Specialty area: Novel Contrast: CEST, Heteronuclear

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Highlights

- CEST and Heteronuclear imaging provide advantages over T1 and T2* agents for monitoring cancer therapy
- ^{19}F imaging agents appears promising for monitoring therapeutic cell grafts
- CEST imaging agents appear promising for monitoring nanoparticle based chemotherapy

Why use Imaging Agents for Cancer Imaging?

There has been a tremendous amount of interest in developing new MR imaging agents for detecting the presence of tumors, determining their type, or monitoring treatment. Recently there has been tremendous progress in the development of both CEST imaging technology and ^{19}F MR imaging agents, allowing their application to cancer. In this syllabus, I will focus on the use of ^{19}F and CEST imaging for the grading of brain tumors, monitoring of radiation therapy for brain tumors, monitoring of nanocarriers of chemotherapeutics, and tracking of therapeutic dendritic cells after transplantation.

CEST imaging and Cancer

CEST imaging studies have been performed on brain tumors for over a decade now, with the first studies focusing on detecting and grading brain tumors through quantifying the amount of amide protons in these tumors through Amide Proton Transfer (APT) contrast [1]. The amount of CEST contrast in APT images has now been related to tumor grade in patients.

In this lecture we will review recent studies that have shown how to develop CEST imaging agents which can be used to monitor cancer treatment. For example, Terreno and co-workers have shown that liposomes which contain paramagnetic shift agents can be used as CEST agents allowing the possibility of developing agents which can be tracked through imaging agent and delivery therapeutics, so called theranostic agents [2]. We will examine a range of theranostic CEST agents have been prepared and tested pre-clinically, and appear quite promising.

^{19}F imaging probes

Perfluorocarbon emulsions have been developed which show great promise for molecular imaging applications by the Lanza, Wickline, and Ahrens groups[3,4]. While sensitivity for these systems has always been a concern, these imaging agents have displayed suitable sensitivity for the tracking of therapeutic transplanted cells, including dendritic cells of interest for treatment of cancer. One advantage of this technology is in quantification, as ^{19}F imaging agents have no background like T1, T2 or T2* contrast agents. Metal-based T1, T2, T2* agents will create image contrast based on the effect the metals have on water relaxation, resulting in difficulties in clarifying whether image contrast is due to presence of imaging agent or from other sources. Recently, theranostic nanocarriers have also been prepared containing ^{19}F imaging agents, allowing their subsequent tracking as well. In addition, 19F agents can report on oxygenation.

References

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2. Aime S, Castelli DD, Terreno E. Highly sensitive MRI chemical exchange saturation transfer agents using liposomes. *Angewandte Chemie-International Edition.* 2005;44(34):5513-5515.
3. Waters EA, Chen J, Allen JS, Zhang H, Lanza GM, Wickline SA. Detection and quantification of angiogenesis in experimental valve disease with integrin-targeted nanoparticles and 19-fluorine MRI/MRS. *J Cardiovasc Magn Reson.* 2008;10:43.
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