Key Imaging Technology

Magnetic Resonance Spectroscopy (MRS) for Measurement of Hepatic Fat

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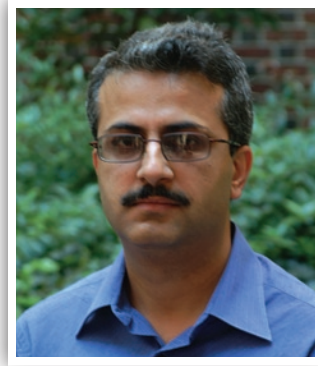

Background

Magnetic resonance spectroscopy (MRS) provides biochemical information about biologic tissues. The technique is very much similar to MRI and can be performed on most clinical MRI machines. While MRI provides anatomical information using differences in the properties of water in various tissues, MRS uses minute differences in the magnetic properties of different chemical compounds to provide a unique biochemical signature for a specific type of tissue. These compounds are typically present in much smaller concentration as compared to water and fat and thus, the signals from MRS are often much weaker that those from MRI.

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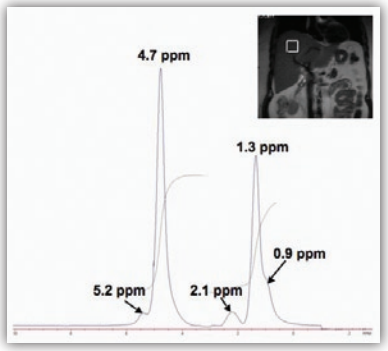
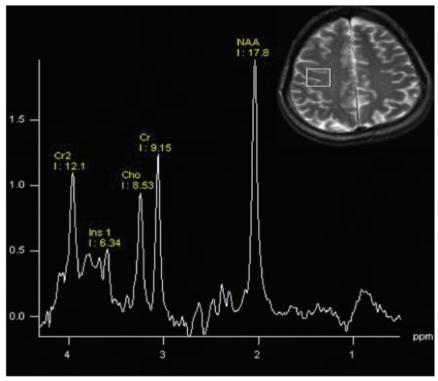


The MR spectrum is a graph of a group of "peaks" in which the characteristic position of the peak is denoted in "parts-per-million" (ppm) values on the x-axis, while the concentration of the peak can be judged by its height. Generally speaking, the position of each peak reflects a chemical compound or part thereof. For example, the water peak appears at 4.7 ppm, while peaks from fat appear at several regions including 0.9, 1.3, 3.2 and 5.2 ppm. Other metabolites of interest that can be detected by MRS include N-acetyl aspartate (NAA), a neuronal marker, observed from healthy brain tissue at 2.02 ppm; total creatine (Cr) reflecting energy metabolism at 3.03 ppm; total choline indicating membrane synthesis and cellular proliferation, observed at 3.22 ppm. Additionally lactate signal arising from anerobic glycolysis is generally observed in cancerous tissue at 1.3 ppm.



In order to accurately assess the biochemical profile of a specific region of the body, spatial localization techniques or pulse sequences are used. Localization methods commonly used in clinical ^{1}H MRS include point-resolved spectroscopy (PRESS) and the stimulated-echo method (STEAM) sequences. MRS has been widely used in the brain in which the viability of normal brain cells is predicated by the presence of NAA. A decrease in the NAA peak is typically observed in brain pathology. Almost all malignant tumors of the body exhibit an increase in the total choline peak, including cancers of the brain, breast and prostate.

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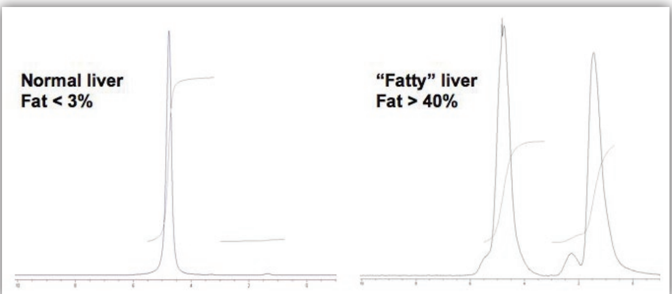
MRS of the Liver in Metabolic Diseases

The liver is the major detoxifying organ of the human body. Increased accumulation of free fatty acids or lipids is observed in liver MRS in response to obesity, alcoholism, and toxicity to drugs. The total fat concentration in the liver is typically expressed as a percentage of total water and fat



content in the tissue. In general, the normal liver has less than 5% fat, which can go up to 30% in a diseased state. The spectrum is typically acquired from the homogenous region of the liver using a single voxel (PRESS) spectroscopy sequence. The scan time typically lasts for less than 2-3 minutes, and thus MRS of the liver is usually performed after the end of the clinical MRI exam. Various analytical methods and commercial software programs are available to analyze the spectral results, which calculate the area of the water and fat peaks. Using mathematical formulas (to account for density and relaxation differences), one can then calculate the percent fat from the voxel studied.

Factors Influencing Multi-Center Trials

As is true for any multi-center trial, MRS of the liver requires standardization of the acquisition protocol across various sites. Since MRS is often not used routinely by imaging centers, additional training is required to ascertain acquisition of reliable and reproducible data. In order to precisely determine the fat and water content, the individual metabolite peaks must be resolved from each other. This can be done using a procedure called “shimming”. The “shimming” requirements for MRS are much more stringent than for MRI, and a poor shim can often lead to unusable spectra. While these additional requirements may impose restrictions on the routine use of MRS, the information gained from MRS exams is often unique and complimentary to that obtained by MRI.

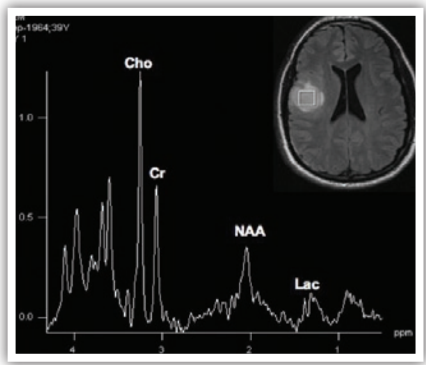


Figure Contributions from Jim Gimpel.

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