MB-EPI PCASL

Release Notes for Version 1.0

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Driven to Discover℠

Background

High-resolution arterial spin labeling (ASL) imaging is highly desirable in both neuroscience research and clinical applications to reduce partial volume effects on gray matter (GM) and white matter (WM) cerebral blood flow (CBF) quantification, to improve the ability to assess perfusion abnormality in sub-cortical brain structures, e.g. the hippocampus, and to identify small brain lesions. Decreased perfusion SNR for high-resolution imaging is a consequence of multiple factors including; 1) increased in-plane resolution, 2) increased through-plane resolution and 3) the need for more slices to cover the same volume resulting in prolonged delay times between labeling and signal acquisition during which labeled spins experience longitudinal relaxation. The necessity of increasing the number of label/control image pairs for sufficient perfusion SNR greatly increases the total imaging acquisition time, limiting the practice of acquiring high-resolution whole brain ASL perfusion data using traditional 2D echo planar imaging method (or called single-band (SB) EPI). To overcome such challenges, different strategies have been previously proposed to increase perfusion SNR of ASL methods: using pulsed- or pseudo-continuous arterial spin labeling (PCASL) coil and 3D imaging acquisition.

Multi-band imaging, or simultaneous multi-slice imaging, provides an attractive and alternative solution to reduce the total acquisition time of high-resolution whole brain imaging with 2D EPI, especially when increased spatial or temporal resolution is desired. Recently theoretical and experimental evaluation of MB-EPI for PCASL imaging [1] indicates that

- MB leakage contamination has minimal impact on CBF quantification in PCASL

imaging

- MB improves SNR efficiency for high-resolution PCASL imaging using 2D EPI
- MB-EPI better supports the single-blood compartment model for CBF quantitation

In contrast to 3D imaging methods, MB-EPI does not suffer adverse within and across slice T_2 blurring.

Installation

The zip package includes several files for MB-EPI PCASL sequence, and these files should be copied into specific directories. The following table and the directions used in the zip package reflect the installation folders for these files. The "TARGET_DRIVE" refers to the drive that has installed Siemens system on the console computer, and is typically "C". In addition, a default protocol for MB-EPI_PCASL_C2P.edx file is provided within the zip package. This protocol can be imported by selecting Exam Explore => USER => Object => Import => Select MB-EPI_PCASL_C2P.edx. The imported protocol will be created under a specific examination protocol folder as shown in Figure 1. Users can also setup their own protocols in Exam Explorer after creating a new protocol by selecting Insert Sequence, USER, then XFL_CMRR_VB17_MB_EPI_PCASL_C2P.

Table 1. MB-EPI PCASL files and their installation directories.

File Name	Location
XFL_CMRR_MB_EPI_PCASL_extrf.dat	TARGET_DRIVE:/MedCom/MriSiteData/measurement
XFL_CMRR_VB17_MB_EPI_PCASL_C2P.dll *and* XFL_CMRR_VB17_MB_EPI_PCASL_C2P.i86	TARGET_DRIVE:/MedCom/MriCustomer/seq
libIceMultiBand.so	TARGET_DRIVE:/MedCom/MCIR/Med/lib
IceMultiBand.dll *and* IceMultiBand.evp	TARGET_DRIVE:/MedCom/bin

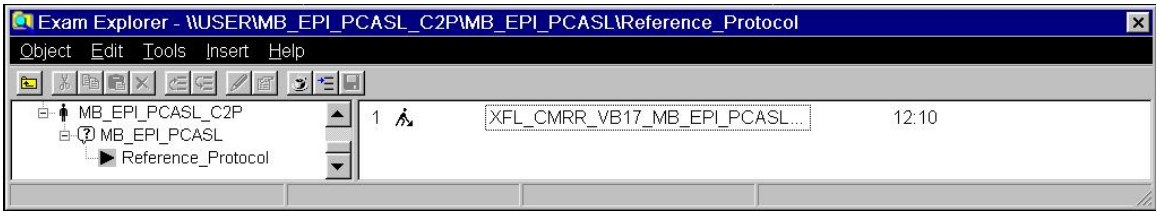

Figure 1. Imported protocol in Exam Explore.

Usage

The position of imaging slices and shimming volume are illustrated in Figure 2 for MB-EPI PCASL imaging. Please refer to the provided reference for detailed information.

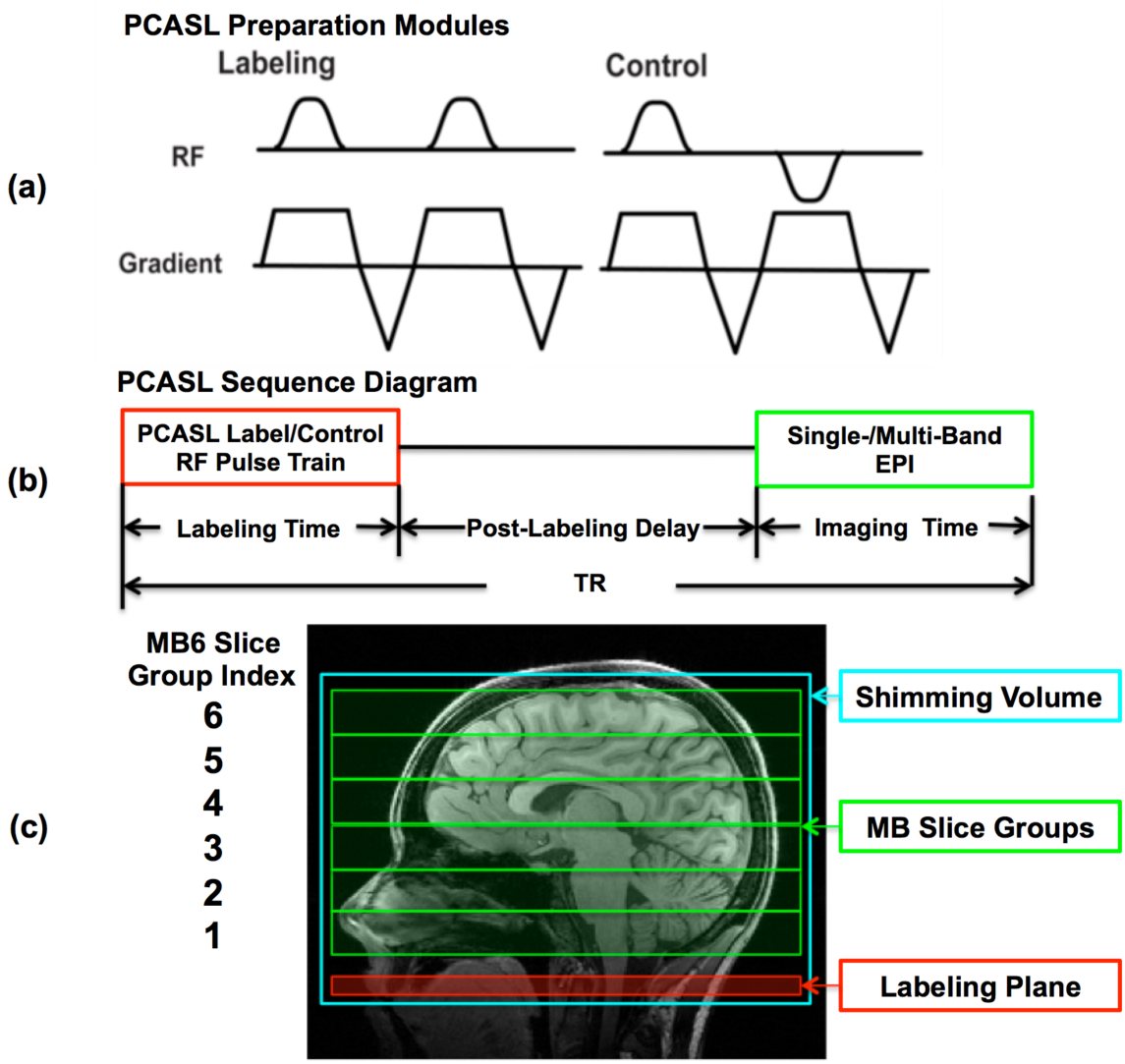

Figure 2. MB-EPI PCASL imaging sequence diagram and positions of imaging slices and shimming volumes.

UI parameters specific to MB-EPI PCASL are located in the Sequence/Special card, and each UI parameter has its own tooltip (Figure 3). When PCASL preparation module is turned off, only MB-EPI BOLD images will be collected.

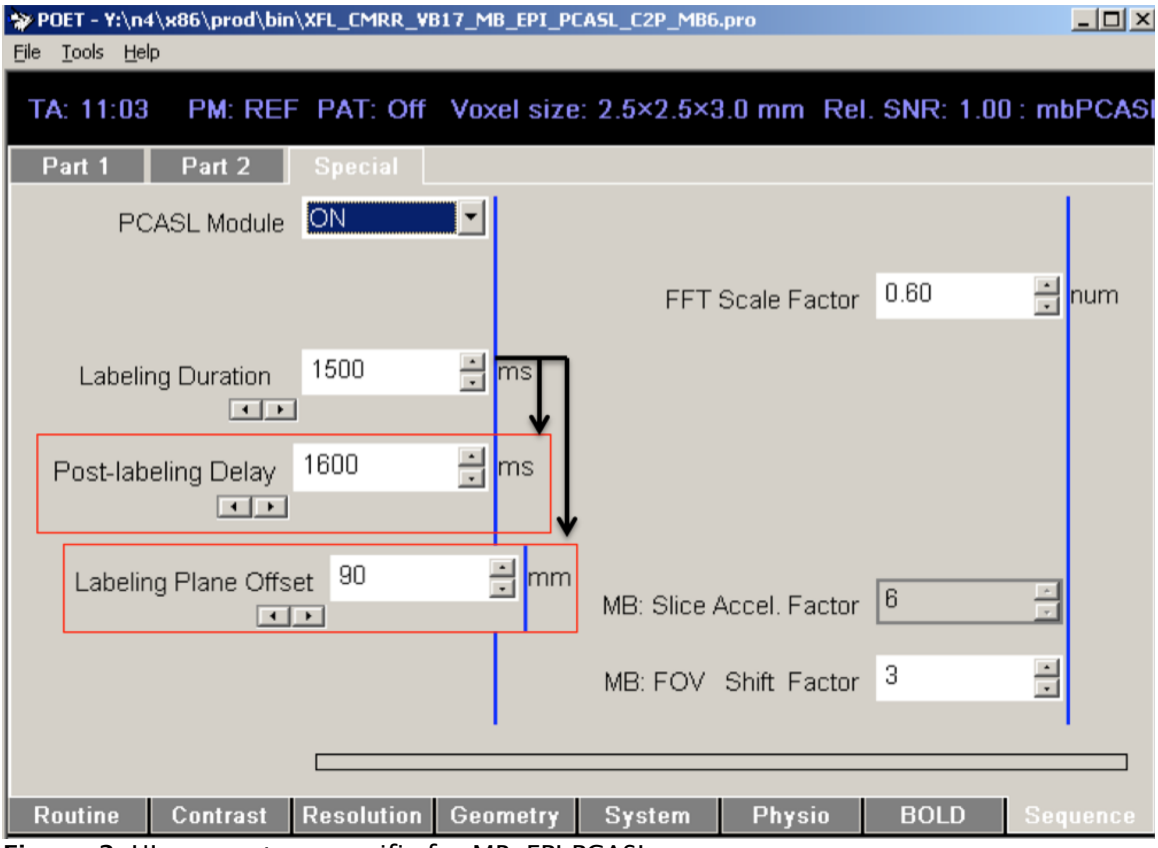

Figure 3. UI parameters specific for MB-EPI PCASL.

To avoid errors in MB-EPI PCASL imaging protocol preparation or modification, some EPI parameters have been specifically customized. For example, parallel imaging has been disabled to avoid excessive ghosting artifacts, and strong fat saturation and ascending slice acquisition order are mandatory.

The implemented MB-EPI PCASL sequence acquires two M0 images after label/control images series. The mean image of these two M0 images can be used for CBF quantification.

Known Issues

The displayed/calculated total imaging time is about 1 to 2 minutes longer than that actually needed (depending on the applied MB factor), which will be fixed in the future version.

References

Please refer to the following article when you report your studies using this C2P sequence:

1. Li X, Wang D, Auerbach EJ, Moeller S, Ugurbil K, et al. (2015) Theoretical and experimental evaluation of multi-band EPI for high-resolution whole brain PCASL Imaging. Neuroimage 106: 170-181.