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Use of Contrast Agents with Fast Field-Cycling MRI

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Fast Field-Cycling (FFC) when combined with MRI allows switching of the magnetic field during an imaging scan [1]. FFC-MRI takes advantage of the T_1 dispersion properties of contrast agents to improve contrast enhancement [2].
A new contrast agent designed specifically for use with FFC (a liposome encapsulating Mn(II) ions in its inner aqueous cavity) was imaged using a home built FFC-MRI system. Its T_1 dispersion curves were obtained using a Stelar SMARtracer relaxometer. FFC-MRI Images were acquired at multiple field strengths, and evolution times. Images were processed and used to create a ΔR_1 image in which contrast depends on the change in R_1 of the sample between two selected fields.
T_1 dispersion curves of Mn(II)-liposomes showed large changes in relaxation rate between fields. For contrast-optimised T_1 weighted images the signal enhancement was seen to increase moderately when the evolution field strength was changed from 59 mT to 5 mT. ΔR_1 mapping increases the signal enhancement of the contrast agent, by allowing quantitative analysis of the change in R_1 between different fields. The herein used liposome of 111 nm diameter contains ca. 10^3 Mn[II] ions. Thus suspensions containing 0.15 mM and 0.06 mM Mn[II] ions correspond to ca. 60 and 30 nM concentration of liposomes, respectively. The observed ΔR_1 enhancements clearly indicate that the proposed method (FFC-MRI and reporting probe) is well suited for molecular imaging applications. The present system has shown consistency in its measurements and has provided a useful test bed for new imaging techniques employing fast field-cycling. Currently a new FFC-MRI system is in its final preparation stages. This system has a much greater field range (between 0 and 0.5 tesla) which will provide larger ΔR_1 values. The system will have improved field homogeneity, and shorter ramp times, thus allowing more accurate and improved ΔR_1 mapping using FFC. This technique could eventually allow contrast agents to be detected with much greater sensitivity in vivo.

References:
[1] Lurie DJ et al.; Phys Med Biol. 43:1877 (1998)
[2] Aime S et al.; Acc Chem Res. 42:822 (2009)