# Hippocampal and thalamic glutamate in human brain

J. W. Pan[1], T. Venkatraman[1]
[1]Neurology, Albert Einstein Coll Medicine, Bronx, NY, United States

**Introduction:** We have previously reported on the implementation of robust approaches to the detection of subcortical glutamate in human brain. This is of particular interest given its central role in neurotransmission and metabolism. In this abstract we describe work using the quad refocusing double echo sequence to ascertain normal brain concentrations of glutamate in gray and white matter from the hippocampus and the thalamus. The nominal voxel resolution achieved with this localized spectroscopic imaging sequence is 0.51cc.

**Methods:** All studies were performed using a Varian 4T Inova whole body MR system with a TEM 1H volume head coil. As previously described (1), localization was achieved through two pairs of adiabatic refocusing pulses applied on orthogonal axes in a double spin echo. The adiabatic decoupling intrinsic to this approach results in much less signal loss due to j-modulation. Additional localization was achieved through 1D ISIS and 2D spectroscopic imaging (24x24, FOV19.2, thk 8mm) to give a nominal voxel size of 0.51cc. Water suppression was performed using a semi-selective excitation pulse and pre-acquisition excitation. Total TE was 37msec, TR 2sec with an acquisition time of 39min. Tissue segmentation was performed using an inversion recovery sequence with automated segmentation into CSF, gray or white matter. The thalamus and basal ganglia were defined manually from the T1 images. Spectra were processed with resolution enhancement with a lorentz to gauss conversion and convolution difference. Phantom spectra (including NAA, glutamate, glutamine, creatine, choline and aspartate) were acquired using the same approach to allow implementation of a LCM approach to curve fitting. N=7 healthy adult subjects were studied for the thalamus and hippocampus.

**Results:** Fig. 1 (scout and spectra) demonstrates the performance of the adiabatic sequence in the hippocampus, demonstrating the excellent signal retention into the pes hippocampus. LCM analysis of voxels from the hippocampus, surrounding gray and white matter (excluding spectra from the pons and midbrain) was performed with data from n=7 normal subjects, and regression data against fraction gray matter are shown in Fig. 2. For consistency of relaxation values, creatine (white matter, 6.3mM, ref. 2) was used as a reference, giving a concentration of glutamate in the temporal lobe white matter at 4.6±0.5mM and in temporal gray matter 8.5±1.2mM. Ratios of Glu/NA from the anterior, middle and posterior thalamus were determined at 0.34±0.07, 0.44±0.09 and 0.46±0.07 respectively.

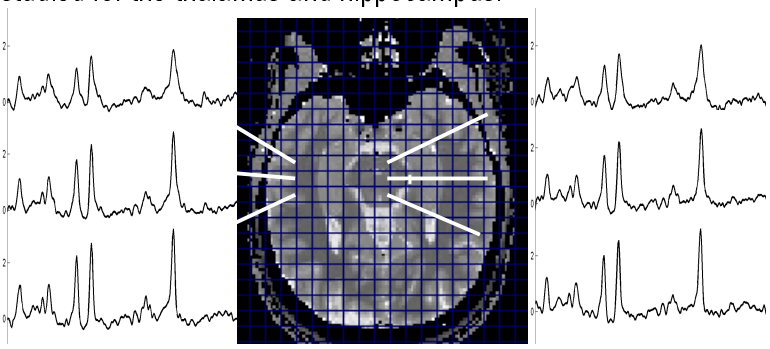

Fig. 1. Scout and spectra from a normal volunteer. Nominal voxel size, 0.51cc; no baseline correction applied.

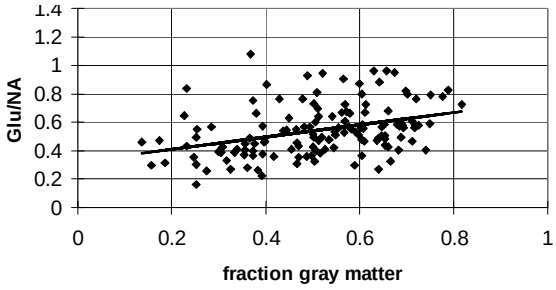


Fig. 2. Regression of Glu/NA against fraction gray matter, all data from the hippocampi and temporal lobes. R = 0.38, $p<1x10^{-5}$

**Conclusions:** Hippocampal and thalamic glutamate are of significant interest for a variety of disorders, including epilepsy, Alzheimers' disease etc. The data find that in the temporal lobe, glutamate is at similar concentrations to other cortical areas. Posterior thalamic glutamate appears to be 6.4±1.4mM, or approximately 75% that of the hippocampal and temporal region (assuming a thalamic creatine level of 8mM), which is consistent with literature data (3).

References: 1 Pan et al ISMRM p269 2003; 2 Michaelis et al Radiology 187:219 1993; 3 Perry et al J Neurochem 18:513 1971. Acknowledgements: This work was supported by NIH R01-NS40550 and M01-RR1224.