Mitigation of Transmit Crosstalk in Multiple-Mouse MRI

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Introduction Transmit crosstalk is less of a problem in multiple-mouse imaging compared to transmit-SENSE [1] because coil-coil isolation is typically better than 20 dBr. When magnetization preparation pulses are considered however, there may be complications. For example, arterial spin-labeling is an important method for physiological investigation in MRI. In multiple mouse applications, we have observed that transmit crosstalk during ASL labeling can generate an artifact in the difference images, which have lower SNR than the raw imaging data. In this abstract we demonstrate the use of amplitude modulation [2,3,4] to cancel out this crosstalk and produce an improved result in phantoms.

Background With an intrinsic isolation between RF probes > 40 dBr (Varian/Agilent Millipede), receive crosstalk is usually hidden below the noise level after 3D spatial encoding, and transmit crosstalk during the imaging RF pulses has no significant effect on flip angles. In typical continuous-ASL application, the power required to achieve velocity-dependent adiabatic inversion is much lower than for the imaging excitation pulses but the duration is longer. In the form of a 1D selective pulse, the crosstalk field can cause saturation in static spins in a localized plane.

In a trans-axial labeling experiment, the ASL labeling planes would remain outside the imaged FOV of all mutually coupled coils, potentially overlapping but contributing no significant error due to the adiabatic labeling condition. In an oblique labeling orientation that optimizes inversion efficiency however, the crosstalk artifact is potentially visualized within the imaged FOV of some samples depending on the sample/coil distribution in the oblique gradient field.

The crosstalk field is resolved in frequency along the oblique labeling axis so it can be independently suppressed. In the case of ASL, where the labeling pulse is played at different frequencies in each coil, suppression corresponds to adding sidebands to each labelling pulse that cancel the unwanted frequencies from the adjacent coils. The necessary frequency is established from the known positions of the ASL labeling planes.

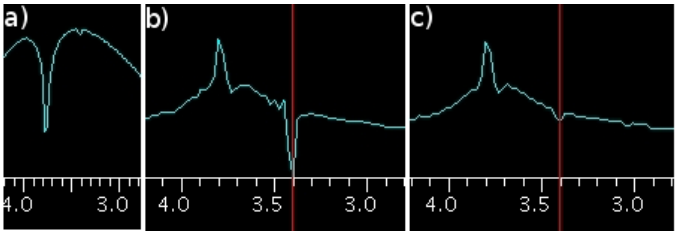

Figure 1: Prescan profile (cm) for sample 1, showing transmit crosstalk from coil 2 at 3.4 cm (a) and with background subtraction (b). With modulation, the artifact is greatly reduced (c).

Methods A prescan module was added to a 3D multiple-mouse ASL protocol. This module acquires a one-dimensional profile of the object along the slice select axis at the oblique ASL angle, thus depicting the amplitude of the cross-talk artifact alongside the nominal labeling plane. Two phantoms were prepared, sample 1 positioned at the XYZ origin (0,0,0) and sample 2 offset in the Z=0 plane at (-2.5,4.3,0) cm. The ASL labeling angle was theta=10 degrees. A 3D scan was performed in the sagittal orientation and the resulting artifact compared.

Results In figure 1a, the prescan profile of sample 1 shows a crosstalk artifact at position 3.4 cm while the actual labeling plane is seen as the larger dip at 3.7 cm. Figure 1b shows the same data with the background subtracted. In figure 1c, the same subtraction profile is shown with amplitude modulation term of 0.9% at 180 degrees phase and virtual elimination of the artifact. In figure 2, 3D imaging results in a water phantom show the artifact (a) and reduced by modulation (b, c=a-b). The horizontal line profiles in (a,b) are shown in (d,e) indicating substantial reduction of artifact.

Conclusions We have demonstrated that amplitude modulation of the ASL labelling pulse can cancel out the transmit crosstalk artifact from adjacent coils in multiple-sample applications. Automation of the method as suggested in [4] is needed to make it useful in a day-to-day scanning routine.

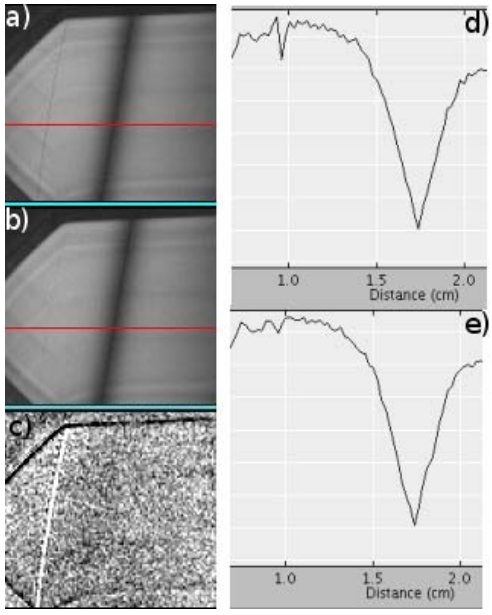

Figure 2: 3D imaging result showing crosstalk artifact to the left of the main band (a), and reduced with modulation (b). The subtraction (a)-(b) is shown in (c). Horizontal line profiles in (a,b) are shown in (d,e) indicating significant reduction of artifact at position 1.0 cm.

References

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