Basis sets were generated in MATLAB with the same sequence timing as on the scanner both with a non-localized simulation (using ideal RF pulses) and with a localized simulation (using the actual RF pulses, gradient waveforms and phase cycling scheme as on the scanner) using full density matrix calculations.

The acquired spectra were analyzed with LCModel. Metabolite concentrations were separately estimated based on the two basis sets.

Results. The estimated concentrations based on localized simulations were closer to true ones for all metabolites: Cho 3.6/3.5 mM, Cr 10.8/10.5 mM, Lac 3.8/5.3 mM, mI 6.5/6.9 mM, Glu 12.7/12.6 mM, NAA 13.3/13.1 mM (ideal/localized). A substantial gain in accuracy was especially seen for lactate which was underestimated by 24% with the non-localized simulation, but overestimated by only 6% by the localized simulation.

Conclusions. Metabolite quantification was improved by inclusion of actual RF pulses, gradient waveforms and phase cycling scheme. This was especially seen for lactate.

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[OA019] Human *in-vivo* Magnetic Resonance Current Density Imaging (MRCDI) and MR Electrical Impedance Tomography (MREIT)

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Purpose. Information on the electrical tissue conductivity might be useful for the diagnosis and characterization of pathologies such as tumors [1]. MRCDI and MREIT are two emerging non-invasive techniques for imaging of weak currents and ohmic conductivities. In this study, we demonstrated human *in vivo* brain MRCDI to pave the way for its clinical use [2,3].

Methods. In short, weak alternating currents up to 1–2 mA are injected into human head in synchrony with tailored phase-sensitive MRI. The currents create a magnetic field $\Delta B_{z,c}$, which shifts the precession frequency of the magnetization and modulates the acquired MR images. The acquired images are used to measure $\Delta B_{z,c}$ and reconstruct the current flow and conductivity distributions. We employed a steady-state free precession free-induction-decay (SSFP-FID) sequence in five subjects, and injected currents of 1 mA by an MR-conditional current source via electrodes attached to the scalp (two current profiles: Right-left (RL), electrodes placed near the temporoparietal junctions; anterior-posterior (AP), one attached to the forehead and one above the inion). Additionally, an ultra-short-echo-time sequence was performed to track the feeding cables for correcting the stray magnetic fields induced by cable currents. Corrected $\Delta B_{z,c}$ measurements were used to calculate current flow distributions and compared with Finite-Element simulations of the current flow based on individualized head models [4].

Results. The current-induced magnetic field $\Delta B_{z,c}$ with ≤ 1 nT was reliably measured and the reconstructed current flows showed good agreement with the simulations (average coefficient of determination R^2= 71%). The injected current flow differed substantially among individuals according to the electrode placements and anatomical differences. The calculated currents are stronger in CSF-filled highly conductive regions, e.g. the longitudinal fissure.

Conclusions. The strong correlation between the simulations and measurements validates the accuracy of the method and demonstrates the potential of the method for determining accurate brain tissue conductivities. These initial current flow recordings pave the way for human brain MREIT that might complement standard MR methods for tumor characterization.

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[OA020] Fast field-cycling MRI: Novel contrast changes through switched magnetic fields

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Purpose. Fast Field-Cycling MRI (FFC-MRI) is a novel MRI technique in which the external magnetic field (B_0) is switched during the imaging experiment, always returning to the same value (B_0^D) for signal detection. By doing this, FFC-MRI grants access to information which is invisible to conventional MRI scanners, including the variation of T_1 with magnetic field. These measurements, known as T_1-dispersion, exhibit great promise as a new form of endogenous image contrast, and may have application in the early diagnosis of a range of diseases. Construction of an MR imaging system capable of rapidly switching magnetic fields, and reaching ultra-low fields (200 μT or lower), requires novel magnets, power supplies and control electronics. Here we will describe progress on a whole-body human sized FFC imaging system and preliminary results from a clinical trial imaging acute stroke using FFC-MRI.

Methods. The magnet (Tesla Engineering Ltd, UK) is of a resistive design with a length of 2 m and an inner bore diameter of 500 mm; it is capable of achieving a maximum field strength (B_0^D) of 0.2 T (8.52 MHz proton Larmor frequency). The system can switch between zero and maximum field in 12 ms, corresponding to a maximum dB/dT of 16.7 T/s. The gradients and RF system are controlled by a commercial MRI console (MR Solutions Ltd, UK) while the main magnet coil, shim coils and earth's-field cancellation coils (necessary for ultra-low field operation) are controlled by a dedicated embedded computer running in-house software written in Labview (National Instruments, US).

Results. The prototype system has been fully commissioned and is now operational. FFC-MRI imaging of patients (with full ethical permissions granted) using the system has now commenced as part of a

clinical study on imaging acute stroke. It is hoped that the new information afforded by FFC-MRI will aid in the detection and assessment of stroke.

Conclusions. The novel system design described here will allow us to explore the unique T_1 dispersion contrast made available by FFC-MRI. Future work will concentrate on identifying how this newly accessible region of the T_1 dispersion curve can be exploited for clinical diagnosis.

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[OA021] Spin coupling signal loss correlates with differentiation grade of lipomatous tumors: Preliminary results

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Purpose. Non-invasive characterization of lipomatous tumors can be challenging as several histological types have similar imaging characteristics. In this study we examine the use of a new biomarker based on spin coupling related signal loss between two acquisitions of different echo spacing to differentiate between benign lipomas, well, intermediate and poorly differentiated liposarcomas (l, wdl, idl and pdl, respectively). This study was based on previous work showing differences between vegetable oils of different botanical origin using the same protocol [1].

Methods. Fourteen patients (9 male, 5 female, age: 37–87, mean 58) with soft tissue masses (5 lipomas, 2 myxoid, 5 dedifferentiated, 2 pleiomorphic liposarcomas) underwent MRI prior to any therapeutic intervention. MRI protocol, among other sequences, included two Multi Echo Spin Echo CPMG sequences with different echo spacing, 13.4 and 26.8 ms respectively, i.e. above and below the approximate threshold of 20 ms in order to have bright and dark fat appearance on T2-w images. All surgically excised specimen were histopathologically examined to determine the kind of lipomatous tumor and to localize sites of well or poor differentiation in the cases of dedifferentiated liposarcomas as distance from the upper tumor limit (z) and distance from the center (x,y). Relative signal loss between bright and dark fat images on TE 80 ms was calculated in order to measure the spin coupling Ratio (Rsc), defined as mean ROI value in the lesion divided by the same value in normal subcutaneous fat for the same patient.

Results. Mean (SD) of Rsc for l, wdl, idl and pdl was 1.036 (0.06), 0.77 (0.18), 0.055 (0.06) and −0.16 (0.57), respectively.

Conclusions. A new biomarker related on spin coupling signal loss is indicative of the differentiation grade of lipomatous tumors, with special interest regarding the clinically challenging question of benign lipomas vs. well differentiated liposarcomas. It is of note that Rsc decreases with increased differentiation grade (1–3).

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[OA022] T2 and T* relaxometry of benign and malignant lipomatous tumors

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Purpose. T2 relaxation constant has been established as an accurate biomarker from the early days of MRI for tissue or material identification as it expresses physical properties without dependence on the MR protocol used. $T2^*$ expresses acceleration of T2 dephasing process by local field inhomogeneities that can be produced by paramagnetic blood products, i.e. deoxyhemoglobin, hemosiderin. Therefore, long $R2' = 1/T2^* - 1/T2$ relaxation rates are found in tissues with low oxygenation and/or high oxygen consumption. The present is a study of T2 and $R2'$ for the differentiation between benign and malignant lipomatous tumors.

Methods. 16 patients with lipomatous tumors underwent preoperatively MRI examination including $T2/T2^*$ relaxometry protocol. T2 relaxometry data were acquired from a Multi Echo Spin Echo CPMG sequence with initial echo at 26.8 ms followed by 9 equidistant echoes (echo spacing 26.8 ms) to avoid spin coupling signal modulation. $T2^*$ protocol comprised 4 opposed-phased echoes (TE: 2.38/7.18/12.0/16.82 ms) and 4 in-phase echoes (4.77/9.59/14.41/19.23 ms). Histologic examination of surgical specimen showed 4 benign lipomas (bl), 4 well differentiated liposarcomas (wdl, Histologic Specific Differentiation Score (HSDS) 1), 2 non round cell myxoid liposarcomas (intermediately differentiated sarcomas, idl, HSDS 2) and 6 poorly differentiated liposarcomas (pdl, HSDS 3). 3D ROI based measurements were performed on areas indicated from histopathologic analysis as indicative of histologic subtype.

Results. Average T2 (SD) constant for bl/wdl/idl/pdl is 102.2 (1.6)/101.9 (6.7)/562.55 (120.1)/131.8 (12.1) ms. $R2'$ for bl/wdl/idl/pdl is 23.1 (1.1)/17.2 (9.3)/1.6 (0.5)/4.6 (1.0) ms^{-1}. Similar metrics were taken on healthy subcutaneous tissue to ensure protocol robustness on healthy tissue (Normal fat $T2/R2'$ range: 98.9–102.0 ms/24.2–25.9 ms^{-1}).