MRI/MRS in Animal Models of Cancer

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Highlights:

- The choice of an appropriate tumor model (subcutaneous, orthotopic or spontaneous) depends on the scientific question being probed.
- Physiological monitoring is important for obtaining quality data.
- Tumor metabolism, such as glycolysis, bioenergetics and lipid metabolism can be studied by MRS, specifically ^{13}C MRS plays a key role in studying oxidative metabolism.
- DCE-MRI can be used as a surrogate of hypoxia and blood flow.
- Diffusion weighted imaging can be used for monitoring response to therapy.

This introductory lecture is geared towards “beginner” level scientists, who are interested in learning how to successfully perform MRI/MRS in animal models of cancer.

Animal models play an essential role in translational research, specifically developing MRI/MRS derived bio-markers for cancer diagnosis and monitoring treatment response. Ever since the first in vivo ^{31}P MRS studies of cancer in the early 70’s, rodent tumor models have played a pivotal role in the development of MRI and MRS methods for monitoring treatment response. However, the challenge remains in the proper choice of tumor models and MRI/MRS methodologies so that the techniques developed in the animal models can be easily translated into the clinic. This lecture will discuss the various models available and their specific applications in studying metabolism, blood flow and response assessment.

Physiological monitoring of ECG, respiration and body temperature is typically performed using MR compatible devices and MRI/MRS signal acquisition can be gated to the cardiac or respiratory rate to reduce motion induced artifacts. The choice of the radio-frequency coil is determined by the tumor model with most studies being performed using a surface coil. We will discuss the various coils available and the experimental setup for physiological monitoring in order to achieve optimal SNR and to minimize motion-induced artifacts.

MRS methods suffer from relatively poor sensitivity and can only detect metabolites in the mM range. However, MRS provides increased specificity to metabolic processes and both steady state as well as kinetic analysis of cancer metabolism can be studied in animal models using ^{1}H, ^{31}P, ^{19}F or ^{13}C MRS. We will discuss some examples illustrating the potential of MRS in studying tumor choline and lipid metabolism as well as bioenergetics and glycolysis.

We will also address the practical issues in performing quantitative DCE-MRI and diffusion imaging studies in cancer models as these studies necessitate high spatial and temporal resolution data and are highly sensitive to motion-induced artifacts. The lecture will illustrate the applications of DCE-MRI as a surrogate marker of blood flow and hypoxia in tumor models and provide the historical perspective of how the ongoing studies on diffusion imaging of cancer models have led to its use as an imaging biomarker of response assessment.

This lecture will provide the student with an overview of the advantages and disadvantages of performing MRI/MRS studies in animal tumor models.