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FAST FIELD-CYCLING MAGNETIC RESONANCE IMAGING

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Most contrast in conventional MRI arises from differences in T_1 between normal and diseased tissues. Several studies on small tissue samples have shown that extra information could be obtained from T_1-dispersion measurements (plots of T_1 versus magnetic field), but this information is invisible to standard MRI scanners, which operate only at fixed magnetic field (e.g. 1.5 T, 3.0 T). We have developed Fast Field-Cycling Magnetic Resonance Imaging (FFC-MRI) to exploit T_1-dispersion as a potential biomarker, with the aim of increasing diagnostic potential [1]. T_1-dispersion is typically measured using FFC, by switching the magnetic field rapidly between levels during the pulse sequence [2]. In this way, a single instrument can be used to measure T_1 over a wide range of magnetic field strengths. FFC-MRI obtains spatially-resolved T_1-dispersion data, by collecting images at a range of evolution fields. In our lab we have built a range of FFC-MRI equipment, including two whole-body human sized scanners, operating at detection fields of 0.06 T [3] and 0.2 T [4]. The 0.06 T device uses a double magnet, with field-cycling being accomplished by switching on and off a resistive magnet inside the bore of a permanent magnet; this has the benefit of inherently high field stability during the detection period. The 0.2 T FFC-MRI system uses a single resistive magnet which has the advantage of increased flexibility in pulse sequence programming, at the expense of lower field stability during the detection period, necessitating more complex instrumentation. Our lab is investigating a range of applications of FFC relaxometry and FFC-MRI. We have demonstrated that FFC relaxometry can detect the formation of cross-linked fibrin protein from fibrinogen *in vitro*, via the measurement of ^{14}N-^{1}H cross-relaxation phenomena [5]. We have also shown that FFC-MRI can detect changes in human cartilage induced by osteoarthritis [6]. Recent work has focused on speeding up the collection of FFC-MRI images by incorporating rapid MRI scanning methods along with the use of improved pulse sequences and algorithms [7,8]. This presentation will cover the main techniques used in FFC-MRI and will summarise current and potential bio-medical applications of the methods.

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