Hot Topics in Body Imaging

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MRI is a powerful diagnostic imaging method providing an unprecedented combination of spatial resolution and depiction of anatomy and pathology. In addition, it provides superior tissue characterization with excellent soft tissue contrast. Improved tissue characterization can also be performed using advanced methods such as dynamic contrast enhanced imaging that provides insight into differences in microvascularity between normal tissue and tumors (eg. invasive cancers of the breast).

In this talk, I will discuss three new areas of improved tissue characterization that are showing tremendous promise for several important clinical applications. First, I will discuss the use of T2* weighted imaging in the abdomen for detection and quantification of iron and oxygen tension. Second, I will discuss the use of chemical shift based imaging to detect and quantify fatty infiltration of important organs such as the liver. Finally, I will describe the use of diffusion weighted imaging for improved characterization of pathology in the breast and abdomen.

Hepatic iron overload is a common problem is patients with hemochromatosis, an autosomal recessive disease caused by the hemochromatosis gene (HFE). Elevated levels of hepatic iron creates oxidative stress within the liver that leads to inflammation, fibrosis, and above certain thresholds of iron content, hepatocellular carcinoma (HCC). In fact, one of the major causes of death in these patients is HCC. Patients with severe anemia (eg. thalassemia) often suffer from hemosiderosis caused by transfusional iron overload, which also results in hepatic iron overload. Recently, work by several investigators have shown that T2, and particularly T2* weighted imaging are excellent indicators of hepatic iron content (HIC). Many investigators now consider MRI to be the gold standard for measuring HIC, surpassing the previous gold standard - biopsy – because of MRI's improved accuracy, reduced cost, safety, and ability to assess the entire liver. I will discuss results from recent studies, and review the currently used and new methods that will make T2* weighted imaging common place in clinical settings in the near future.

Blood oxygen level dependent (BOLD) imaging is a method commonly used for functional imaging of the brain. This method exploits the fact that deoxygenated hemoglobin (deoxyHb) is paramagnetic while oxygenated hemoglobin is diamagnetic. Increased concentrations of deoxyHb result in a microscopic disruption of the local magnetic field resulting from the fact that deoxyHb is "packaged" within erythrocytes. T2* weighted imaging is very sensitive to these magnetic field disruptions and can be used to obtain indirect indicators of tissue oxygen tension. One particular application that has shown promise is the application of BOLD imaging to renal transplant imaging for early detection of rejection, reflected in alterations of oxygen tension in the renal cortex and medulla. Results from recent studies and technique for T2* weighted BOLD imaging in renal transplant patients will be discussed.

Fatty infiltration of the liver (hepatic steatosis) is an increasingly common condition with recognition as the most common cause of chronic liver disease, often leading to severe fibrosis and liver failure. It is closely associated with insulin resistance,

type II diabetes and obesity. Unfortunately, assessment of steatosis is very limited, relying on non-targeted liver biopsy has very high sampling variability, is risky, and histology is graded on a subjective scale.

MRI is the leading alternative for non-invasive assessment of hepatic steatosis, because it is exquisitely sensitive to chemical shift differences between water and fat. In-phase and opposed phase imaging of the liver has been a traditional method for *detection* of steatosis, but is very limited for quantification of fat. Quantification of steatosis will be increasingly important with the advent of new treatments for insulin resistance and NAFLD, where quantitative methods are needed for drug trials, and monitoring of therapy. In this talk, I will discuss new methods for water-fat separation and subsequent quantification of fatty infiltration.

Finally, there has been increasing interest in the use of diffusion weighted imaging (DWI) for improved characterization of abnormalities such as abscesses and tumors in the breast and abdomen. DWI creates contrast in images by weighting signal by the amount of diffusion of water within tissue. Gradients are used to create diffusion weighting to attenuate signal from spins that are rapidly diffusing. Spins that have *restricted diffusion* appear bright relative to areas of unrestricted diffusion. DWI is widely used for imaging infarctions in neuro-imaging, where areas of infarction appear relatively bright on diffusion weighted images. Apparent diffusion coefficient (ADC) maps can be calculated as well, to remove the effects of underlying T2 (“T2 shine through”). In this talk I will discuss the application of DWI in breast and abdominal imaging to improve the characterization of lesions, in attempts to increase the *specificity* of lesion identification.