# Hippocampal blood flow and vascular reserve: TrueFisp ASL at 3T

**H. Rusinek[1], M. Brys[2], R. Switalski[2], F. Haas[2], K. Mcgorty[2], M. de Leon[2], and Q. Chen[2]**
[1]NYU School of Medicine, New York, NY, United States, [2]NYU School of Medicine

Hippocampus plays an essential role in the formation of new memories and, as a central structure of the medial temporal lobe system, it is involved in general declarative memory function. Compromised hippocampal perfusion is implicated in Alzheimer's disease, epilepsy, and other neurological disorders. Current techniques to measure hippocampal blood flow and its cerebrovascular reactivity in vivo either lack spatial resolution (SPECT Xenon method, PET O-15 labelled water method) or suffer from severe signal loss and image distortions (arterial spin labelling, ASL method using echo-planar sequences, Fig. 1). Because of these limitations, very little is known about regional cerebral blood flow (rCBF) in human hippocampus. We present promising results obtained in normal subjects using ASL segmented True Fast Imaging with Steady-state Precession (TFISP) sequence at 3T.

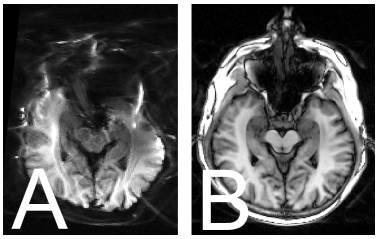


Fig. 1. ASL methods are typically based on echo planar imaging (A), which is prone to severe signal loss and image distortions in the hippocampal region. The same axial section imaged at 3T TFISP (B) shows minimal distortions.

## Methods

Eleven normal volunteers (age 34±10 years, 5 females) underwent a pulsed ASL-MRI assessment of rCBF in a 6-mm thick axial slice through the hippocampus (Fig. 2). The measurements were done at rest and were repeated during the carbon dioxide (CO2) challenge achieved with rebreathing technique. To reduce the variability in CO2 activation, before each MRI exam we performed a 10min trial to establish the length of respiratory tube needed to raise end-tidal CO2 by 6 mm Hg. While in the magnet, each subject was fitted with a mouthpiece, a nose clip, and a removable respiratory tube. End-tidal CO2 levels, heart rate, blood oxygen were monitored during the entire ASL-MRI exam.

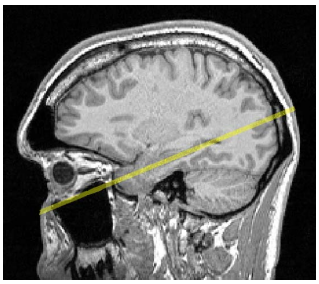

Fig. 2. A 6 mm hippocampal slice.

A segmented true FISP 2D sequence was combined with a FAIR spin labeling, in which slice-selective and slice-nonselective inversion pulses were applied to generate control and labeled images. Imaging parameters were: TR/TE = 2.5ms/1.7ms, FA = 50 deg, 256 x 168 matrix, 30 x 20 cm FOV, NEX = 8. Spin labeling in a 15 mm-thick slab was achieved with a FOCI pulse. Labeled and control image were collected at inversion times TI of 1200 ms and 110 ms. Data acquired at an early (110 ms) TI were used to estimate the signal difference (labeled-control) when minimal perfusion effects were expected. A reference image for estimation of equilibrium magnetization was also acquired using the TFISP sequence with inversion pulse turned off. All studies were performed on a 3-T Siemens TIM Trio scanner using a 12-element receiver head coil and body-coil for excitation.

## Results and Discussion

CO2 levels increased significantly during rebreathing (39.6±3.8 mmHg at baseline vs. 46.2±3.5 during challenge, p=0.002, Fig.4). There was a significant increase of rCBF during CO2 challenge in both the right (96.2±19.2 challenge vs. 79.4±16.7 baseline, ml/100g/min, p<0.05) and the left hippocapus (98.5±22.9 vs. 84.3±21.9, ml/100g/min, p=0.005). Similarly, there was a significant increase of rCBF in the cortical gray matter (95.7±20.62 vs. 82.5±21, ml/100g/min, p<0.05). The hippocampi and the lateral temporal lobe gray matter demonstrated similar cerebrovascular reactivity in response to CO2 challenge (+3.3±2.4% right hippocampus, 2.8±1.5% left hippocampus, 4.0±1.8% cortex).

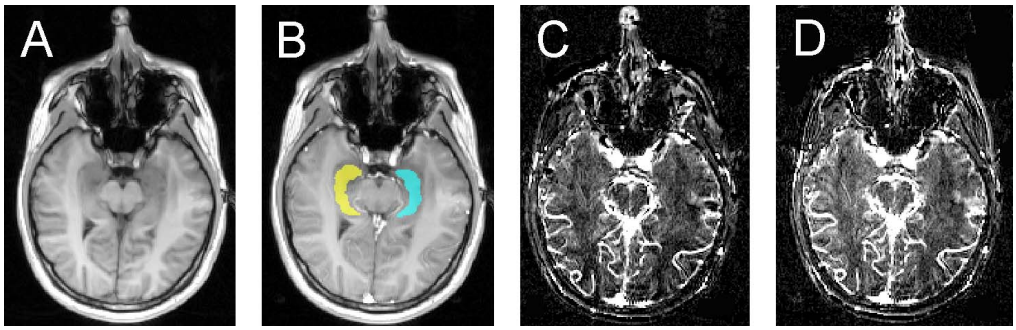


Fig. 3. Control (A) and labeled (B) images collected using TFISP at TI=1200 ms from a representative subject. Left and right hippocampus ROI is drawn to avoid large vessels. rCBF map constructed at baseline (C) and during CO2 challenge (D).

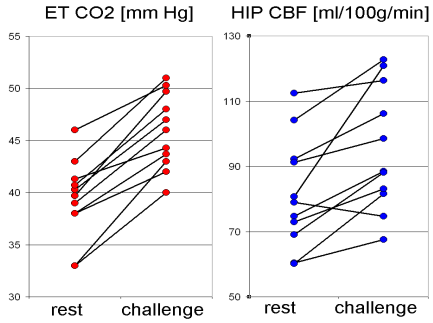


Fig. 4. End-tidal CO2 and hippocampal blood flow (average of left and right sides) in each subject.

The ASL-MRI segmented true FISP technique has adequate spatial resolution to reliably assess rCBF and cerebrovascular reactivity in hippocampus. The images are relatively quick to acquire (about 5+5 min for the rest+challenge), but present a challenge in image analysis due to high signal from cerebral arteries. TFISP ASL rCBF measurements are easily repeatable, which may be of particular importance in research on Alzheimer's disease, epilepsy, and other neurological disorders of medial temporal lobe.