ISM RM 2008 Toronto Meeting - Syllabus Contributions

Imaging Brain Tumors: From Physiology to Therapy

Tumor Biology with MR Spectroscopic and Perfusion Imaging

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Educational Objectives
Upon completion of this course, participants should be able to

▪ describe clinical relevance of physiological MRI techniques in the diagnosis of brain tumors;
▪ summarize recent findings related to the use of H-MRS, PWI, fMRI and DTI for planning tumor resection and fractionated radiation therapy; and
▪ discuss how physiological MRI techniques can be used to obtain a quantitative assessment of response to therapy.

SPECIFIC LEARNING OBJECTIVES

1. To provide an update of the literature on MR Perfusion and MR Spectroscopic Imaging in the characterization of tumor biology
2. To provide some standardized guidelines for performing perfusion MR and MR Spectroscopic imaging in brain tumor imaging
3. To understand how to increase our diagnostic accuracy and specificity for differentiating tumoral from non-tumoral diseases such as ischemia, encephalitis, tumefactive demyelinating lesions, radiation/therapeutic necrosis from recurrent tumor, primary from metastatic disease and understand some of the pitfalls associated with using these techniques
4. To review whether MR Spectroscopic and Perfusion Imaging can be used to characterize glioma biology and quantify response to therapy
5. To correlate functional genomics with advanced imaging techniques
MR spectroscopic (MRS) and Perfusion MR Imaging are now widely utilized in characterizing brain tumors, from the quantitation of physiology to the monitoring of therapy: differentiating between neoplastic and non-neoplastic lesions, characterizing tumor biology and grade, targeting sites for biopsy, assessment of tumor infiltration, progression and therapeutic response, and identification of residual or recurrent tumor (1-3). MRS is sometimes limited by its apparent low specificity. Increased Cho/Cr ratio is identified in numerous intracranial pathologies. To increase specificity, it is important to compare the abnormal spectrum with one from the contralateral normal brain. Increased Cho levels in comparison with the contralateral normal Cho, i.e. $\text{Cho}_{Abn}/\text{Cho}_n$, is in keeping with tumoral disease, with higher Cho levels indicating higher glioma grade. On the other hand, a decrease in $\text{Cho}_{Abn}/\text{Cho}_n$ would more likely favor non-neoplastic pathology, such as ischemia, encephalitis, radiation necrosis or a tumefactive demyelination lesion. Dynamic susceptibility contrast magnetic resonance imaging (DSC MRI) is one of the most commonly used techniques for characterizing brain tumors (4). It allows the non-invasive evaluation of hemodynamic parameters, such as cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT), and time to peak (TTP), as well as the estimation of the vascular permeability. Acute ischemia generally demonstrates decreased CBF and increased MTT/TTP. The CBV can be elevated or decreased depending on the level of hypoperfusion (vasodilation due to autoregulation or collateral vascularization results in an increase in CBV, with more severe hypoperfusion and chronic ischemia, CBV is decreased). We will review the recent findings related to the application of MRS and Perfusion imaging in brain tumor diagnosis and therapy, particularly in the quantitation of various metrics. We will also propose a quantitative,
algorithmic approach to imaging brain tumors (5, 6) which incorporates MR spectroscopy, diffusion and perfusion imaging, to increase our diagnostic accuracy and specificity in neurodiagnosis.

Despite the widespread application of perfusion MR and MR Spectroscopic imaging in both clinical practice and research, there are no standardized guidelines available. We provide some standards and guidelines which can be used not only in individual centers but could be applied in multi-center, prospective clinical trials which may require the use of a surrogate biomarker as end points for determination of therapeutic efficacy.

References