Perfusion Imaging with FAIR Turboprop

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Introduction:

Arterial spin labelling has been demonstrated as a way to achieve both quantitative and perfusion-weighted images in the brain[1,2]. Here, we demonstrate the use of an arterial spin labelling method with a multi-shot imaging technique, Turboprop [3] with an inherent ability to improve spatial resolution, off-resonance behavior and correct for patient motion.

Methods:

Pulse Sequence Generally, one-shot pulse sequences like echo-planar or spiral imaging have been widely used but require many repetitions to accumulate a sufficient signal-to-noise ratio. If necessary, each repeated image can be individually corrected for patient motion before subtracting flow sensitive and reference images. Multi-shot sequences are thought to be too sensitive to motion. However, the "Turboprop" [3] imaging sequence offers the ability to correct for head motion by exploiting the repeated sampling of the central region of k-space in each "blade" of the propeller. A fast spin echo sequence is used to increase the number of lines of k-space acquired per excitation pulse. Multiple gradients are generated from each spin echo to further increase the number of lines acquired in k-space and are dubbed the turbo factor. With a turbo factor of 5 and an echo train length of 8, 40 lines of k-space are collected in a pair of orthogonal blades. The number of blades collected is independently controllable by an oversampling factor and the field of view.

Perfusion Sensitivity The Turboprop pulse sequence was made sensitive to cerebral blood flow (CBF) with a "flow-sensitive alternating inversion recovery" (FAIR) preparation sequence[2]. Frequency Offset Corrected Inversion (FOCI) adiabatic RF pulses[4] were used because of their sharp slice profiles. Suppression of background static tissue can be achieved through the use of the "Attenuating Static Signal in Arterial Spin Tagging" (ASSIST) pulse sequence[5].

Results:

FAIR arterial spin tagging perfusion images with the Turboprop pulse sequence were acquired and images are shown in Figure 1. A lower slice is shown in Figure 2 where spiral-FAIR has significant off-resonance geometric distortion.

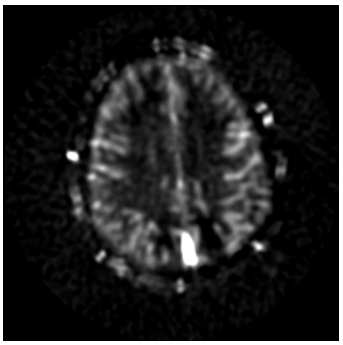

Figure 1. Turboprop FAIR

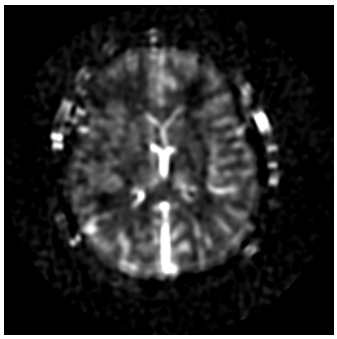

Figure 2. Turboprop FAIR Low slice with susceptibility variations.

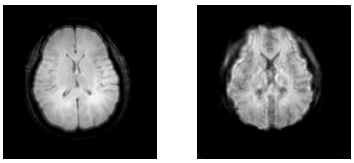

Figure 3. Unsubtracted FAIR Images. Turboprop images show negligible off-resonance distortion where spiral images show significant geometric distortion.

Discussion and Conclusion:

The quality of perfusion measurements in the brain can be affected by off-resonance and patient motion. The use of a multi-shot pulse sequence like "Turboprop" allows the collection of perfusion weighted images even in the presence of significant magnetic field inhomogeneity.

1. Detre JA, Leigh JS, Williams DS, Koretsky AP. Magn. Reson. Med. 1992;23 37-45
2. Kim SG. Magn. Reson. Med. 1995:34 293-301
3. Pipe JG. ISMRM Book of Abstracts. 2002
4. Ordidge RJ, Wylezinska M, Hugg JW, Butterworth E,Franconi F. Magn. Reson. Med. 1996;36 562-566
5. Ye FQ, Frank JA, Weinderger DR, McLaughlin AC. Magn. Reson. Med. 2000;44 515-522
6. Pipe JG. Magn. Reson. Med. 1999:42 963-969
7. Pipe JG, Farthing VG, Forbes KP. Magn. Reson. Med. 2002;47 42-52