**Quantitative Imaging of Sodium during Migraine Progression**

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**Introduction**

Alterations of sodium concentration have been reported in the lumbar CSF with the onset of migraine [1]. The purpose of this study was to evaluate *in vivo* (23Na) fluxes in the brain using rat models. Therefore, the ultra-high fields of 21.1 T to assess alterations in bulk sodium induced by migraine at higher resolutions that previously achieved. 3D scans at 1-mm isotropic resolution were acquired to minimize volume averaging and isolate regions of interest related to sodium changes with migraine onset.

**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=11) to induce migraine or saline (N=6) to serve as a control.2D sodium scans were acquired in 21 min using an Ultra-short Echo Time (2D-UTE) sequence at an in-plane resolution of 800 m with a 7-mm slice thickness. 2D 23Na MRI were acquired at the pre-injection, post-injection early (~10 min after injection) and post-injection late (~2.5 h after injection) time points. 3D sodium scans were acquired in 30 min using a 3D fast low angle shot (3D FLASH) sequence at an isotropic resolution of 1 mm for pre-injection and post-injection late time points.

**Results and Discussion**

 Preliminary analysis did not display significant changes in sodium signal based on 2D images, with a trend toward higher sodium signal immediately after injection as opposed to longer times following injection. 3D 23Na scans (Fig 10 were segmented to analyze the eyes, olfactory bulb (olf), hippocampus (hippo), corpus callosum (cc), cerebellum, brainstem, neocortex and ventricular system. As shown in Fig 2, this segmentation displayed trends toward decreased sodium in the olf, hippo and cc compared to saline injected controls. These higher resolution images demonstrate potentially differential impacts of NTG-induced migraine in the brain but indicate a temporal dependence on sodium signal following injection.

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**References**

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

[2] Harrington, M.G., *et al.*, Cephalalgia, **31(12)**,1254-1265 (2011).



**Fig. 1** 23Na 3D FLASH (TE/TR=1/50 ms) acquired at 1-mm isotropic resolution at pre- and post-injection points.

**Fig. 2** Percentage difference between pre- and late-post injection time points for anatomical regions segmented from 3D 23Na FLASH.