

Dual Echo Dynamic MRI using Dy- micelles and Gd-DTPA as a contrast agent

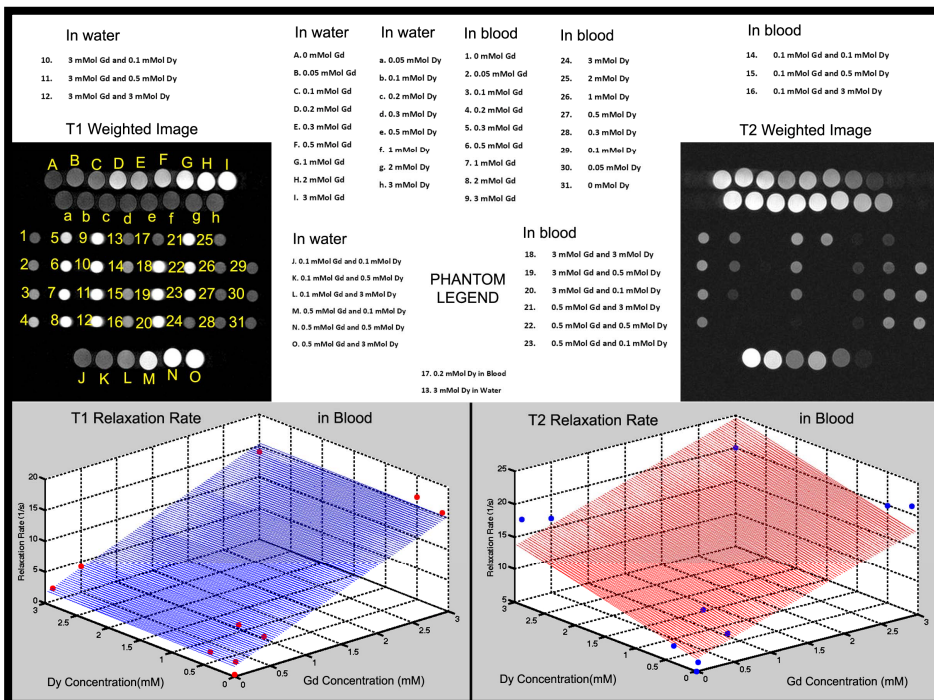
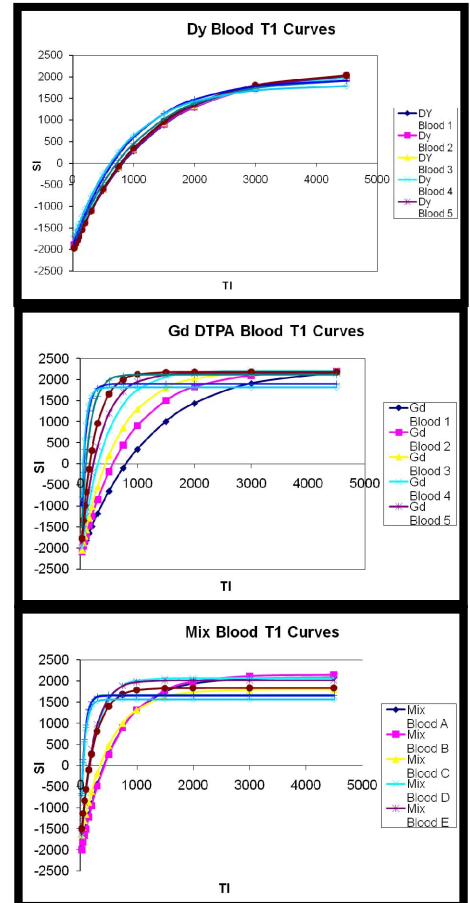
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Introduction: Dynamic contrast enhanced MRI can examine tissue vascularization but cannot distinguish between perfusion and permeability effects. By injecting Gd-DTPA (extravascular contrast agent) concurrently with Dy-micelles (intravascular within the imaging time frame) and imaging them at different echo times, it might be possible to estimate both perfusion and permeability parameters simultaneously. The contrast agent with higher R1/R2 ratio (Gd) would primarily influence signal intensity in short echoes, while the contrast agent with very low R1/R2 ratio (Dy) would have limited effect on the signal intensity in the short echo while still affecting longer echoes, thereby potentially allowing dissection of different vascular properties of tissues. To evaluate feasibility of this approach, we tested relaxation properties of a mixture of different concentrations of Gd-DTPA and Dy-micelles in water and blood.

Methods: Dy-DTPA-bis(stearyl amid) was integrated into PEG-DSPE micelles using thin film techniques to produce Dy-micelles. Phantoms containing Gd-DTPA and Dy-micelles (0.1 mMol to 3 mMol concentrations) and a mixture of both Gd –DTPA and Dy-micelles in water and in blood were imaged on a 1.5T MR system (Figure below). T1 and T2 maps were obtained using inversion recovery and multi echo spin echo techniques. Dynamic images (5 second temporal resolution) were then acquired using a double echo TSE sequence.

Results: The Dy-micelles did not have any effect of the T1 relaxation rates as shown in the figures on the right. Additionally, it was possible to dissect the effects of the contributions of Gd-DTPA and Dy-micelles to both the T1 and T2 relaxation rates. **The contributions of Gd-DTPA and Dy-micelles to T1 and T2 rates were empirically determined to be linearly additive in both blood and water.** The figure below shows a



fitting plane drawn through T1 and T2 rate maps for the mix of Gd-DTPA and Dy-micelles.

Discussion: It may be possible to optimize the dose of Gd-DTPA and Dy-micelles to be used for in vivo imaging based on the results of this current study. Low concentrations of Gd-DTPA (<0.1 mMol) and high concentrations of Dy- micelles (>3 mMol) will probably be required to discern the specific contributions of vascular permeability and perfusion to the observed MR signal intensities on the double echo TSE sequence.

Conclusions: The combination of Gd-DTPA and Dy-micelles may serve as an effective contrast agent for dynamic imaging using MRI.