Title

Fast Field-Cycling MRI for medical applications

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Disclosure statement

DJL conflict of interest: Recipient of research funding from GE Healthcare

Topic

Abstract categories

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Purpose

The relationship between T_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 can measure T_1 as a function of field strength, accessing that rich source of information. This T_1-dispersion contrast is showing significant potential as a novel contrast mechanism.

Methods and materials

Fast Field-Cycling (FFC) is employed to measure T_1-dispersion: the scanner's B_0 field is switched rapidly during the pulse sequence, typically within 20 ms. Our prototype human-scale FFC-MRI scanner can reach any B_0 value between 25 μT and 0.2 T (Figure1). Its resistive magnet was built (Tesla Engineering, Storrington, UK) and is interfaced with power amplifiers (IECO, Finland) to have full control of the field with a 15 ms B_0 field-stabilisation time. Additional coils outside the main magnet, seen in Figure 1, 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. Figure 2 shows an image of the head of a normal volunteer obtained at 100 mT, while Figure 3 shows an image of a volunteer's knee obtained at 200 mT. Dispersion images were obtained that agreed with non-imaging T_1-dispersion acquisitions on tissue samples from a benchtop FFC instrument (Stelar S.r.l., Italy).

Conclusion

The novel scanner described here allows us to explore and take advantage of the unique T_1 dispersion contrast made available by FFC-MRI. The use of a purely resistive magnet allows us to access ultra-low magnetic fields (less than Earth's field), providing information on slow molecular dynamics. Our work currently concentrates on identifying how this newly accessible region of the T_1

dispersion curve can be exploited for clinical diagnosis. The system has been used to image volunteers and patients to study the brain in stroke and cartilage in osteoarthritis; studies on patients with Alzheimer's disease are planned.

Figure 1: The FFC-MRI system and earth's field cancellation coils.

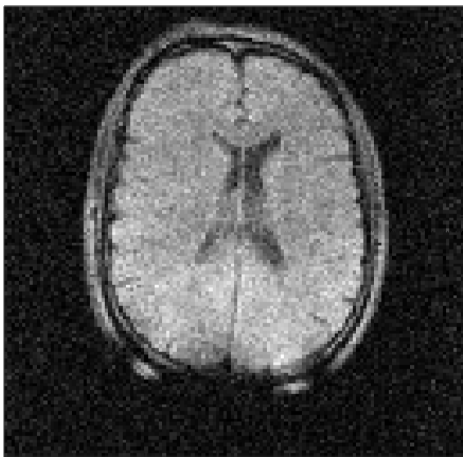

Figure 2: Image from a volunteer's head, obtained at an evolution field of 100 mT.

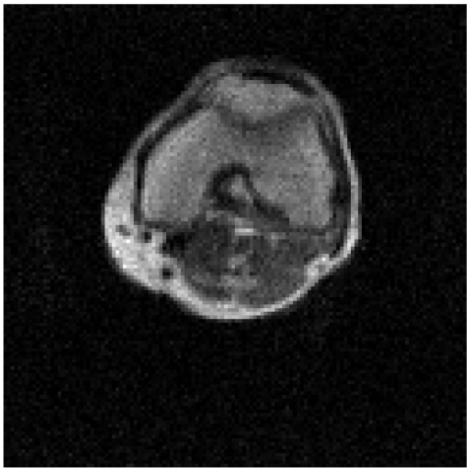

Figure 3: Image from a volunteer's knee, obtained at an evolution field of 200 mT.