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Chemical Exchange Saturation Transfer (CEST) enhanced molecular imaging

Chemical exchange saturation transfer (CEST) based magnetic resonance (MR) methods are widely used to probe chemical exchange phenomenon in both model systems as well as in biological tissues *in vivo*. These methods probe exchanging spin dynamics and provide endogenous molecular contrast, which among other MR parameters depends on the concentration and pH of the solute spins.

CEST methods require slow to intermediate exchange on the NMR time scale (chemical shift ($\Delta\omega$)> exchange rate (k)), and they primarily probe longitudinal magnetization exchange. The major advantage of the CEST method is that, depending upon the rates of exchangeable spins, it inherently has an order of magnitude or greater sensitivity advantage over conventional magnetic resonance spectroscopy (MRS) methods. CEST has been exploited to assess pH in biological tissues in vivo, to quantifyglycogen in liver, glycosaminoglycans in cartilage, myoinositol (MI) and glutamate (Glu) in brain, creatine (Cr) in brain, skeletal muscle and myocardium as well as in studying gene expression, and differentiation between gliomas and radiation necrosis. Recently, some preliminary results demonstrating the feasibility of measuring pH based cell viability and glucose as a biodegradable MRI contrast agent have been described

Given the broad spectrum of exchange rates of amide, amine and hydroxyl protons on biologically important molecules, higher static magnetic field strengths allow a wider range of exchange rates to be probed. Consequently, the advent of whole body 7T MRI scanners has reinvigorated research activity in CEST mediated molecular imaging and expanded the range of the metabolites able to be probed *in vivo*. In addition, there is a separate class of exogenous agents, known as PARACEST agents that combine exchangeable protons capable of providing CEST with a paramagnetic metal ion. Since PARACEST agents create larger chemical shifts between exchangeable protons, CEST experiments involving these agents have significantly reduced direct water saturation effects.

In this presentation, brief outline of the basic principles, technical requirements, sensitivity advantages and recent developments of CEST methods, and their implementation in measuring endogenous metabolites in biological systems will be provided. Some representative examples of detecting endogenous metabolites in pathological conditions such as tumors and Alzheimer's disease will be described. In addition, advantages and potential challenges of CEST MRI in quantifying the metabolites under *in vivo* environments will be discussed.

Biography

Ravinder Reddy joined the Scientific Advisory Board in 2005 and is currently a Professor of radiology at the University of Pennsylvania and a director of the Center for Magnetic Resonance and Optical Imaging, a NIH-funded research center. His research interests include novel, multinuclear magnetic resonance imaging and spectroscopic techniques for early diagnosis of cancer and Alzheimer's disease. He is an active member in the International Society of Magnetic Resonance Imaging in Medicine and the Osteoarthritis Research Society International, and serves as a referee for the *Journal of Magnetic Resonance and Magnetic Resonance in Medicine*. Ravinder holds a B.Sc. in math, physics and chemistry from Osmania University in Hyderabad, India, a M.Sc. in chemistry from Kakatiya University in Warangal, India and a Ph.D. in chemistry from the Indian Institute of Technology in Kanpur, India.

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