Sequences for current-density and conductivity imaging with ultra-low-field MRI

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Introduction

Ultra-low-field magnetic resonance imaging (ULF MRI), where MR signals are acquired in microtesla-range magnetic fields using superconducting quantum interference devices, allows flexible imaging sequences. This is particularly useful when imaging current densities and conductivities. In conventional high-field MRI, the permanent main field makes the imaging of all three components of a static current density difficult. However, in ULF MRI, the orientation and amplitude of the MRI fields can be easily varied for such purposes.

Methods

We present two ULF-MRI sequences to image three-dimensional current densities and conductivities. By supplying a weak electric current through electrodes to an object, a current density, which depends on the conductivity structure, is generated. The first sequence utilizes adiabatic switching of the MRI fields to image the direction of the magnetic field produced by the current density. Subsequently, the amplitude of the magnetic field and the underlying current density can be calculated. The second sequence is based on letting the magnetization dephase in a field generated by an applied current density. By measuring the phase of the magnetization, the current density can be reconstructed. By performing either one of the sequences for two different current densities, the conductivity structure of the object can be reconstructed.

Results

We will present simulation results using both sequences.

Conclusion

ULF MRI allows imaging of three-dimensional current densities and conductivities. In addition, conductivity can be seen as a new contrast for ULF MRI.