

Recent advances in hardware and software have made possible the development of new Magnetic Resonance Imaging (MRI) and Spectroscopic Imaging (MRSI) techniques in clinical scanners that are able to integrate information about the morphological, structural and vascular properties of tissue with parameters that reflect both normal and abnormal cellular metabolism. These have important implications for all phases in the management of cancer patients, including making an initial diagnosis, evaluating prognosis, planning focal therapy and assessing whether post-therapy changes correspond to the formation of necrosis or tumor recurrence.

Diffusion tensor imaging (DTI) is a technique used to measure the apparent diffusion coefficient and to determine whether the tissue architecture provides a preferred direction for the diffusion of water. This employs fast imaging techniques such as echo planar or single shot fast spin echo imaging which rely upon fast gradient switching. Although many of the applications have focused on DTI of brain tumors, tissue such as the breast and prostate also have ordered structures that are disrupted by tumor infiltration.

The most common techniques for evaluation of vasculature in the brain involves tracking the susceptibility effect of the first pass of a bolus of Gadolinium. The magnitude of the signal drop reflects the relative cerebral blood volume (rCBV) and the percent signal recovery reflects the integrity of the blood brain barrier. As high grade tumors are known to have increased vascularity with the possibility of a compromised blood brain barrier, these parameters can be used infer the spatial extent of the abnormality and to aid in distinguishing between high and low grade lesions. In the body the more commonly used technique focuses on the permeability of the microvasculature. Major applications include the evaluation of breast lesions, head and neck cancers, sarcomas and prostate cancer.

Major applications of MRSI have been the evaluation of patients with brain tumors and prostate cancer. In both cases the differences in metabolic signatures for water suppressed proton spectra between normal, necrotic and tumor tissue are considerable. For typical acquisition parameters the three main peaks in normal brain spectra are choline (Cho), creatine (Cr) and N-acetylaspartate (NAA). In pathology the NAA is reduced or absent due to a loss of normal neuronal function and the intensity of the Cho peak is elevated well above the level in normal tissue. In necrosis there is very little evidence of normal brain metabolites but there may be lipid or lactate due to a loss of tissue integrity. Similar increases in Cho are observed for patients with prostate cancer, with the markers of normal tissue function being citrate and a broad peak corresponding to polyamines.

The educational objectives of this presentation are to familiarize the audience with the major techniques used to obtain MRI and MRSI data from cancer patients and to illustrate how the integration of this information can be used in characterizing lesions, planning focal therapy and evaluating response to therapy.