Cerebral Blood Volume Imaging using DANTE-based Flow Suppression

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Target audience: MR engineers, basic and clinical neuroimaging researchers.

Introduction. Non-invasively measuring cerebral blood volume (CBV) is difficult due to the incapability of separating tissue signal from signal of both arterial and venous blood. DANTE (Delays Alternating with Nutation for Tailored Excitation) pulse trains are a series of short low flip angle RF pulses separated with gradients. Depending on how the gradients are applied, DANTE can be used for spatial tagging or flowing spins suppressing. Recent work has demonstrated that DANTE can substantially suppress spins flowing along the applied gradient direction with a wide range of velocities, while signal of static tissue/fluid is mostly preserved [1]. Therefore, an MRI-based noninvasive CBV measurement can be achieved by using DANTE to suppress both arterial and venous blood signal before imaging the brain. This study was to assess that possibility.

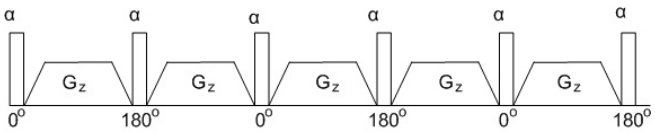
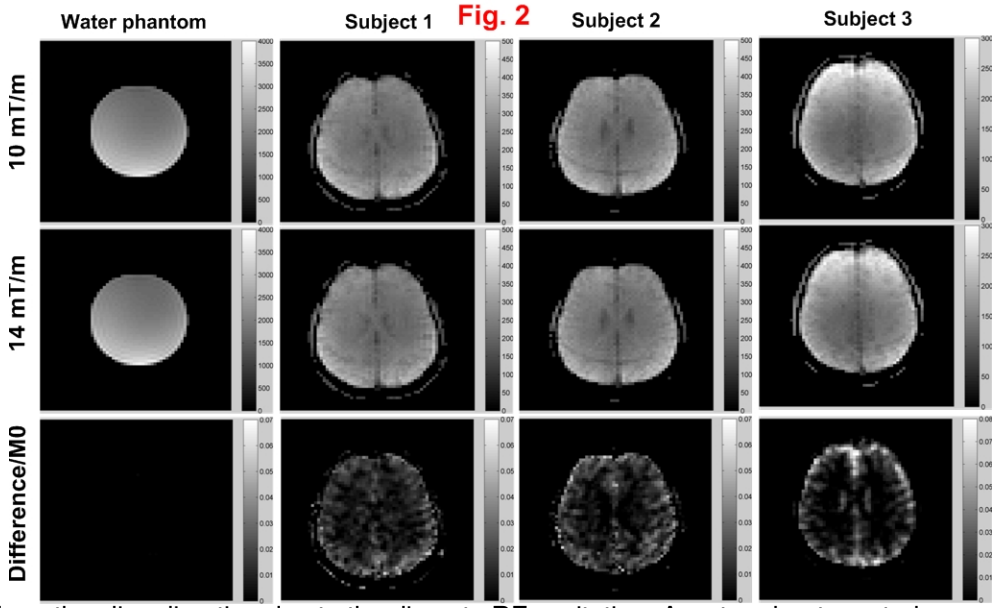


Fig. 1 DANTE preparation sequence.

Materials and Methods.

The DANTE preparation sequence (Fig. 1) was implemented with a hard pulse (duration=100us) train and trapezoidal gradients (ramp up/flat top time=100/350us). Gradient echo-based EPI readout was used for data acquisition. To differentiate static tissue signal from blood signal, DANTE pulses with the same inter-pulse duration but with different gradient magnitudes (10mT/m and 14mT/m) were used to acquire 2 image series. Image acquisition parameters were: FOV=220x220 mm, slice thickness=5mm, 1 slice, image matrix=64x64, bandwidth=2046 Hz/pixel. To get the same tissue signal, the gradients were chosen to have the same number of image intensity banding due to the magnetization modulation along the slice direction due to the discrete RF excitation. A water phantom study was performed to confirm that the two DANTE gradient amplitudes produced nearly identical image intensity (Fig. 2, the leftmost column). Three healthy volunteers were scanned with IRB approvals and signed consent forms. For each subject, 3 image series were acquired using the same DANTE RF trains (flip angle=7°) but with 3 different gradient amplitudes: 0, 10, 14 mT/m. Water phantom, subject 1 and 2 were scanned with an 8-channel; subject 3 was scanned using a 32 channel coil. 30 images were acquired for each scan. CBV weighted signal was extracted from the difference between the images acquired with 10mT/m and 14mT/m. Image intensity from the deep white matter was extracted from the DANTE images without inter-RF gradients (0 mT/m), which was subsequently used as a calibration scale for converting the CBV weighted difference into a ratio map (dividing the difference by the scale).



Results and Discussion.

CBV measuring results for the 3 subjects were shown in the right 3 columns of Fig. 2. The approximate CBV values in grey matter (GM) /white matter (WM) were about 5.6%/3% for subject 1 and 2, respectively. They were 6.8%/2% for subject 3. Although these values are in the reasonable range reported in the literature, getting quantitative CBV values will need precise information about how much signal loss has occurred due to the 2 different gradients applied, which will be addressed in the ongoing study.

In conclusion, we reported preliminary results of using DANTE-based flow-suppression for measuring CBV. The results showed reasonable CBV approximations and CBV contrast between GM and WM, suggesting DANTE as a potentially useful tool for measuring at least the CBV weighted signal.

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Reference [1]. Li et al, MRM, 2012, 68(5):1423-38.