Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2008
Lab 9- Week of 3/08

1. **Compare pulsed and pseudocontinuous ASL**. In this exercise you will compare two ASL methods for quantitative measurement of CBF: PICORE tagging with QUIPSS II; and pseudocontinuous ASL with a post labeling delay. For the four scans described below, calculate the average ASL signal (all control images minus all tag images), and compare the relative ASL signals with those predicted from theory. For each of the two tagging methods, you will acquire one data set with a short delay between the end of the tag and image acquisition, and one with a long delay. In principle, if all of the tagged blood is delivered to the image slices, you should calculate the same relative CBF from each scan.
   a. **Acquire a 3D TOF angiogram**. This should span from the nose to about one inch below the chin, and will be used to choose a tagging location.
   b. **General ASL imaging parameters**. For ASL acquisition, use spep_product in gradient echo mode, with: FOV=24cm; 5 slices 8mm skip 2mm, centered in the middle of the brain; 64x64 resolution; min TE; TR=3000. Do an autoprescan before turning the tag on so that prescan will be adjusted for maximum signal intensity, and do not do any more prescans.
   c. **Collect 2 pasl and 2 casl scans according to the Table below**. The signal equation for pasl and casl are given below. pld in the casl expression stands for post labeling delay, and is equal to (prepti-pwpcasl). Check to see that these expressions match the cartoon of relative pasl and casl signals in slide 5 of the lecture. Use as a rough approximation of M_{0b} 0.93*(Signal in CSF in Scan 0).

$$pasl : \Delta M = 2M_{0b}(TI_1)(cbf)e^{-TI/T_{1b}}$$

$$casl : \Delta M = 2M_{0b}(cbf) \int_{pld}^{pld+pwpcasl} e^{-t/T_{1b}} dt$$

Common CVs:
tagslgap -> from Angio. Gap in mm from top of tag slab to bottom of bottom imaging slice:
 Choose a tagging location where the carotids and vertebrals are relatively straight
reps -> 80   Number of images
bgs_on -> 0 This turns background suppression off
dda -> 2 Number of dummy scans for equilibration before data acquisition starts

Parameter	CV	Scan 0	Scan 1	Scan 2	Scan 3	Scan 4
Tagging type	tag	0 (reps=1)	3 (PICORE)	3	9 (PCASL)	9
QUIPSS	q	0	2	2	0	0
Start of tag	prepti	-	2200ms	1200ms	2200ms	1200ms
Tag duration(pasl)	prepti1	-	1000ms	1000ms	-	-
Tag duration(casl)	pwpcasl	-	-	-	1000ms	1000ms

Questions:
1. For each scan, calculate a map of CBF. (5 points)
2. Name at least two approximations that are implicit in the signal equations above. (2 points)
3. Which of the scans are most likely to reflect the true CBF? Why? (3 points)

2. **Combined ASL and BOLD fMRI**. In this exercise, you will collect dual echo ASL data during the performance of a functional task. Using the parameters from Scans 3 and 4 above, collect 2 functional scans with task timing 30s off - 4x(30s on, 30s off). Finger tapping will work well. For both scans, set the following 2 CVs:
   - opnecho->2 to prescribe a dual echo acquisition. This collects one minimum TE scan, followed immediately by a second scan at longer TE.
   - opte2->30ms – this sets the second echo time to 30ms

When you reconstruct this data, you will end up with 4 time series: one for each echo of each scan. To get a quick look at the data, you can look at it in afni to see the BOLD signal. Which echo should you be looking at? Recollect data if you don't see a clear activation. For each of the 4 image time series, go through the following processing steps:

a. Within afni, run the plugin a3/d3 to generate separate ASL and BOLD time series. This plugin subtracts from each image the average of the previous and the next image, creating a new time series of signal differences (the ASL signal), and it also adds to each image the average of the previous and the next image, creating a new time series with the ASL alternation removed (this can be used as a BOLD timecourse). You now have 8 time series (4 ASL and 4 BOLD).

b. From the short TE ASL data set (whichever TI looks better), look for functional activation and generate a mask for the activated ROI. Use the same mask for all data sets.

c. From each of your 8 timecourses, calculate the absolute and fractional signal increase with activation within the ROI. (3 points)

Questions (1 point each):
1. Which ASL data set gives the largest absolute activation? Why?
2. Which ASL data set give the largest fractional activation? Why?
3. Which ASL data set is most likely to reflect the true fractional CBF increase? Why?
4. Should the first or second echo be used for the ASL measurement? Why?
5. Which BOLD data set gives the largest absolute activation? Why?
6. Which BOLD data set gives the largest fractional activation? Why?
7. Should the first or second echo be used for the BOLD measurement? Why?