Quantitative Perfusion Imaging Using Q2TIPS-FAIR PROPELLER EPI

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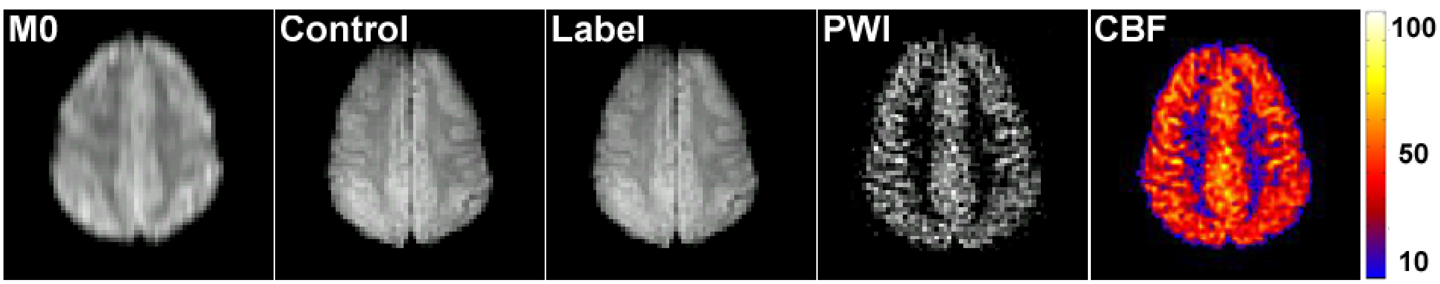
Introduction: Arterial spin labeling (ASL) is a powerful and repeatable MRI technique that allows quantitative measurement of brain perfusion. In this study, we show that the pulsed ASL method can be incorporated with PROPELLER EPI [1, 2] to produce quantitative CBF maps.

Materials and Methods: Each PROPELLER blade can be corrected for motion individually before the subtraction of the control and the label images. A PROPELLER blade with less phase encoding than a normal Cartesian acquisition is less susceptible to magnetic field inhomogeneity and allows for shorter TE, which is essential to the perfusion sensitivity. The perfusion sequence was carried out by Q2TIPS [3] – FAIR [4] with single shot gradient echo PROPELLER EPI. Images were acquired from a healthy female volunteer after informed consent on a GE 1.5T (Twinspeed, GE Medical Systems, Milwaukee, Wisconsin) scanner with a neurovascular receive only head coil. The phase field of view (FOV) was two times larger than the frequency FOV. This allowed the odd and even lines to be reconstructed separately to eliminate Nyquist ghosts for each blade. Each blade had an echo train length of 64, hence 32 phase lines after combining odd and even encodings. The image matrix size was 128 x 128 with a FOV of 320 mm. A total of 64 blades with rotation angles uniformly distributed across 0 to 180 degrees were acquired for each control and label image. Other parameters of interest were TE=32ms, TI1=800ms, TI1s=1200ms, TI2=2000ms, TR=3000ms, b=5.25 mm^2/sec, slice thickness=8mm, number of slices=5. Total acquisition time was 6:30 seconds. After the control and label images were reconstructed with the PROPELLER reconstruction algorithm [1], they were subtracted to generate the perfusion weighted image. A low resolution proton density image was acquired with a single PROPELLER blade at 0 degrees at the beginning of the sequence as the spins were achieving steady state. The signal intensity of white matter was manually measured. With this additional information and assuming that the T1 of blood and T1 of grey matter are equal, the perfusion weighted image was scaled to produce a quantitative cerebral perfusion map.



Results: Example of acquired images and calculated relative and quantitative perfusion maps is illustrated above. The low resolution proton density image reconstructed from a single PROPELLER blade at 0 degrees (labeled M0 on Figure) is used for CBF quantification. The final PROPELLER reconstructed Control and Label images are subtracted to produce a perfusion weighted image (PWI). This perfusion weighted image is then scaled by the M0 of white matter as described in [3] to produce a quantitative CBF map displayed as a color map in units of ml blood / 100 grams tissue / minute.

Discussion and Conclusion: An advantage of PROPELLER is that it is less sensitive to subject motion. In addition, PROPELLER has shorter TEs and faster imaging times per slice compared to conventional EPI, both of which are essential for improving perfusion SNR and slice coverage. A disadvantage of PROPELLER is that it is susceptible to off-resonance effects that vary from blade to blade causing slight blurring at the edges. In conclusion, PROPELLER is an advanced imaging technique that can be combined with ASL methods to yield quantitative CBF maps with improved image quality.

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References

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