Appendix E1

As referenced in the methods section, the IR LL EPI scans are used to obtain estimates of T1 changes on a single section containing normal white matter (WM) before and after the injection of a T1-shortening contrast agent. These estimates are then used to calculate cerebral blood volume (CBV) as a change in T1 of WM per unit change to the T1 change of the blood pool. This value of CBV is referred to as the "steady-state" value of CBV, as it is not calculated from the first pass of the contrast agent but is derived for the postinjection T1 values of WM during the distribution phase of the contrast agent (16,17):

$$CBV_{SS}(\text{mL/100 g}) = WCF(\Delta R1_{Blood}) \cdot \frac{1}{\rho} \cdot \frac{1\text{-}Hct_{LV}}{1\text{-}Hct_{SV}} \cdot \frac{(1/T_1^{Post} - 1/T_1^{Pre})_{WM}}{(1/T_1^{Post} - 1/T_1^{Pre})_{Blood}}, \quad (2)$$

where T_1^{Pre} and T_1^{Post} are T1 values before and after contrast agent injection, $WCF(\Delta R1)$ is the water correction factor determined from the change in $1/T_1$ ($\Delta R1$) of blood following contrast agent injection, ρ is the average density of a brain voxel (1.04 mL/g), and Hct_{LV} and Hct_{SV} are the hematocrit levels in large and small vessels, respectively. The WCF corrects for the effects of contrast agent compartmentalization by accounting for the intra- to extravascular exchange of water in the capillary bed. The derivation is beyond the scope of this article and the interested reader is referred to the work of Shin et al (14), Hazelwood et al (36), and Donahue et al (37).

This approach produces a patient-specific calibration factor that assigns quantitative values of perfusion to the rCBV and rCBF images given by:

$$CF = < CBV_{SS} > / < rCBV >,$$

where $<CBV_{SS}>$ is the mean parenchymal white matter value of CBV_{SS} in a large region of interest and <rCBV> is the mean value of the relative CBV in the same region. Quantitative CBF (qCBF) in mL/100 g/min is calculated as:

$$qCBF = CF \times rCBF,$$

where rCBVand rCBF are relative CBV and CBF values as calculated from DSC MR imaging.

References

36. Hazlewood CF, Chang DC, Nichols BL, Woessner DE. Nuclear magnetic resonance transverse relaxation times of water protons in skeletal muscle. Biophys J 1974;14(8):583–606.

37. Donahue KM, Weisskoff RM, Chesler DA, et al. Improving MR quantification of regional blood volume with intravascular T1 contrast agents: accuracy, precision, and water exchange. Magn Reson Med 1996;36(6):858–867.