Continuous Arterial Spin Labeling Perfusion MRI at 7T

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Introduction

Recently, the continuous arterial spin labeling (CASL) perfusion method using a separate neck labeling coil (1-3) has attracted much attention because of its ability to provide whole brain coverage and absence of magnetization transfer effects. In addition, when coupled with receiver coil arrays, it has been shown that this method can yield high-resolution perfusion images of the human brain in reasonable scan times (4). Development of high field human MRI scanners allows further enhancement in sensitivity of ASL perfusion studies. Current work is aimed at extending the above CASL perfusion methodology to 7T field strength.

Method

Volunteers were scanned under an NIH approved IRB protocol using a 7.0 T human scanner (GE, Signa Excite) with a whole body gradients (TRM, 4.0 G/cm maximum amplitude and 150 mTm slew rate). A head, volume RF coil was used for excitation and an 8-element, brain array coil was used for signal reception (Nova Medical Co). Continuous arterial spin labeling of the blood flowing in the carotid /vertebral arteries was accomplished using a separate surface labeling coil (two 6.5 cm X 4.5 cm rectangular loops) placed on the neck. The labeling coil was connected to the second RF exciter of the scanner, an RF amplifier and an inline power meter.

Image acquisition was performed with a single shot, 2D gradient-echo EPI sequence. Arterial spin labeled images were acquired by applying RF power (4.7 W average) to the labeling coil for 3 s at an offset of approximately -20 kHz in the presence of a 0.3 G/cm gradient along the S/I direction. A post-labeling delay of 1.5 s was allowed between the labeling and the image acquisition (5 slices in 0.5 ms) periods (effective TR = 5 s). The transmit coil and the receiver coil array were detuned during the labeling period and the labeling coil was detuned during image acquisition. Arterial spin labeled and control images were acquired alternatively by turning on and off RF to the labeling coil. Images were acquired with TE of 22 ms, 3.0 mm slice thickness, 20 cm FOV, 96 X 96 matrix and a SENSE acceleration factor of 2.

Results

Figure 1 shows 7T, 2.1 X 2.1 x 3.0 mm^3, brain CASL perfusion images of a normal volunteer obtained in 8 minutes. Perfusion in the cortex is depicted with good sensitivity indicating good labeling efficiency in the carotid arteries. The difference signal in the gray matter was ~1.4 % of the control image intensity in two subjects. No signal difference between control and label images were observed when the labeling RF offset was changed to a positive value indicating that perfusion signal seen in Fig 1 is not contaminated by other effects.

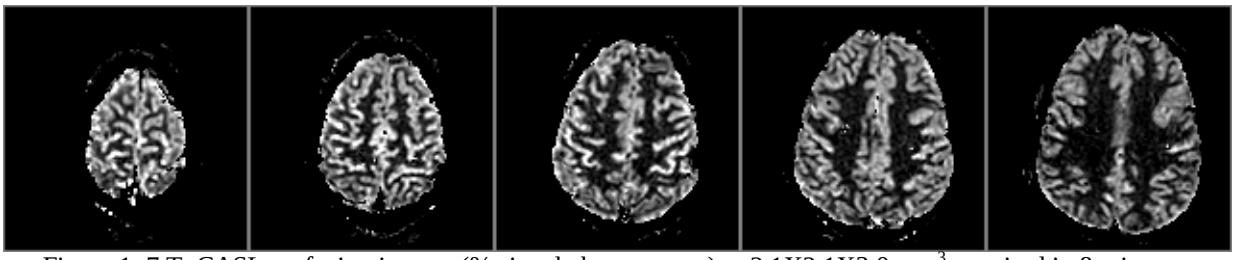

Figure 1: 7 T, CASL perfusion images (% signal change maps) at 2.1X2.1X3.0 mm^3 acquired in 8 minutes.

Discussion

Results shown above demonstrate that it is possible to perform CASL perfusion imaging of humans at 7 T. These preliminary results show an increased signal change due to labeling compared to lower field strength probably due to longer T1 at high field. Further optimization of the labeling efficiency and homogeneity will allow high-resolution, whole brain CASL perfusion imaging at 7T.

References

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