Regional Difference of GABA Concentration in the Human Brain Measured by MEGA-PRESS with LCModel fitting on Clinical 3T Apparatus

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Introduction:

γ-amino butyric acid (GABA) is one of the neurotransmitter agents which is mainly located in inhibitory nervous system. Recently GABA was measured using proton MR spectroscopy by editing technique or multi-dimensional observation. MEGA-PRESS has been reported as a useful tool to detect GABA signal separated from other major metabolites. As reported in the previous paper, MEGA has several advantages for mechanical environment and especially we considered it is useful for clinical setting. The purpose of this study was to observe regional difference of absolute GABA concentration in the human brain by MEGA-PRESS and to find pathological changes of GABA concentration in cerebral disorders.

Subjects and Method:

Our created MEGA-PRESS was the almost same as the previous reported one and employs gradients surrounding the frequency selective pulses at 1.9 ppm to dephase transverse magnetization (Fig.1). Water suppression was used conventional three CHESS pulses after manual optimization. The sequence parameter was as following: TR = 1500 ms, TE = 68 ms, ROI = 3.0 x 3.0 x 3.0 cm3 (27ml), summation = 256 signals for each spectrum, total acquisition time = 13 min. The measurements with and without the frequency selective pulses were conducted alternatively, i.e. during odd-numbered acquisitions, J evolution for the GABA was refocused and during even-numbered acquisitions, it was not refocused. The difference of the acquired spectra provided an edited spectrum of GABA. The in-vitro data of NAA, Glutamine, Glutamate and GABA were acquired by MEGA-PRESS and set as a basis-set for LCModel. The quantification of signals in the difference spectra by MEGA-PRESS was conducted by LCModel.

The subjects were six normal volunteers (3 male, 3 female, age 25 - 32 years) and the measurements of GABA were conducted in left lenticular nucleus, left parietal white matter and right hemisphere of the cerebellum. The patients with Parkinson disease, Progressive multifocal leukoencephalopathy (PML) or multiple system atrophy (MSA). This study was permitted by the institutional committee of the University Hospital of Tokushima and the informed consents were obtained from all subjects.

Results:

An example of GABA-edited spectrum on a normal volunteer was shown in Fig.2. The peak of GABA was found at 3.02 ppm and those of Glx and macromolecule were observed in this spectrum. The concentration of GABA in the cerebellum (2.7±0.8 mM) was the highest in three regions and that in the parietal white matter (1.1±0.4 mM) was the lowest. The concentration of GABA in the cerebellum with MSA (0.9 mM)was lower than that in the normal volunteers. In a patient with PML, the concentration of GABA (0.6 mM) was lower than the normal value, but the increase of macromolecule signal was found as shown in Fig.3.

Conclusion:

The concentration of GABA could be measured by MEGA-PRESS with LCModel analysis even in the clinical setting, and the regional difference and the pathological change of the GABA concentration were confirmed in this study. The influence of macromolecule to refocused GABA peak at 3.02 ppm was not prominent as shown in a PML case.

Reference:

M. Mescher et al. NMR in Biomed. 11, 266-272, 1998

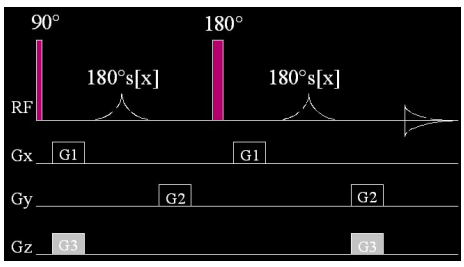


Fig.1: Sequence chart of MEGA-PRESS

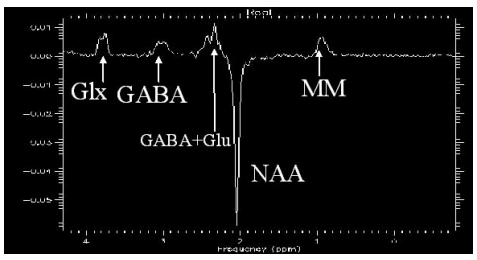
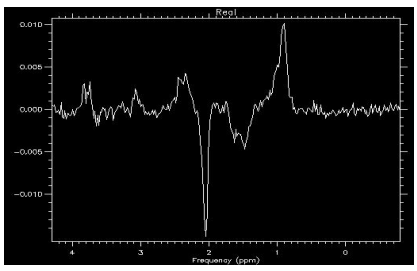


Fig.2: difference spectrum of a volunteer



Fg.3:difference spectrum of a patient with PML