[O016] Challenges in quantitative MRI
Gunther Helms*  
Lund University, Medical Radiation Physics, Lund, Sweden  
* Corresponding author.

Purpose. Quantitative MRI (qMRI) yields reproducible “maps” of physiological and/or biophysical tissue parameters. These spatially resolved metrics are mainly used in clinical imaging research for cross-sectional and longitudinal studies. The field of qMRI has considerable expanded during the past two decades. Rather than focusing on particular methods, this talk highlights general concepts of accuracy and precision, the relationship to QA, and ongoing endeavors for validation.

Methods. Parameters are derived from models of the MR experiment. They thus share the limited resolution of MRI. At a second level, physiological and microscopic properties of tissue can be derived. Adequate QA has to be performed to control systematic error (bias), especially when comparing results obtained on scanners of different makes and model. Increasingly, validation experiments are performed to relate macroscopic maps to underlying microscopic tissue properties.

Results. Flip angle (B1+) mapping is a prime example for bias correction, especially at high and ultra-high magnetic field strength. However, magnetic field strength and model-specific implementations still can be large source of bias. Ideally, individual correction should also comprise control or correction for gross and physiological patient motion. Regular QA is advised to maintain the comparability of metrics over time. Recent progress in validation has mainly focused on tissue iron and myelin for improved interpretation of qMRI metrics as given by ever more-complex models of microscopic tissue properties.

Conclusions. In-depth knowledge of the MR system’s performance increases accuracy and is a prerequisite for validation and interpretation. Quantitative MRI across different platforms and field strengths remains challenging.

https://doi.org/10.1016/j.ejmp.2018.06.089

[OA018] Improved absolute metabolite quantification by localized magnetic resonance spectroscopy simulations
Oscar Jalnefjord a,b, Patrick Pettersson b, Maria Ljungberg a  
* Sahlgrenska University Hospital, Department of Medical Physics and Biomedical Engineering, Gothenburg, Sweden  
b Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Department of Radiation Physics, Gothenburg, Sweden  
* Corresponding author.

Purpose. Magnetic resonance spectroscopy (MRS) provides a non-invasive method for assessment of the in vivo abundance of metabolites and serves as a useful diagnostic tool for several pathologies. The most common method for quantification of metabolite abundance includes fitting a linear combination of individual a priori acquired metabolite spectra. The set of individual metabolite spectra (basis set) can either be acquired through phantom measurements or simulations. While simulation has recently become more popular, it is not clear at what complexity level the simulations have to be run.

The aim of this work was to study the impact of simulation complexity on absolute concentration estimates. Specifically, results based on non-localized and localized simulations were compared.

Methods. The Braino phantom (General Electric) containing the most common brain metabolites was used in this study. It included choline (Cho, 3.0 mM), creatine (Cr, 10.0 mM), lactate (Lac, 5.0 mM), myoinositol (ml, 7.5 mM), glutamic acid (Glu, 12.5 mM) and N-acetylaspartic acid (NAA, 12.5 mM).

MR spectra were acquired on a Philips Achieva 3 T scanner with the PRESS pulse sequence. Parameters: echo time 35 ms, repetition time 5000 ms, number of acquisitions 128, volume of interest size 20 × 20 × 20 mm3.
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, ml 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.

https://doi.org/10.1016/j.ejmp.2018.06.090

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

Cihan Göksu a,*, Lars G. Hanson b, Hartwig R. Siebner b, Philipp Ehses c, Klaus Scheffler b, Axel Thielcher b

a Center for Magnetic Resonance, Dtu Elektro, Technical University of Denmark, Kgs. Lyngby, Denmark
b Danish Research Centre for Magnetic Resonance, Centre for Functional and Diagnostic Imaging and Research, Copenhagen University Hospital Hvidovre, Hvidovre, Denmark
c Department of Neurology, Copenhagen University Hospital, Bispebjerg, Denmark

**References**


https://doi.org/10.1016/j.ejmp.2018.06.091

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

James Ross a,*, Lionel Broche a, Mary Joan MacLeod b, Gareth Davies c, David Lurie c

a University of Aberdeen, Aberdeen Biomedical Imaging Centre, Aberdeen, United Kingdom
b University of Aberdeen, School of Medicine and Dentistry, Aberdeen, United Kingdom
c Biomedical Physics, School of Medicine, Medical Sciences & Nutrition, University of Aberdeen, Aberdeen, United Kingdom

* Corresponding author.

**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 \(\mathbf{B}_\text{c}\), which shifts the precession frequency of the magnetization and modulates the acquired MR images. The acquired images are used to measure \(\Delta\mathbf{B}_\text{c}\) and reconstruct the current flow and conductivity distributions. We employed a steady-state free precession free-induction-decay (SSF-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 \(\Delta\mathbf{B}_\text{c}\) 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 \(\mathbf{B}_\text{c}\), with \(\leq 1\) mT 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.