**Quantitative Spectroscopy of Sodium during Migraine Progression**

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**Introduction**

The brain allocates over 50% of its energy reserves on a cellular basis to the regulation of sodium concentrations; therefore, the alteration of sodium concentrations and fluxes related to these distributions are critical. In this study, rat models were used to evaluate *in vivo* sodium (23Na) fluxes during the onset and progression of migraine. MR spectroscopy performed at 21.1 T provided the sensitivity and resolution to evaluate the local redistribution of sodium under migraine conditions.

**Experimental**

All scans were performed using the 21.1-T, 900-MHz ultra-wide bore at the National High Magnetic Field Laboratory, Tallahassee, FL. Animal procedures were approved by the Institutional Animal Care and Use Committee at the Florida State University and the Huntington Medical Research Institutes (HMRI) in Pasadena, CA. After baseline scans, 17 anesthetized Sprague-Dawley male rats were administered *in situ* an intra-peritoneal injection of either nitroglycerine (NTG, N=7) to induce migraine or saline (N=6) to serve as a control.A voxel selective STEAM sequence was used to acquire the total sodium signal in under 1.2 min from a (4-mm)3 voxel placed in the right cerebral hemisphere, and 14 spectra were acquired from pre injection to ~2.5 h post injection. Chemical Shift Imaging (CSI) with a 3-mm slice thickness also was acquired in 4 min using a 16x16 matrix over a 3.2x3.2-cm FOV at pre-injection and post-injection (~2.5 h after injection) time points.

**Results and Discussion**

 23Na spectroscopy was collected using both voxel selective and CSI approaches. STEAM voxels demonstrated a trend of initial increase in 23Na signal following NTG that returned to control levels after 1 h. CSI scans appeared more sensitive to changes mediated via NTG, with a general increasing trend evident for NTG samples compared to controls between pre- and post-injection time points but more intense and localized sodium signal differences identifiable in the ventricles. These results extend the initial findings of a sodium change in migraine [1, 2].

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**References**

[1] Harrington, M.G., *et al.*, Headache, **50(3)**, 459-478 (2010).

[2] Harrington, M.G., *et al.*, Cephalalgia, **3(12)**, 1254-1265 (2011).



**Fig. 2** Representative 23Na CSI overlaid on reference 1H scans were used to generate mean difference 23Na images for all samples. **Top Row** NTG administered. **Bottom Row** Saline administered. Yellow arrows indicate the position of ventricles.

**Fig. 1** A)Sample time course 23Na spectra acquired with 14 scans over ~2.5 hr after injection. B) Mean 23Na SNR normalized to the pre-injection point shows increases in sodium signal following NTG.