Brown Adipose Tissue Thermometry in the Paraventricular Specific Knock-out Mouse Model at 15.2T

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Introduction: Brown adipose tissue (BAT) is a metabolically dynamic organ involved in adaptive non-shivering thermogenesis[1]. There has been a recent surge in studies focused on the molecular functionality of BAT and unlocking its therapeutic potential for obesity and diabetes[2,3]. However, full understanding of BAT functionality remains elusive, mainly due to the lack of non-invasive, direct and reliable means to measure the activation and deactivation states of BAT[4].

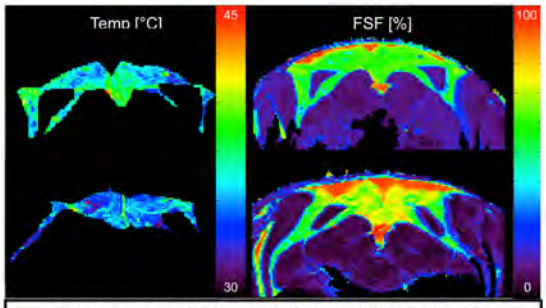

Figure 1. Axial slices from high-resolution 2D FLASH scans showing: column 1: masked temperature maps; and column 2: FSF maps used to create BAT mask

Purpose: In this work we apply a modified fat-water MRI (FWMRI) data analysis which includes a water offset frequency to estimate voxel temperature in interscapular BAT depot in the Paraventricular (PVN) specific knock-out mouse model (PVN LpR KO), at ultra high field (15.2T) using the Bruker CryoProbe® surface coil with 2D FLASH sequence with muti-interleaved echo count that can provide uniquely higher (1) SNR, and (2) spatial resolution. **Methodology:** Paraventricular (PVN) specific knock-out mouse model (LepRfloxflox/ sim1-Cre, referred as PVNLpRKO) (n=2) were bred using the Cre recombinase method[5]. Mice were scanned under anesthesia (5% isoflurane/oxygen), and FWMRI was acquired using a multi-stack, multi-slice, 2D FLASH acquisition pulse with 10 stacks, and 30 contiguous slices per stack. Parameters: TR=650 ms, 50 total echoes (5 echoes, 10 interleaves), TE_1=1.59ms, $\Delta TE_{effective}$=0.159 ms, flip angle=20, readout sampling bandwidth=300kHz (1172 Hz/pixel), axial in-plane FOV=2×2 cm^2 and acquired voxel size=0.08×0.08×0.5 mm^3. 3D fat-water separation, R2*, and field map estimation for each slice were acquired from the implementation of a multi-scale algorithm with global image optimization[6] using (1) high echo count (50 echoes) and, (2) initial guess for each parameter was directly estimated from the conventional fat water separation using a 9-peak fat, 1 peak water model[7] based on Hernando et al work[8]. The signal fitting function was modified to additionally solve for a temperature dependent frequency shift of the water peak. **Results**: Figure 1 shows two representative axial slices of PVNLpRKO of the examined anatomical regions of temperature maps (column 1) and fat signal fraction maps (column 2). The lower and upper bound of 95% confidence intervals of estimated temperature values PVNLpRKO for ROIs corresponding to interscapular BAT are 29.3-37.9 °C. **Discussion:** Despite the small sample number (n=2) in this study, we were able to successfully measure temperatures within murine BAT depots at ultra high field using FWMRI-derived temperature mapping developed by our group [9]. This work presents the first report using 15.2 T MRI to determine the absolute temperature of BAT in mice at ultra high field, which will be crucial for future characterization of the thermoregulation of the PVNLpRKO mouse model.

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