AbstractID: 14522 Title: Advances in MR: State of the Art Today and Future Directions – Advanced Applications

Much of the research in magnetic resonance can be interpreted as the development of imaging biomarkers. A biomarker is defined as a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention. For example, measuring the uptake of glucose can be used as an indirect biomarker of metabolism and is often different between normal and cancerous tissues. Imaging biomarkers are of particular importance in the evaluation of novel drugs and treatments, and are most useful when a specific property of tissue or an organ can be described quantitatively. At present several quantitative MR imaging biomarkers are emerging into practical applications.

In the cancer field, measurements of water apparent diffusion rates, tissue vascular properties and blood flow (via the use of dynamic contrast enhanced MRI and arterial spin labeling methods) are being applied in clinical trials and are likely to be useful in cancer management, especially to assess whether a patient is likely to respond to a treatment, or to evaluate the treatment response. Important new insights into tumor metabolism will potentially become available using novel hyperpolarization techniques whereby substrates labelled with carbon-13 or nitrogen-15 can be imaged in vivo with adequate signal to noise ratio. Other approaches under development include the use of oxygen-17 as an imaging agent and high resolution MR spectroscopy to assess metabolic markers such as choline and lactate.

In neuroscience, functional MRI based on BOLD (blood oxygen level dependent) signals provides unique insights into neural circuits and their functional connectivities, which may be quantified to assess changes with treatment or as an index of severity of disease. Pharmaceutical MRI uses similar measurements to evaluate the actions of drugs and signaling pathways in the brain. Functional measurements can also be tied to structural information such as that provided by diffusion tensor imaging of white matter tracts. In the study of diabetes and metabolic disorders, measurements of visceral fat distributions and the metabolism of carbon-13 labelled glucose may be used as quantitative biomarkers in the assessment of diabetes. Many of these techniques will be enhanced by moving to higher field magnets such as 3T and 7T.

There are numerous such biomarkers under investigation. The earlier and more accurate detection and diagnosis of diseases will doubtless be enabled in the future by recent progress in other technologies such as proteomic or gene analyses, but there will still be a major continuing role for non-invasive imaging to obtain information on the location and extent of diseases, as well as assessments of tissue characteristics that can monitor and predict treatment response and guide patient management. Magnetic resonance will uniquely be able to provide such insights.

Learning objectives:

1. to understand the role of imaging biomarkers ADC and DCE-MRI in characterizing tumors
2. to understand how hyperpolarization can be used to obtain images of metabolites
3. to understand how functional MRI can be used to characterize drug effects on the brain