Applied Magnetic Resonance 2008 vol.33 N4, pages 469-480

Paramagnetic liposomes as thermosensitive probes for MRI-guided thermal treatment: In vitro feasibility studies

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Abstract

In this work the potential of thermosensitive paramagnetic liposomes for in vitro temperature monitoring during radiofrequency heating has been assessed. Two thermosensitive liposome formulations with different phase-transition properties were investigated. Temperature-dependent spin-lattice (T 1) relaxivity measurements were performed at 0.24 T. Magnetic resonance imaging was performed at 2 T in liposome-containing phantom models and T 1 relaxation rates (R 1) were quantified as a function of temperature. Independent temperature measurements were performed using both thermocouple and magnetic-resonance-based methods (proton resonance frequency and diffusion-based thermometry). The relaxometric measurements showed that the T 1 relaxivity increased from low values (about 0.3 s -1mM -1 at 35 °C) to about 4 s -1mM -1 when the temperature approached and exceeded the phase-transition temperature (T c) of the liposome preparations. These data correlated well to the imaging data where an increased signal intensity was observed on T 1-weighted images at temperatures above T c. The derived R 1 maps reflected the measured liposomal temperature sensitivity and temperature quantification was possible on the basis of the measured linear temperature versus R 1 correlation in the transition range of the liposomes. The studies have therefore shown that thermosensitive paramagnetic liposomes exhibit the required temperature sensitivity to allow for an accurate mapping of the temperature changes in an in vitro imaging model. © 2008 Springer-Verlag.

http://dx.doi.org/10.1007/s00723-008-0086-8