

Medical applications of fast field-cycling MRI

Lionel M. Broche¹, George P. Ashcroft¹, David Boddie², Sinclair Dundas², Tanja Gagliardi¹, Steve D. Heys², Brett W.C. Kennedy¹, David J. Lurie¹, Campbell Maceachern³, Teena McKenzie², Iain Miller², Kerrin J. Pine¹, P. James Ross¹

¹ *School of Medicine and Dentistry, University of Aberdeen, Aberdeen, UK*

² *Division of Applied Medicine, University of Aberdeen, Aberdeen, UK.*

³ *Aberdeen Orthopaedic Trauma Unit, Aberdeen Royal Infirmary, UK*

Purpose

Fast-field cycling MRI (FFC-MRI) is a new imaging technique that opens up many possibilities for new molecular-based contrast in images [1]. It also benefits from decades of research in FFC NMR that have shown how versatile this technique can be. In particular, field-cycling allows non-invasive and contrast-agent-free detection of certain immobile proteins thanks to cross-relaxation effects between water protons and ¹⁴N. Previous pilot studies have shown that this is the case with proteoglycans, albumin and fibrin, to name a few. Here we present the results of several studies that use FFC-MRI for detection or characterisation of diseased tissues in osteoarthritis, cancer, muscle atrophy, and thrombosis [2, 3].

Methods

The studies make use of two features: the quadrupolar signal and the profile of the spin-lattice dispersion curve over 3 decades of magnetic field. These features were measured from imaging experiments performed on a 59 mT field-cycling scanner [4], while FFC NMR data acquisition were performed on a SMARtracer relaxometer (Stelar, Italy). In most studies we made use of both platforms, with additional high-field scans on a 3T MRI scanner (Achieva, Philips Healthcare, Netherlands) and Raman spectroscopy in the case of osteoarthritis samples.

Results

Significant differences were observed between healthy and diseased tissues in all pathologies explored so far. Most tissues show quadrupolar signal, with variations between individuals and conditions. In particular, significant differences in the level of quadrupolar signals were observed between healthy and diseased cartilage, normal and swollen muscle, and normal and cancerous tissues.

Conclusions

FFC-MRI demonstrated capabilities in the detection of certain disease mechanisms, some of which are difficult to observe on conventional fixed-field MRI devices. Field-cycling is a promising tool for medical research, and has already shown abilities for quantitative detection of proteins.

References

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