Metabolic Assessment of Migraines using Ultra-High Magnetic Fields

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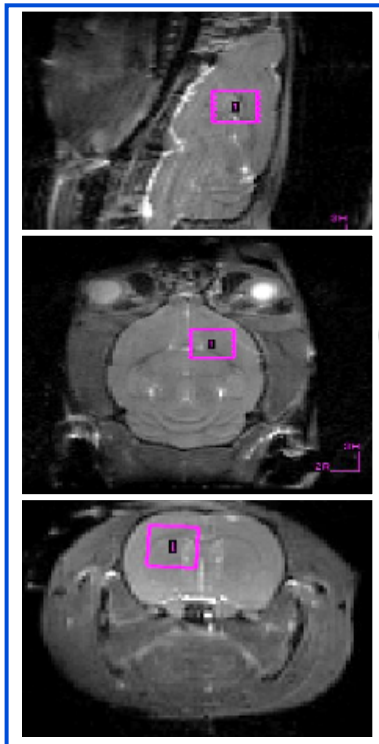
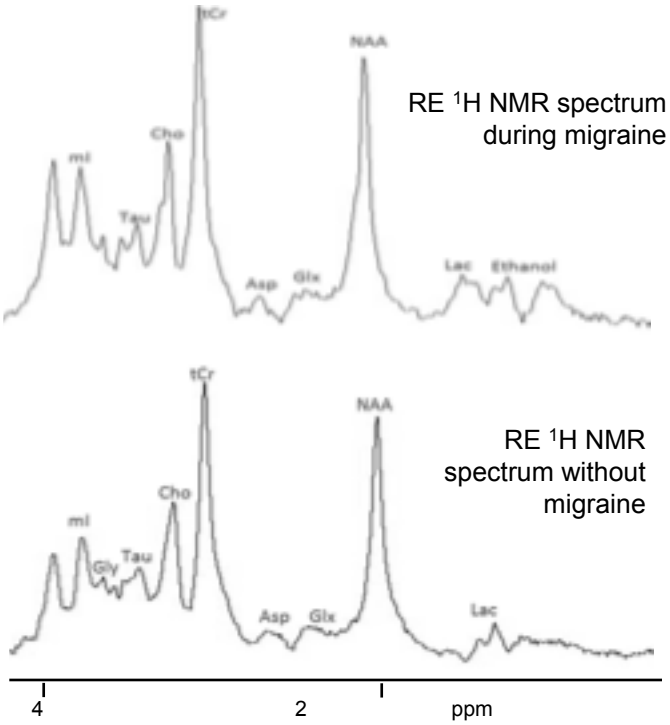
This study uses high-field NMR to evaluate biochemical imbalances in the brain that develop during the onset and progression of a migraine. Small molecules involved in energetic neuroprotective and neurotransmitter action in the rat brain were evaluated with a frequency-selective magnetic resonance technique called relaxation-enhanced (RE) ^{1}H spectroscopy in the MagLab's unique 21.1T NMR/MRI magnet. Specific chemical signals were monitored in a $(4mm)^3$ volume in the brain via repeated acquisitions every 10 minutes over 3 hours before, during, and after the injection of nitroglycerine (NTG) to induce a migraine analog in the rat. *This approach enabled the most complete detection and monitoring of temporal biochemical changes related to migraine.*

By following, for example, increasing lactate and elevated taurine levels in the brain, energetic and protective chemical actions were found to occur in the brain even before the rats' behavior indicates migraine-associated pain. *This finding suggests that the onset of the NTG-induced central sensitiztion involves either more extensive metabolism or -more likely- conversion from aerobic to anaerobic metabolism,* which would be consistent with an osmoregulatory impact if ionic distributions in the brain are disturbed.





Using MagLab-developed NMR pulse sequences $(4\ mm)^3$ volumes in the rat cortex (pink boxes) are selected to acquire relaxation-enhanced (RE) ^{1}H NMR spectra over 3 hours. Spectra were acquired after either a nitroglycerine injection to induce migraine or a sham saline injection. Lactate (Lac), N-acetyl Aspartate (NAA), Total Creatine (tCr), Choline (Cho), Aspartate (Asp), Taurine (Tau) were identified in the brain, along with Glutamine, Glutamate & GABA (together denoted Glx) and Glycine, Glutamine & Glutamate (together denoted Gly).

Facility Used: 900 MHz 105mm diameter Ultra-Wide-Bore NMR/MRI Magnet, NMR/MRI Facility at the MagLab/FSU

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