AbstractID: 10774 Title: Development of multi-parametric molecular imager by integrating Overhauser-enhanced MRI (OMRI) with prepolarized MRI (PMRI)

Purpose:
To develop a multi-parametric molecular imager to assess tumor hypoxia and redox status by integrating Overhauser-enhanced MRI (OMRI) with prepolarized MRI (PMRI).
Method and Materials:
PMRI system acquires anatomic MR images comparable to conventional MRI. With a moderate hardware augmentation of the PMRI, we implemented field-cycled OMRI and obtained electron paramagnetic resonance (EPR) images of nitroxide spin probes. Phantoms were made of 2-cc tubes filled with pure water, <5-mM solutions of 3-carbamoyl-PROXYL. A custom MRI console was used to insert 25-W EPR radiofrequency (RF) pulses that enhanced NMR signal of the coupled water protons. A saddle coil (3.5 cm diameter, 2.5 cm length) tuned to 186 MHz was used as the EPR irradiator. To elicit the Overhauser effect, each NMR RF pulse (2.23 MHz) was preceded by the EPR RF pulse during a low field-cycled interval. Free induction decay (FID) was observed at the EPR B_0 swept from 4.2 mT to 9.5 mT. For OMRI, the low-field cycle was fixed at 4.8 mT to exploit the low-frequency hyperfine peak of the nitroxide. Generic gradient-echo 0.05-T MR images were obtained with either prepolarization or Overhauser enhancement.
Results:
FID acquisition of a 2.5-mM nitroxide phantom identified three hyperfine lines of ^{14}N at 4.8, 6.2 and 8.1 mT. Each peak represented an enhancement factor of 13 with 300-ms EPR RF pulse. Increasing enhancements were observed with longer durations of EPR irradiation, which indicated 0.71-s T_1 of the phantom. We observed similar intensities of water and <5-mM nitroxide solutions from 0.15-T PMRI. The OMRI showed characteristic EPR intensities and clearly separated the 2.5-mM and 5-mM nitroxide phantoms from the water phantom.
Conclusion:
The integrated OMRI-PMRI system demonstrated sensitivity to both EPR and NMR. The imager can potentially acquire physiological information in small animals accurately co-registered with high-quality anatomic NMR images.