Title: Divalent Europium in Magnetic Resonance Imaging

Abstract: Eu$^{II}$ is isoelectronic with Gd$^{III}$, resulting in both ions having desirable properties with respect to enhancing contrast in magnetic resonance imaging. Recently, the use of Eu$^{II}$ as an in vivo contrast agent was reported. In this context, the contrast enhancement ceased upon oxidation, enabling the hypoxic core of a tumor to be imaged. However, the oxidized europium species did not produce enhancement in $T_1$-weighted images, leading to a desire to couple a detection method for Eu$^{III}$ with Eu$^{II}$-based contrast agents. To detect Eu in both the +2 and +3 oxidation state, we used a variety of ligands to access properties amenable to imaging techniques other than $T_1$-weighted $^1$H-magnetic resonance imaging. These methods include imaging other nuclei or using chemical exchange saturation transfer with magnetic resonance imaging. Our results indicate that it is possible to detect both oxidation states of europium, but that the best method of detection depends on the ligand.