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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. Fast Field-Cycling (FFC) MRI exploits T_1-dispersion as a novel biomarker [1].
FFC relaxometry is conventionally used to measure T_1-dispersion (T_1 *versus* field strength), by switching the magnetic field rapidly between levels [2]. FFC-MRI obtains spatially-resolved T_1-dispersion data, by collecting MR images at a range of evolution magnetic fields [3].
We have built two whole-body human sized FFC scanners, operating at detection fields of 0.06 T [4] and 0.2 T [5]. The 0.06 T device uses a double magnet (resistive offset coil inside a permanent magnet), while the 0.2 T FFC-MRI system uses a single resistive magnet.
We have demonstrated that FFC relaxometry can detect the formation of cross-linked fibrin protein from fibrinogen *in vitro* [6]. We have also shown that FFC can detect changes in human cartilage induced by osteoarthritis [7] and differences between normal tissue and tumour [8].
We have performed *in vivo* FFC-MRI studies on patients with acute ischaemic stroke; FFC-MRI images exhibited increased intensity in stroke-affected regions, with maximum contrast typically at the lowest field used (0.2 mT) [9]. All human studies were conducted following approval of the relevant Research Ethics Committees and with the informed consent of patients.
Other work has focused on speeding up the collection of FFC-MRI images as well as the use of improved pulse sequences and algorithms [10,11]. Work to improve the hardware and software is ongoing, including the implementation of improved radiofrequency coils [12].
FFC-MRI has significant potential for the generation and use of novel biomarkers arising from ultra-low field MRI contrast and from low- and ultra-low field T_1-dispersion phenomena.
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References:
[1] D.J. Lurie et al. *Comptes Rendus Physique* 11, 136-148 (2010).
[2] R. Kimmich and E. Anoardo *Prog.Nucl.Magn.Reson.Spectrosc.* 44, 257-320 (2004).
[3] D.J. Lurie, P.J. Ross and L.M. Broche, in: New Developments in NMR No. 18, Kimmich R., ed., Royal Society of Chemistry, UK, pp 358-384 (2018).
[4] D.J. Lurie et al. *Phys.Med.Biol.* 43, 1877-1886 (1998).
[5] L.M. Broche et al. *Scientific Reports* 9:10402 (2019).
[6] L.M. Broche et al. *Magn.Reson.Med.* 67, 1453-1457 (2012).
[7] L.M. Broche, G.P. Ashcroft and D.J. Lurie *Magn.Reson.Med.* 68, 358-362 (2012).
[8] E. Masiewicz et al. *Scientific Reports* 10:14207 (2020).
[9] L.M. Broche et al. *11th Conference on FFC NMR Relaxometry, Pisa, Italy*, p6 (2019).
[10] P.J. Ross, L.M. Broche and D.J. Lurie *Magn.Reson.Med.* 73, 1120-1124 (2015).
[11] L.M. Broche, P.J. Ross, K.J. Pine and D.J. Lurie *J.Magn.Reson.* 238, 44-51 (2014).
[12] G.R. Davies et al. *ISMRM 27th Annual Meeting, Montreal, Canada*, p1570 (2019).