Chemical Exchange Saturation Transfer (CEST)

Chemical Exchange Saturation Transfer (CEST) has drawn considerable attention as a novel mechanism of MRI contrast. This method provides more detailed physiological and functional information than conventional MRI and has emerged in the field of molecular imaging [1) 2)].

A CEST MRI with unevenly segmented RF saturation was implemented, including a long primary RF saturation to induce the steady-state CEST effect, maintained with repetitive short secondary RF irradiation between readouts. This configuration reduces relaxation-induced blur artifacts during acquisition, allowing fast 3D spatial coverage. Numerical simulations were performed to select parameters such as flip angle (FA), short RF saturation duration (Ts2), and the number of readout segments. The sequence was validated experimentally with data from a phantom, healthy volunteers, and a brain tumor patient.

Results: Based on the numerical simulation and l-carnosine gel phantom experiment, FA, Ts2, and the number of segments were set to 20°, 0.3 s, and the range from 4 to 8, respectively. The proposed method minimized signal modulation in the human brain images in the kz direction during the acquisition and provided blur artifacts-free CEST contrast over the whole volume. Additionally, the CEST contrast in the tumor tissue region is higher than in the contralateral normal tissue region.

It is feasible to implement a highly accelerated 3D EPI CEST imaging with unevenly segmented RF irradiation [3)]

The aim of a study was to detect and localize fungal brain lesions caused by Cryptococcus species based on Chemical Exchange Saturation Transfer (CEST) MR imaging of endogenous trehalose, and hereby to distinguish cryptococcomas from gliomas. In phantoms, trehalose and cryptococcal cells generated a concentration-dependent CEST contrast in the 0.2 - 2 ppm chemical shift range, similar to glucose, but approximately twice as strong. In vivo single voxel MRS of a murine cryptococcoma model confirmed the presence of trehalose in cryptococcomas, but mainly for lesions that were large enough compared to the size of the MRS voxel. With CEST MRI, combining the more specific CEST signal at 0.7 ppm with the higher signal-to-noise ratio signal at 4 ppm in the CryptoCEST contrast enabled localization and distinction of cryptococcomas from the normal brain and from gliomas, even for lesions smaller than 1 mm3. Thanks to the high endogenous concentration of the fungal biomarker trehalose in cryptococcal cells, the CryptoCEST contrast allowed identification of cryptococcomas with high spatial resolution and differentiation from gliomas in mice. Furthermore, the CryptoCEST contrast was tested to follow up antifungal treatment of cryptococcomas. Translation of this non-invasive method to the clinic holds potential for improving the differential diagnosis and follow-up of cryptococcal infections in the brain [4)].

1)
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