AbstractID: 1644 Title: Temperature dependence of nuclear magnetization and relaxation

Magnetic resonance imaging may be used to monitor changes in tissue induced by heating. We review and demonstrate experimentally the temperature dependence of the equilibrium nuclear magnetization and relaxation to account for thermally induced contrast relevant to clinical applications of hyperthermia. Using conventional spin-echo sequences, the temperature dependences of equilibrium nuclear magnetization and relaxation times must each be considered to quantify the effects of temperature on MRI signals. The temperature dependence of equilibrium magnetization is negative for substances through Boltzmann's relation, so the overall temperature dependence of signal observed can be negative, weak or positive depending on the temperature dependence of the longitudinal and transverse relaxation times (T_1 and T_2), echo time (T_E) and the recovery time (T_R) in a pulse sequence. The temperature dependence of the signal is illustrated with H_2O-D_2O mixtures in which the nuclear density and relaxation times vary. For thermal contrast, to interpret the variations measured in NMR signals, it is necessary to analyze the effects of temperature on each of several parameters for each pulse sequence. In thermal imaging, these relations are important especially when attempts are made to measure the change in NMR signal using only a few echoes near the critical decay time where signal shows weak temperature dependence. Therefore, echo times much smaller ($t<<t_0$) or much larger ($t>>t_0$) than the critical decay time are necessary to observe a significant temperature dependence of the signal. The effects of temperature on the equilibrium magnetization are significant and should be considered when analyzing MR images.