Brief Communication

Quantitative proton magnetic resonance spectroscopy of human precentral gyrus and hippocampus. *Absolute concentrations of metabolites*

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Proton magnetic resonance spectroscopy (^{1}H-MRS) provides a noninvasive tool for assessing brain metabolites in vivo. The precentral gyrus (PG), which functions as the primary motor cortex,[1] is considered relevant to some diseases such as amyotrophic lateral sclerosis (ALS), whilst, the hippocampus is a brain center that is sensitive to the effects of stress exposure, and has been demonstrated to be affected in a variety of disorders.[2] Currently, relative quantification (ratio) has gained popularity in quantifying metabolite concentrations for its technical ease of measurement. This approach is based on the assumption that total creatine (tCr) concentration is both relatively constant throughout the brain and resistant to change. However, this viewpoint has been challenged by some findings, which revealed Cr distribution discrepancy, age-related changes, and alterations under pathological conditions. Furthermore, it is hard to determine which metabolite alters when observing a change in the ratio. In consideration of these drawbacks, a more objective and accurate methodology is required. A new developing approach named absolute quantification meets this requirement. The objective of this experiment is to study the metabolic characteristics and absolute concentrations of the PG and hippocampus using ^{1}H-MRS with LCModel software (S-Provencher Company, Oakville, Ontario, Canada).[3]

This study was carried out in the Medical Imaging Department of the 2nd Affiliated Hospital of Shantou University Medical College, Shantou, China between December 2008 and July 2009. Fourteen healthy adults (5 women and 9 men; age range 23-29 years old, mean 26 years) were enrolled in this study. All of them are right-handed and clinically asymptomatic. They all first underwent MRI study. Only those with normal MRI proceeded to MRS. No one was rejected from the study. The local ethics committee approved the study, and all volunteers gave informed consent.

The MR study was performed on a 1.5T GE Signa HDX scanner (GE Healthcare, Wauwatosa, Wisconsin, USA) with the standard head coil. Routine MR imaging including transverse, sagittal, and coronal scanning were obtained using Fast Gradient Echo (FGRE) (TR 5.4msec, TE 1.6msec). Localized proton spectra were acquired using stimulated-echo acquisition mode (STEAM) sequence (TR 3000 ms, TE 20 ms, TM 13.7ms). Voxels (15×15×20 mm) were located in the left PG and hippocampus. We used 3 planes to determine the volumes of interest. Voxel of the PG was placed anterior to the central sulcus, while voxel selection of hippocampus was based on the maximal structure displaying. The full width at half maximum was less than 5 Hz, and water suppression reached 98%. After acquisition, MRS data were processed using the LCModel software. Absolute metabolic concentrations of N-acetylaspartate (NAA), total creatine (tCr), total choline (tCho), myoinositol (mI), Glx (glutamate [Glu] + glutamine [Gln]) were measured.

Using the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA) version 10, the paired-samples t-test was used to compare the metabolic concentrations between the PG and hippocampus. Bivariate correlations and linear regression analysis were performed to determine whether some metabolites were correlated with Cr levels. Statistical significance was set at $p<0.05$.

The metabolic concentrations that were calculated from the STEAM spectral data are presented in **Table 1**. Results showed significantly lower NAA level and higher Cho and mI in the hippocampus than in the PG, while no significant difference for Cr and GLX concentrations in these 2 locations was observed. Linear regression analysis showed a linear relation between NAA and Cr both in the PG and hippocampus (PG, Pearson correlation coefficient: r=0.664, and p=0.013; hippocampus, r=0.632, p=0.015).

Our study was consistent with the result of Geurts et al,[4] whose quantitative study was performed with

Table 1 - Comparison between the precentral gyrus and hippocampus metabolites with short echo time STEAM sequence (TR 3000, TE 20 ms) (Mean±SD, n=14).

Metabolites	Precentral gyrus (mmol/L)	Hippocampus (mmol/L)	*P*-value
N-acetylaspartate	7.510±1.02	6.163±1.36	0.023
Choline	1.035±0.29	1.847±0.45	0.000
Creatine	4.890±0.85	5.231±1.12	0.400
Myoinositol	4.301±0.70	6.140±2.06	0.007
Glutamate +glutamine	10.022±1.476	9.243±3.637	0.550

STEAM - stimulated-echo acquisition mode

Disclosure. This study is supported in part by a grant from the National Natural Science Foundation of China (NSFC), key program: 30930027.

the external standard method. Currently, there is considerable neurochemistry evidence demonstrating relatively high NAA levels in the cortex. In addition, histology has certified low neuronal density in the hippocampus and subiculum hippocampi. The present study acquired relatively higher Cho and mI levels in the hippocampus, which concurs with some proven findings[5] that suggest the hippocampus contained more glial cells compared to other regions in the brain. With regard to Cr level in both locations, our results are in good agreement with numerous previous studies.[6]

Regression analysis presented a linear correlation between NAA and Cr in the PG and in the hippocampus. This result is consistent with Bowen et al,[7] whose study revealed positive correlations between NAA and Cr, and between Glu and Cr in the PG of both ALS patients and control subjects. It was postulated that the neuronal metabolism of Glu and NAA in the PG is closely linked to the presence of Cr. A laboratory study showed oral administration of Cr produced a dose-dependent improvement in motor performance in transgenic ALS mice and protected them from loss of motor neurons.

In conclusion, to study the metabolic characteristics and absolute concentrations of the PG and hippocampus is of great significance. Nevertheless, the present study is preliminary and the subject number is small. In addition, although the LCModel is a valuable tool for obtaining absolute concentrations, under the conditions of 1.5 Tesla and TE 20 ms, it is more difficult for the LCModel in terms of signal to noise ratio and spectral uniqueness. Continuous efforts should be made to obtain reliable concentrations, and therefore establish a quantitative basis.

Received 18th September 2010. Accepted 23rd November 2010.

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