Presentation 11 – Richard Briggs

Perfusion and Regional Cerebral Blood Flow (rCBF) Using MRI Arterial Spin Labeling (ASL)

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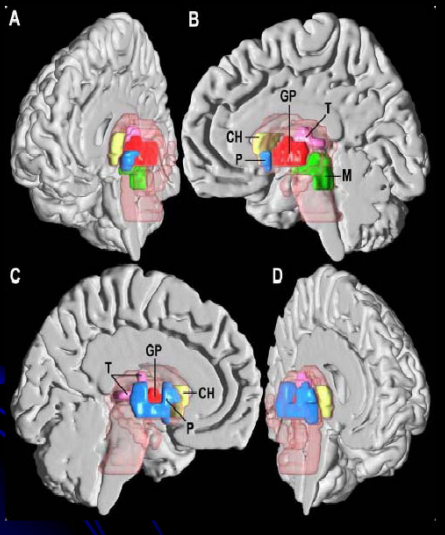
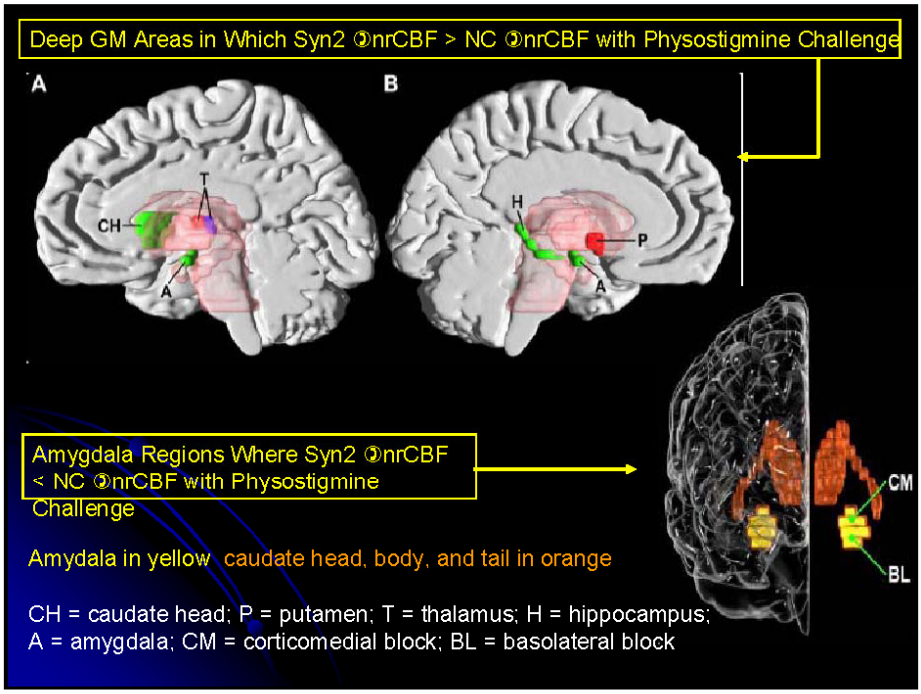
Deep GM Areas in Which Baseline Syn2 nrCBF < NC nrCBF



CH = caudate head
P = putamen
T = thalamus
GP = globus pallidus
M = midbrain

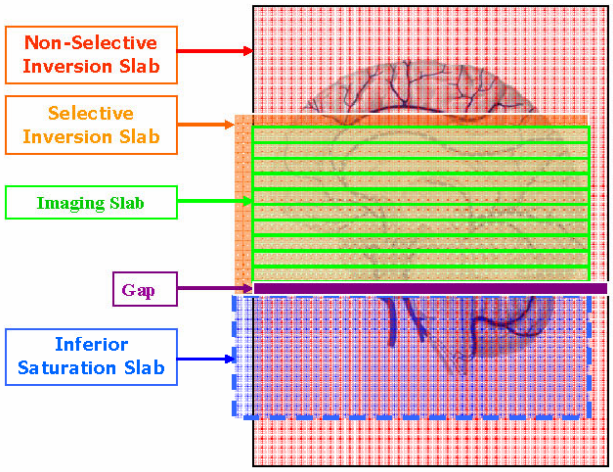
Haley RW, Spence JS, Carmack PS, Gunst RF, Schucany WR, Petty F, Devous MD Sr., Bonte FJ, Trivedi MH. Abnormal brain response to cholinergic challenge in chronic encephalopathy from the 1991 Gulf War. Unpublished results (manuscript in preparation).



Objectives of ASL Sub-Core

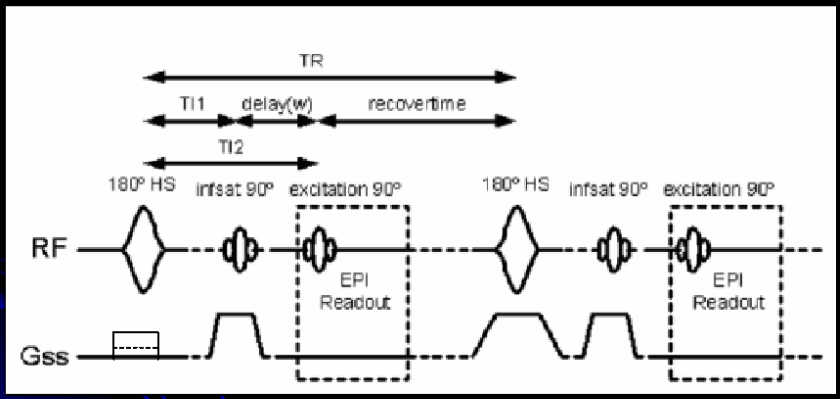
- To do a follow-up to the SPECT study in the original cohort of Gulf War veterans and controls, adding ASL for comparison and cross-validation
- To compare and cross-validate SPECT and ASL estimates of resting rCBF and responses to physostigmine challenge
- To develop and test improved methods for measuring both relative and absolute rCBF
- To apply these improved methods of quantitative mapping of brain blood flow and perfusion in GWI veterans from the RTI survey sample

FAIR QUIPSS II for Perfusion Studies



Wong EC, Buxton RB, Frank LR, Magn Reson Med 39: 702–708 (1998)
Wang J, Alsop DC, Li L, Listerud J, Gonzalez-At JB, Schnall MD, Detre JA, Magn Reson Med 48: 242-254 (2002)
(brain picture from Fix, James D., Neuroanatomy, 3rd ed., Lippincott Williams & Wilkins, Philadelphia, 2002)

FAIR QUIPSS II Sequence Diagram



Wang J, Licht DJ, Jahng, G-H, Liu C-S, Rubin JT, Haselgrove J, Zimmerman RA, Detre JA,
J Magn Reson Imaging 18: 404-413 (2003)

ASL Protocol

Part I Preparation scans

1.	Auto-align scout	(0:46)	aids reproducible slice positioning
2.	Localizer	(0:17)	for slice position planning
3.	MPRage	(4:38)	high-resolution, high-contrast anatomic reference
4.	GRE	(2:26)	same slice orientation as ASL, allows better co-registration between ASL and MPRage images

Total Time = 8:07 min

Part II ASL perfusion scans

1. Large coverage whole-brain scans: (1) superior brain (2) inferior brain

   Total time = 4:49 min x 2 (ROIs) = 9:38 min

2. Smaller coverage scans: (1) deep brain (2) amygdala (3) pons and cerebellum

   Total Time = 4:49 min X 3 (ROIs) = 14:27 min

Total study time is about 32 minutes.

Data Analysis Strategy and Procedure

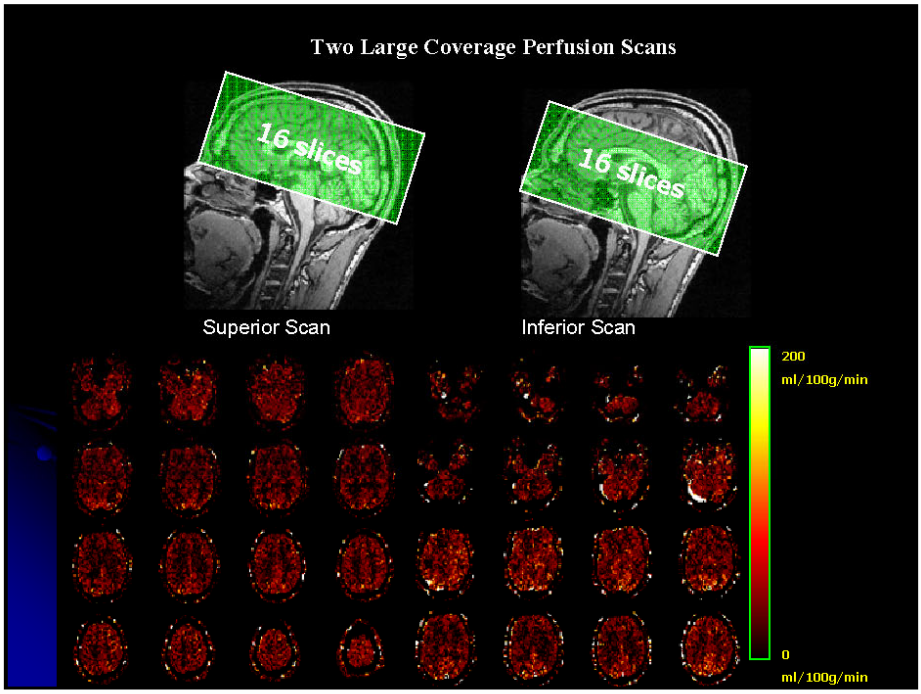
1. Check image quality for motion and other possible artifacts.

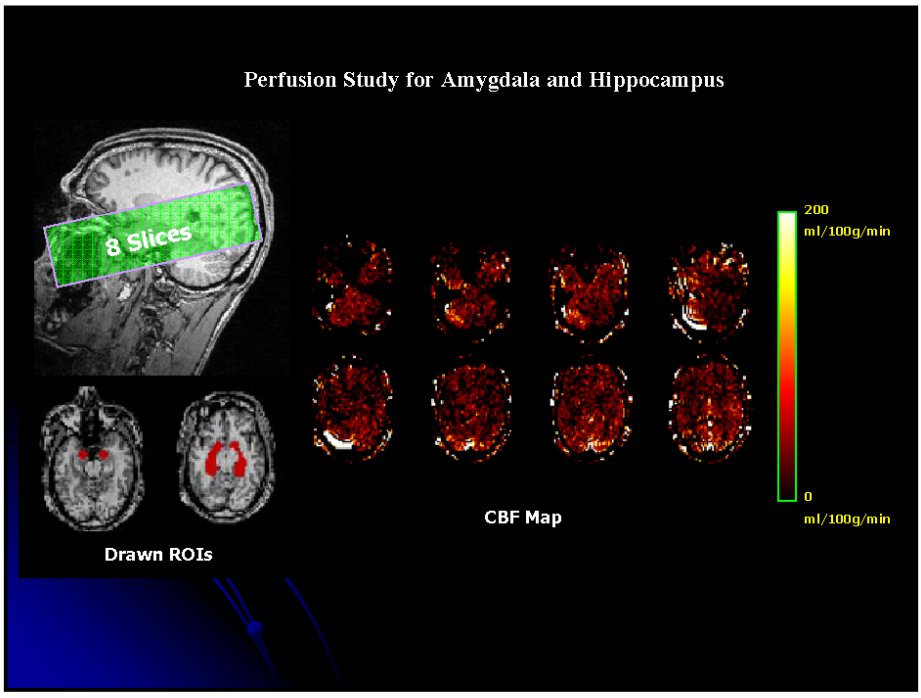
2. Pre-processed using SPM2: necessary motion correction, co-registration, segmentation, mean M0 calculation.

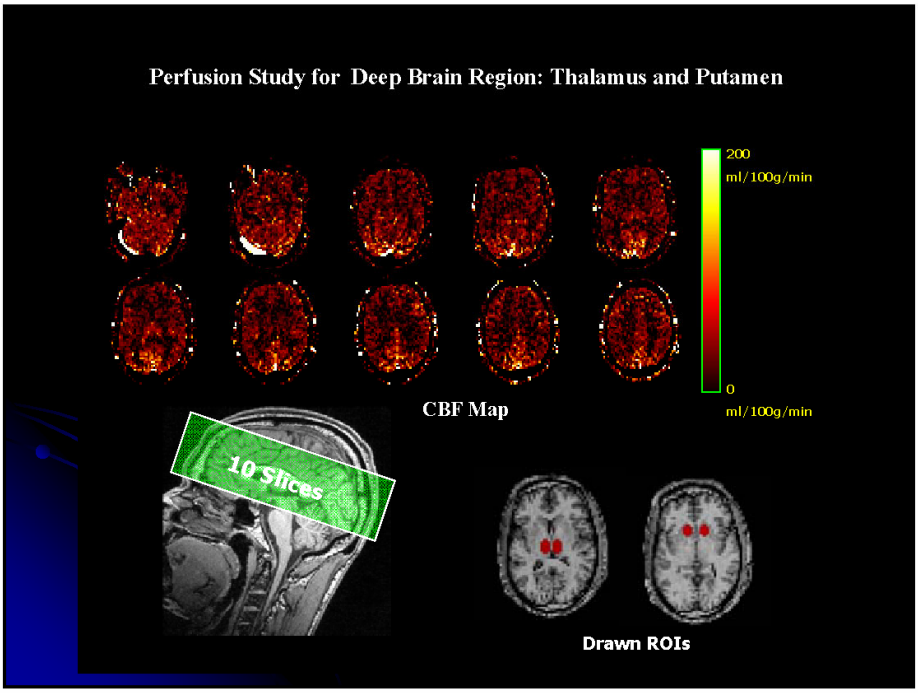
3. Analyze CBF data in original ASL image space; co-register high-resolution anatomic images to the CBF series.

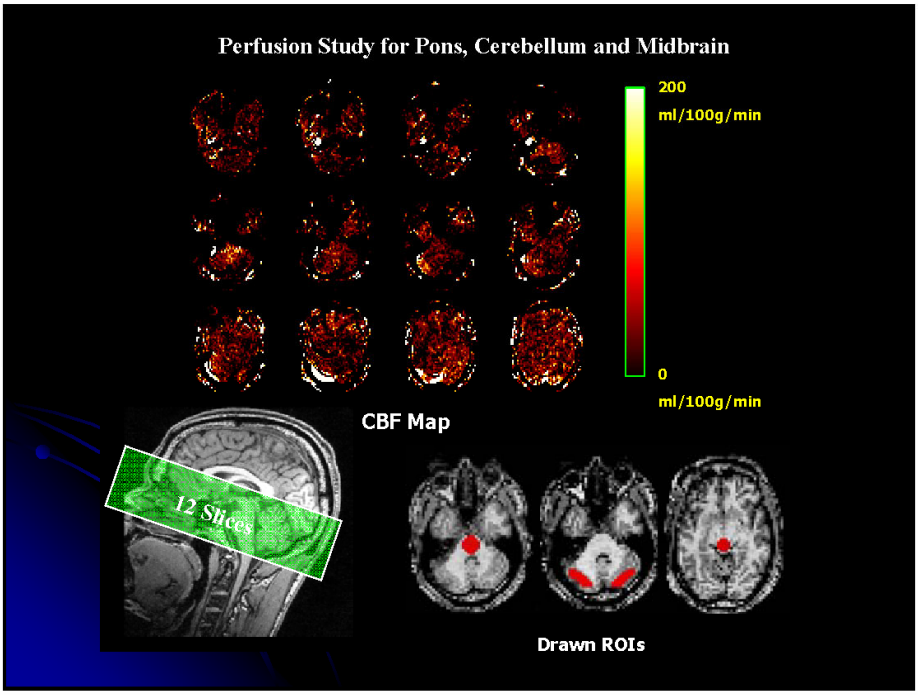
4. Generate raw CBF maps by pair-wise subtraction of label and control images followed by parameter estimation using a single-compartment perfusion model.

5. Draw ROIs manually for each brain region on the co-registered anatomic images.

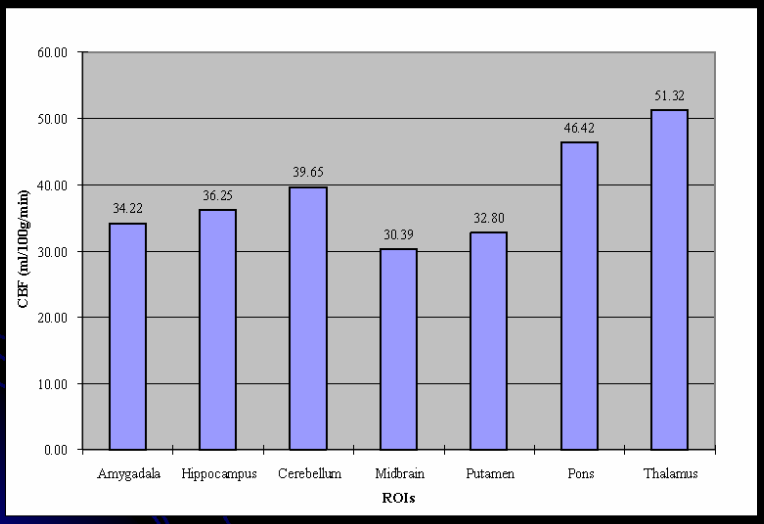

Two Large Coverage Perfusion Scans
16 slices
16 slices
Superior Scan
Inferior Scan
200
ml/100g/min
0
ml/100g/min


Perfusion Study for Amygdala and Hippocampus
8 Slices
200
ml/100g/min
0
ml/100g/min
CBF Map
Drawn ROIs


Perfusion Study for Deep Brain Region: Thalamus and Putamen
200
ml/100g/min
0
ml/100g/min
CBF Map
10 Slices
Drawn ROIs


Perfusion Study for Pons, Cerebellum and Midbrain
200
ml/100g/min
0
ml/100g/min
CBF Map
12 Slices
Drawn ROIs

Quantitative CBF Estimation



Discussion

1. EPI distortions cause slight (1-2 pixels) misregistration of perfusion and anatomic images in some regions (e.g., midbrain and amygdala).

2. The data processing is currently intensive and time consuming, about 10 hours per data set.

3. Effects on CBF of voxel size and number and position of slices need further examination.

4. Inter-subject variability of measured CBF is currently being studied.

5. Voxel-based CBF analysis is being considered.

Conclusions and Current Research

1. The protocol runs smoothly with a total time of 32 minutes.
2. The measured CBF for different ROIs from the three limited-coverage regional ASL scans appears to be robust and reliable.
3. ASL methods for higher spatial resolution and more accurate quantification of absolute rCBF are being developed.