The main clinical MRI tool to measure perfusion today is based on dynamic imaging of a bolus of a gadolinium-based contrast agent injected, a method known as Dynamic Susceptibility Contrast (DSC) MRI (1,2). As the contrast agent changes the magnetic properties of the surrounding tissue, the passage of the bolus through the brain can be tracked with the use of fast imaging sequences, and the important perfusion-related parameters cerebral blood volume (CBV), cerebral blood flow (CBF) and mean transit time (MTT) can be extracted. The use of gadolinium-based contrast agents in MRI has been linked with a potentially extremely severe disease (Nephrogenic Systemic Fibrosis) which may occur in patients with moderate to end-stage kidney disease. Recently it has also been indicated that gadolinium–based contrast agents are associated with neuronal tissue deposition and bone accumulation in the setting of relatively normal renal function (3,4). Therefore, many clinicians are presently looking for a good replacement technique to obtain similar information. The current non-MRI perfusion methodologies include either PET-investigations with 15O-labeled water, an invasive and expensive technique, Xe-CT or CT-perfusion. All the alternative methods involve ionizing radiation and administration of an exogenous contrast agent. ASL, on the other hand, is completely non-invasive, can easily be attached to any existing MRI protocol, and is performed within a few minutes. It is therefore very suitable for perfusion studies of healthy volunteers and in patient groups in which other methods would not be possible, such as patients with kidney disease.

The basic ASL idea (5) is that spins in a specific region are exposed to a radio-frequency (RF) pulse (tagged or labelled) and that the tagged spins are transported with the blood flow to a selected imaging plane and incorporated in the tissue by water exchange in proportion to capillary perfusion. Imaging is performed twice, once with and once without the tagging procedure. ASL methods were previously often divided into two branches, where one used either a continuous RF tagging (CASL) or pulsed RF tagging (PASL). However a hybrid method called PCASL combines the advantages of CASL (high SNR) and PASL (high tagging efficiency) (6) and is currently considered the method of choice (7).

There are many applications for ASL. Some of them include; dementia, infarctions, tumours, constrictions and stenosis of blood vessels.

References

Keywords: ASL, Perfusion, Neuro
High-resolution fMRI in Animals at Ultrahigh Fields

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High-resolution fMRI is increasing used for mapping functional networks in whole brains at a fine scale. In human fMRI studies, one millimeter isotropic resolution fMRI has been used with multiple receiver coils and improved multi-slice imaging techniques. In animal studies, even higher spatial resolution is needed for matching brain resolution due to the different brain size (e.g., 20 cm FOV in humans vs. ~2 cm FOV in rats). To improve fMRI sensitivity, several approaches could be taken, including the use of ultrahigh field and small sensitive coil. We used ultrahigh fields of 9.4 T and 15.2 T for our rodent fMRI studies. Two issues were examined; 1) field dependency of gradient-echo and spin-echo BOLD fMRI of rat brain, and 2) high-resolution fMRI of mouse. Both experiments adopted forepaw stimulation for comparing BOLD signals of the primary somatosensory cortex with previous fMRI studies at different magnetic fields. Both gradient-echo and spin-echo BOLD fMRI percent changes linearly increase with magnetic field strength. At ultrahigh resolution fMRI, the signal-to-noise ratio increases approximately with magnetic field, resulting in the fMRI sensitivity gain. With an improved sensitivity at 15.2T, whole brain fMRI with <200 × <200 × 500 μm3 was obtained in anesthetized mouse during forepaw stimulation and sensory pathways including thalamic nuclei were successfully mapped. Overall, higher field is advantageous for high resolution fMRI.

Keywords: fMRI, High Field, Neuroimaging
Recent advances in MR Spectral Editing

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A number of technical advances have occurred for proton MR spectroscopy (MRS) of the brain over the last few years. Spectral editing techniques allow for the selective measurement of certain target molecules free from overlap with larger signals arising from more abundant molecules. Since first demonstrated for GABA in the human brain in 1993 (1), editing methods have subsequently been developed for compounds such as glutathione (GSH), lactate (Lac), Ascorbate (Asc), Aspartate (Asp) and N-acetyl aspartyl glutamate (NAAG), amongst others. The most commonly used editing method is ‘J-difference’ spectroscopy in the form of the spatially localized ‘MEGA-PRESS’ sequence (2).

This presentation will briefly review the existing methods for J-difference editing, and present some recent work which extends these methods to measure multiple metabolites at the same time, and also from multiple brain regions. Examples will be shown for simultaneous detection of GABA and GSH (both at 3T and 7T(3)), as well as NAA, NAAG and Asp (4). Considerations for combining spectral editing with MR spectroscopic imaging (MRSI) will also be discussed (5, 6). By simultaneously measuring several molecules from more than one region of the brain, large reductions in scan time are possible with minimal loss of quality (e.g. SNR) compared to conventional ‘single voxel/single metabolite’ sequential acquisitions.

Sources of variability in measurements of edited metabolites will also be discussed, including the effects of experimental imperfections such as field drift (7), motion and eddy currents (8). Post-processing software that carefully identifies and corrects for instabilities is essential for reliable spectral editing results (9). In addition, the results of a research study investigating involving 24 different sites (scanners from 3 different vendors) in healthy brain will also be presented (10).

Literature Cited


Keywords : Brain, MRS, Editing, GABA