AbstractID: 4418 Title: Advanced MR Imaging of Brain Gliomas: Implications for Radiation Therapy

Brain gliomas are characterized by local infiltration and invasion of surrounding brain tissue. The limited responsiveness of these tumors to conventional modes of treatment underscores the critical need to improve our understanding about tumor heterogeneity through the use of in-vivo imaging, ultimately leading to the design and testing of new treatments.

Radiation therapy (RT) is a mainstay in the treatment of malignant brain tumors but there is significant room for improvement. Recent technical advances in the field of RT delivery allow for optimized, normal tissue sparing treatments with greater radiobiological effectiveness. However, these new powerful tools can only garner the greatest benefit if directed to the most appropriate (most aggressive and/or radioresistant) tumor region.

Magnetic resonance imaging (MRI) is considered the current imaging standard for brain gliomas and is widely used for target definition in RT. However, its information is limited to the morphologic tumor appearance. Radiographically, the presence of contrast enhancement on T1-weighted images indicates leakage of intravenous contrast into the tumor and signals a disruption of the blood-brain-barrier (BBB). This area is currently considered to reflect the most malignant area of the tumor whereas the hyperintensity on T2-weighted images is presumed to reflect a mixture of edema and tumor cell infiltration. However, it is increasingly accepted that this assumption is not fully justified due to the presence of contrast enhancement in areas of necrosis, the lack of contrast enhancement in certain regions of metabolically active tumor, and the inability of the T2 hyperintensity to distinguish between infiltration and nonspecific processes such as inflammation and reactive edema. Similarly, morphologic imaging is limited in the assessment of treatment effects/response.

New MR-based techniques have shown promise as a means of providing information on tumor metabolic characteristics and its biological behavior which ultimately will allow us to optimize, monitor, and assess therapeutic interventions beyond that currently provided by tools for the morphologic assessment of a malignant brain tumor. 3D Proton Magnetic Resonance Spectroscopy Imaging (MRSI) provides information on tumor cellularity and cell membrane breakdown, cellular energetics, neuronal activity, and hypoxia through its ability to distinguish signals from cellular metabolites such as choline, creatine, NAA, lactate, and lipid. Diffusion Weighted Imaging (DWI) provides additional information on cellularity, cell membrane permeability, intra- and extracellular diffusion, and tissue architecture, whereas Perfusion Weighted Imaging (PWI) provides insight into overall cerebral blood volume, tissue microvasculature and vessel permeability. The combination of these metabolic and physiologic modalities with standard anatomic MR modalities will enhance our current understanding of tumor heterogeneity and will provide guidance as to how to optimize current treatment approaches. Based on results from our current studies, we hypothesize that the continued failure of current targeted treatment approaches is in large part caused by insufficient knowledge about the tumor extent, its heterogeneity, and its biological behavior, resulting in directing some or all of the focal therapy to the wrong location.

In addition to assisting in image guidance for RT, these imaging tools hold promise for assessing and predicting therapeutic response and to help distinguish treatment effect and tumor recurrence.