1D and 2D MRS studies as related to Glx and other cerebral metabolites in bipolar depression.

References:

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