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PL3

## MRS of the human brain at high magnetic field strengths

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Since the early days of nuclear magnetic resonance, it has been known that signal-to-noise increases with increasing magnetic field strength. In addition, for MR spectroscopy, the chemical shift dispersion (i.e. spectral resolution) also increases with higher fields. Therefore, over the last 3 decades, there has been a trend for MRS to be performed at higher and higher field strengths, ranging from 1.5, 3.0, 4.0, 7.0 to 9.4T (1-4).

However, increases in field strength are also accompanied by technical challenges, such as achieving sufficient B0 and B1 field homogeneity, minimization of chemical shift displacement effects, and other issues. These challenges need to be overcome before the expected improvements in spectral resolution and sensitivity are achieved. This presentation will review some recent technical advances and applications of proton MRS and the related technique of MR spectroscopic imaging (MRSI) of the human brain performed at 7T.

Improvements in spectral quality compared to lower field strengths are particularly beneficial for some of the smaller signals in the spectrum, such as glutamate and glutamine. It has been shown that as many as 17 metabolites can be reliably detected using MRS at 7T. 7T brain MRS is therefore particularly useful for investigating subtle spectral abnormalities, for instance as found in psychiatric diseases such as schizophrenia (5), or in non-lesional temporal lobe epilepsy. Other applications may take advantage of the higher spatial resolution available at 7T for MRSI (6).

This presentation will review techniques for high-field MRS and MRSI and discuss applications to psychiatric and other diseases.

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## **MR molecular imaging: current promises and challenges**

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Molecular imaging is aimed at visualizing molecular or cellular events. There are several imaging modalities for molecular imaging: Optical imaging, radionuclide imaging, ultrasound imaging, and MR imaging and so on. It can provide plentiful information on cell, tissue, organ function beyond understanding anatomical structure, and it would help to guide diagnosis and treatment for individualized therapy.

With regard to MR molecular imaging, there are two main streams; cellular imaging and molecular targeted imaging. However, molecular targeted imaging have been demonstrating a limited role because of the low sensitivity of MR imaging probes. A lot of effort has been given to develop high-specificity /high-sensitivity MR imaging probes. As a first step, novel nanoparticle fabrication with optimal and tunable magnetism is required and notable advances in nanotechnology allowed it feasible. Secondly, surface coating is important for stabilization. Finally, for MR molecular targeted imaging, functionalization with ligand moiety should to be well designed and selected for good affinity to the targets and also for proper circulation time in the blood. These targeted probes may be applicable for depiction of the tumor-cell membrane markers or endothelial markers of tumor angiogenesis. I present here examples of cancer targeting application of ultra-sensitive magnetic nanoparticles (Magnetism-engineered iron oxide; MEIO). In addition, I will briefly introduce new perspectives about multi-modal, activatable probe imaging as well as multifunctional imaging. For the success of cancer targeting molecular MR imaging, multidisciplinary approaches are required, involving imaging methodology and device, imaging probes, and biological models. I expect novel multifunctional probes for imaging and therapy in the not distant future

For cellular MR imaging, I will briefly introduce in-vivo cellular labeling and in vitro labeling methods. In vitro labeling has been introduced with tissue engineering and cell-based therapy. Monitoring with stem cell labeling has been paid attention but not approved for medical application.

There are several challenges to translate these promising techniques to clinical application: Even though the proof of concept of new imaging probe has been well established in the laboratory environment, mass production and proper market are other issue for pharmaceutical companies to release a new drug for clinical practice.

**Keywords :** MR imaging, Molecular imaging, MR contrast agents