Industry Day # Sustainable Medical Technologies

Development of CEST MRI methods with Clinical Applications

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Abstract

Development and optimization of Chemical Exchange Saturation Transfer (CEST) MRI methods for better computation of CEST contrast along with evaluation of clinical applications in differentiation of neo-plastic from infective mass lesions. Studies were carried out using numerical simulations as well as experimental data from human brain and rat brain at 3T, 7T and 9.4T MRI Scanner.

Introduction

CEST MRI[1,2] is a novel non-invasive MRI technique for high spatial resolution molecular mapping at very low concentration. It is based on chemical exchange phenomenon between protons of small molecules and bulk water. It provides molecular information for characterization and understanding of tissue. CEST has shown potential in pre-clinical and clinical applications for better diagnosis of diseases as well as monitoring of treatment responses. The objectives of the study were:

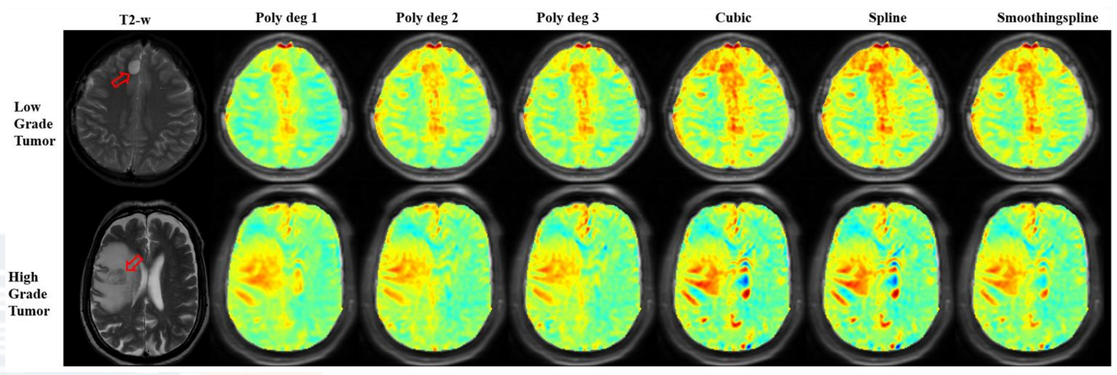
(i) Optimization of parameters for acquisition of CEST data at optimal scan time
(ii) Development of Z-spectra fitting methods for accurate computation of CEST contrast
(iii) To differentiate between neo-plastic and infective mass lesions as well as among different groups of Intra-cranial mass lesions[5]
(iv) Pulse sequence development for maximization of CEST contrast and minimization of scan time

Materials and Methods

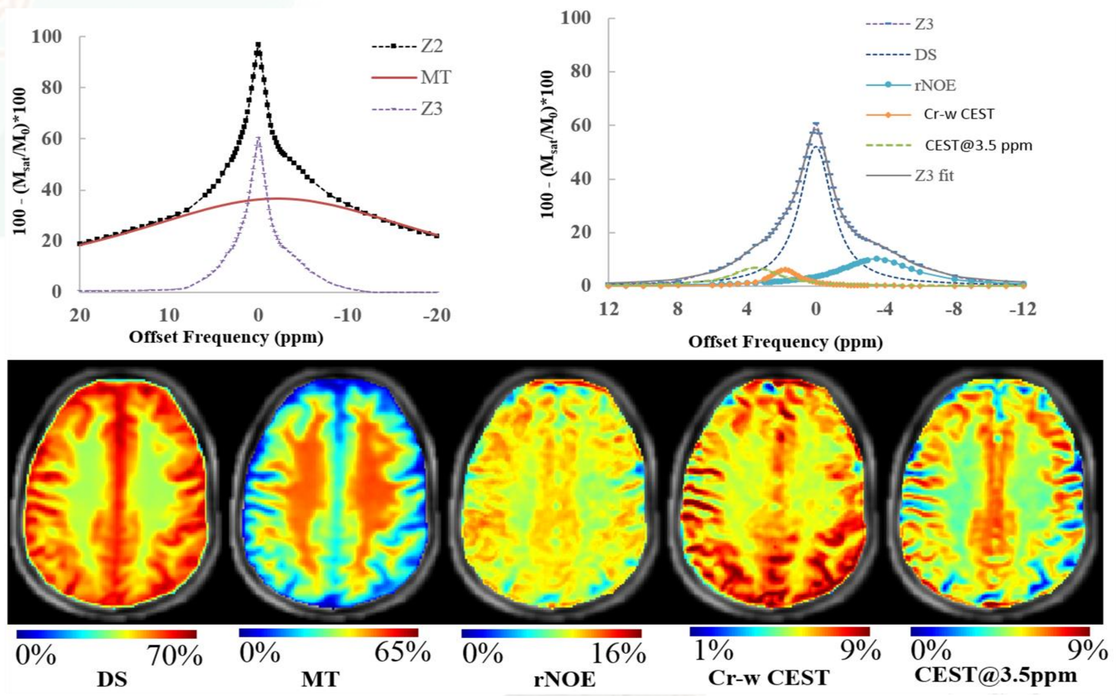
- Generally, CEST contrast is computed using CEST asymmetry analysis ($CEST_{asy}$). CEST data or Z-spectra[3,4] data is also acquired at multiple offset saturation frequencies followed by fitting of different components of Z-spectra to compute individual CEST contrast.
- Developed pulse sequence was tested on designed phantom using egg white portion.

Results

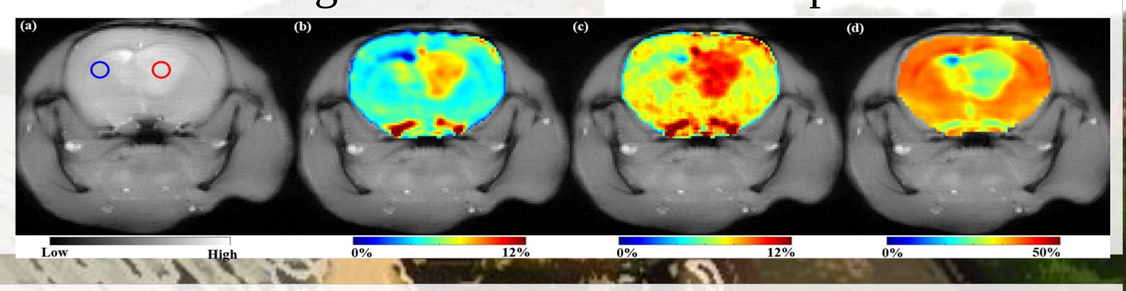
- Finer step-size provides good quality of CEST maps while higher sampling step-size provide coarser quality of contrast with high normalized-mean-square-errors. Optimal step-size: 0.2 to 0.3 ppm
- Optimal Interpolation method – 2nd, 3rd Polynomial



- Proposed[6] Z-spectral fitting method is better than existing conventional super-position of Lorentzians in term of stability to noise.



- Application in rat brain tumor by removal of contaminating effects for accurate computation



Conclusions

The study developed CEST methods for better quantitation of CEST contrast as well as evaluated the potential of CEST MRI in different disease conditions such as differentiation of Low grade and high grade tumors, Tuberculosis etc

Industrial Significance

Method development for better diagnosis of disease

Technology Readiness Level: The study can be translated to clinical practice

References

[1] Ward KM et al JMR 2000 [2] Zhou J et al Nat Med 2003 [3] Cai K et al Nat Med 2012 [4] Debnath et al ISMRM 2017 [5] Debnath et al Molecular Imaging and Biology 2019 [6] Singh et al NMR in Biomedicine 2019

Acknowledgement

The authors acknowledge Dr. Ravinder Reddy at University of Pennsylvania, USA for CEST data at 7T (human data) and 9.4T (rat data). The authors also thank Dr. RK Gupta at Fortis Hospital, India for patient data at 3T.

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