AbstractID: 13410 Title: Advancing an integrated Overhauser-enhanced MRI (OMRI) - prepolarized MRI (PMRI) system toward quantitative longitudinal studies of tumor hypoxia and redox status

Purpose:
To advance the imaging performance of an integrated Overhauser-enhanced MRI (OMRI) - prepolarized MRI (PMRI) system to enable quantitative longitudinal imaging studies of multi-faceted tumor environment by using both electron paramagnetic resonance (EPR) and nuclear magnetic resonance (NMR)

Method and Materials:
A field-cycled OMRI-PMRI system was further developed to achieve the sensitivity that identifies radiobiological hypoxia and redox status. A dedicated 5-cm saddle coil delivered 154-MHz EPR radiofrequency (RF) pulses to induce the Overhauser effect with a high EPR B_1 efficiency. A 3-cm 5.5-MHz NMR Litz-wire saddle coil concentric to the EPR coil achieved high signal-to-noise ratio with an efficient filling factor. B_0 was at 5 mT, 0.13 T, 0.5 T for EPR irradiation, NMR readout, NMR prepolarization respectively. Gradient echo and multi-spin echo pulse sequences were implemented using a custom MRI console to acquire images with minimal phase distortion. Trityl phantoms were prepared under normoxic and anoxic environment for pO_2 calibration. Various amounts of ascorbic acid (AsA) were injected to the mixtures of trityl and nitroxide (3-carbamoyl PROXYL) phantoms to characterize the redox sensitivity.

Results:
Oxygen resolution of 4.1 torr and 3.5 torr were obtained from 4-min double power (0.3, 32 W) spin-echo OMRI (TR/TE 1600/30 ms) for pure deoxygenated 1-mM and 2-mM trityl phantoms. Trityl radicals were not reduced by AsA, and did not alter the reduction decay rate of the nitroxides (-0.07/min, -0.13/min for 5, 10-mM AsA). Saturation factor measurements at various EPR RF power levels indicated a feasibility of accurate pO_2 calibration for the mixtures of trityl and nitroxide radicals.

Conclusion:
Our OMRI-PMRI system is capable of multi-parametric imaging sensitive to pO_2, redox status, proton T1 and T2. The imager is ready to acquire physiological information in small animals accurately co-registered with diagnostic quality anatomic NMR images.