Cerebral blood flow (CBF) using a custom control data

### Introduction

**Migraine**
- Recurrent disabling neurological disorder
- Afflicting more than 38 million people in the USA
- Fundamental understanding of the physiology behind migraine is lacking

**Arterial Spin Labeling (ASL) at 21.1 T**
- Non-invasive MRI used to measure quantitatively tissue perfusion by magnetically tagging blood
- Pulsed ASL variant employing flow alternating inversion recovery (FAIR) with EPI readout

**Evolution of Cerebral Hemodynamics with Migraine**

- **Methods**
  - 8 animal subjects – Sprague-Dawley rats
  - N=5 – injected with nitroglycerin (NTG)
  - N=3 – injected with saline
  - All anesthetized & loaded into 21.1-T magnet
  - FAIR EPI consists of:
    1. M₀ image with a FISP readout
    2. ASL FISP with non-selective, global inversion
    3. ASL FISP with selective inversion

  - For all three protocols, the readout parameters were identical. TI maps of each slice were acquired using 8 TIs (0.1-1 s).

  - Baseline ASL acquired for 30 min – **Pre-injection**
  - ASL acquired for up to 2 h – **Post injection**
  - Cerebral blood flow (CBF) using a custom Matlab® script calculated by:

\[
\text{CBF} = \frac{\Delta M\lambda}{2M_0} \left( \frac{1}{T_{1\text{blood}}} - \frac{1}{T_{1\text{app}}} \right)
\]

  - \( \Delta M \) – change in magnetization
  - \( M_0 \) – tissue magnetization
  - \( \lambda \) – blood-tissue water partition coefficient
  - CBF – blood flow
  - TI – inversion time
  - \( T_{1\text{app}} \) – flow dependent tissue relaxation time
  - \( T_{1\text{blood}} \) – blood relaxation time

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**Results**

**Calculations**
- Left and right lobes of the thalamus were measured separately
  - These values were averaged to give an overall value for the whole thalamus
  - The averaged values were normalized to baseline for each subject
- CBF values for each time point were averaged across all subjects
- Percent change (mean ± SD) was calculated in reference to mean baseline

**Trends**
- There is a slight discrepancy between left & right lobes of the thalamus
- Evident for both NTG and saline subjects
- Displayed in Figures 3 & 4

**Discussion**

- Figures 1 and 2 show the CBF maps & associated time course for migraine onset and progression
  - Control data – no significance in terms of perfusion or anesthesia impacts
  - Migraine data – increasing trend towards significance around 1.5 h post-injection
    - Return to baseline > 1.5 h post-injection

- No recruitment of capillary perfusion preceding behavioral migraine onset (45 min post-injection)

**Future work**
- Expand to include more subjects
- Explore other regions of the brain
- Evaluate the impact of migraine drugs on CBF

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