Fast field-cycling MRI for protein detection

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Conventional MRI scanners operate at precise and fixed magnetic fields. In contrast, Fast Field-Cycling MRI (FFC MRI) scanners can select different magnetic fields during operation. This allows the measurement of tissue properties at a variety of fields and in particular the measurements of the transverse relaxation rate (R_1) against magnetic field strength, also named the 'dispersion spectrum'. Transverse relaxation mechanisms are closely linked to the microscopic properties of a sample and generally present different features corresponding to different properties [1].

The three studies presented here focus on one feature of interest of the dispersion curve, the quadrupolar signal, and exploit it in three domains of medical research: thrombosis characterisation, detection of oedema and osteoarthritis.

A thrombus is a blood clot that develops in a vein or an artery. It can cause life-threatening complications such as embolisms or heart attacks. We showed that FFC quadrupole-based techniques can quantitatively detect fibrin [2], a major constituent of thrombi, and are now designing human studies to test if this can help determining clot maturity *in vivo*. Such information would be an innovation that could help orient treatments.

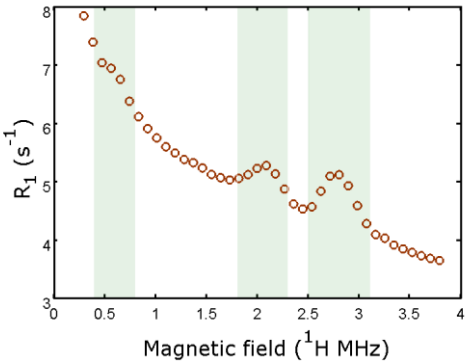

Figure 1: dispersion curve obtained *in vivo* from lower leg muscles. The vertical bands indicate the peaks of quadrupolar signal.

Sports injuries are often associated with oedemas, which are characterised by excessive amounts of fluid in the tissues. We have shown that FFC MRI is sensitive enough to detect oedema *in vivo* [3]. This result can be exploited in sports medicine or for the study of medical conditions such as sarcopenia.

Osteoarthritis is a condition that affects articular cartilages and weakens them until they disappear. This disease is associated with protein loss in the affected cartilage. We have successfully detected this reduction in protein between healthy and diseased cartilage using FFC NMR and are planning *in vivo* investigations. This result could lead to a fast and early detection method for osteoarthritis.

Figure 2: the whole-body FFC MRI scanner used for our studies.

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