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Fast field-cycling MRI for medical applications

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Purpose:

The relationship between 1_1-relaxation time and field strength in MRI is known to be very informative on molecular dynamics but is not accessible by conventional MRI systems. Here we introduce a new technology that measures T_1 as a function of field strength, accessing that rich source of information to provide novel contrast.

Methods and Materials:

Our prototype human-scale Fast Field-Cycling (FFC) measures T_{r-}dispersion by rapidly switching the main magnetic field (Bo) during the pulse sequence to reach any field strength between 25 uT and 0.2 T within 20 ms. Its resistive magnet is driven by power amplifiers giving full control of Bo with a 15 ms stabilisation time. Additional coils outside the main magnet provide local cancellation of the Earth's field.

Results:

The system has been fully commissioned and is capable of in vivo imaging using its full field range. Images of the head and knees were obtained from normal volunteers and patients within 40 minutes for a resolution of 4x4x8 mm over 250 mm field of view. T_1-dispersion images were obtained that agreed with measurements on excised tissues from a benchtop FFC instrument.

Conclusion:
FFC-MRI allows us to explore and take advantage of the unique $^{-}1_1$-dispersion contrast. The use of a purely resistive magnet allows us to access ultra-low magnetic fields, providing information on slow molecular dynamics. Our work currently concentrates on demonstrating how this newly accessible region of the T_1 dispersion curve can be exploited for clinical diagnosis in stroke, osteoarthritis and Alzheimer's disease.

Author Disclosures:
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