ALTERED CEST SPECTRUM WITH DIFFERENT IMAGING READOUT SCHEMES

Sheng-Min Huang[1], Shang-Yueh Tsai[2], Teng-Yi Huang[3], Yi-Chun Wu[4], and Fu-Nien Wang[1]

[1]*Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, Hsinchu, Taiwan,* [2]*Graduate Institute of Applied Physics, National Chengchi University, Taipei, Taiwan,* [3]*Department of Electrical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan,* [4]*Molecular Imaging Center, Chang Gung Memorial Hospital, Taoyuan, Taiwan*

Introduction

Chemical exchange saturation transfer (CEST) is a novel technology for measuring microenvironment properties and has promising *in vivo* applications such as pH detection and molecular imaging. [1, 2] Conventionally, the pulse sequence of CEST consists of two parts: magnetization preparation and image acquisition. A long continuous wave (CW) or a series of pulses are utilized for the saturation transfer effect in the magnetization preparation part, and the optimization method of the magnetization preparation part had been studied in previous reports. [3, 4, 5] Here we aim to investigate the effect of the image acquisition RF on the Z-spectra and MTR_{asym}. Two imaging readout schemes, RARE and spin-echo EPI, were utilized in this phantom experiment.

Materials and Methods

As shown in Fig. 1, a dual gel phantom was prepared by 50mM creatine in 3% agarose and filled into a 50 mL centrifuge tubes, and then put into a 150 mL plastic bottle, which was filled with 3% agarose only. The pH value of creatine was titrated to 6.96 carefully by sodium hydroxide for fine CEST contrast. All experiments were carried out on a 4.7 T Bruker Biospec 47/40 spectrometer with a volume coil for both RF transmission and reception. Fastmap shimming was used to reduce the field inhomogeneity, and the basic frequency of water was carefully adjusted. RARE and spin-echo EPI acquisitions were performed after an identical 1.25μT, 4 sec CW RF magnetization saturation irradiation. Scanning parameters including RF pulse shape, length and power were all identical for ensuring that number of refocusing RF pulses was the only varying factor. Hermite RF pulse shape was used both for excitation and refocusing, and the length of π/2 RF and π RF are 2.368 ms and 1.500 ms, where the corresponding bandwidth were both 2280 Hz. Imaging parameters were: FOV=8x8cm, matrix size=64x64, slice thickness=5mm, TE (effective TE for RARE)=50ms, TR=11.5s. The off-resonance frequencies of CW RF were swept between -600 to +600 Hz of water frequency with a step of 100 Hz. Z-spectra and MTR_{asym} were both evaluated by MATLAB scripts.

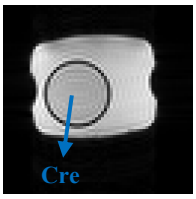

Fig. 1 A dual 3% gel phantom with creatine in the inner tube for CEST effect.

Results

Fig. 2 shows the two z-spectra evaluated from RARE and spin-echo EPI image series. It is noted that the z-spectrum acquired by RARE was lower than by spin-echo EPI. This difference indicated that direct saturation, or so-called spillover effect, was higher in RARE. Since RARE and spin-echo EPI are vary with the number of refocusing RF, it is speculated to be the contribution of multiple π RF pulses. In Fig. 3, the MTR_{asyms} of RARE image and spin-echo EPI image were displayed. Note the larger MTR_{asym} was achieved by spin-echo EPI, since the spillover effect may reduce the MTR_{asym} by using RARE.

Discussion and Conclusion

Conventionally, the spillover effect explains the signal suppression by the off-resonance RF of magnetization preparation part of CEST pulse sequences. In this study, we have demonstrated that the imaging acquisition RF also has a spillover effect because of refocusing π RF pulse. The imaging RF effects were ignored previously. Since both the power and bandwidth of 180 refocusing RF pulse are relatively large, the spillover effect generated by multiple refocusing RF pulses is strong. Consequently, though we can obtain fine image quality by RARE acquisition, special optimization of the multiple refocusing RF pulses is necessary. Further investigation is needed for applying high quality RARE for CEST imaging.

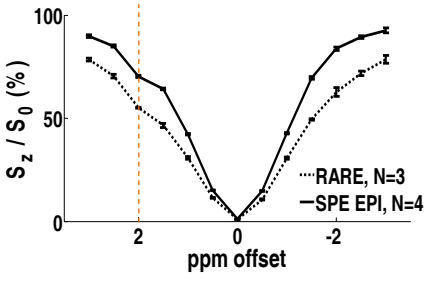

Fig. 2 Z-spectra evaluated from RARE and spin-echo EPI image series. Note the significant broadening of RARE z-spectrum than of spin-echo z-spectrum.

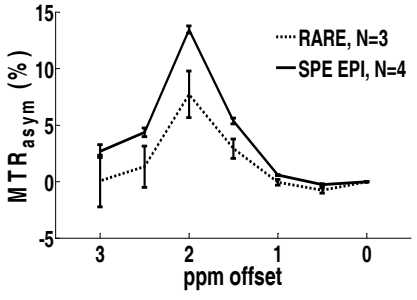

Fig. 3 MTR_{asym} of RARE and spin-echo EPI readout. Note the MTR_{asym} of spin-echo EPI was larger than of RARE acquisition.

References

1. Ward KM et al. Magn Reson Med 44(5):799-802, 2000.
2. Zhou J et al. Prog Nucl Magn Reson Spectrosc 48(2-3):109-136, 2006.
3. Sun PZ et al. J Magn Reson 175(2):193-200, 2005.
4. Schmitt B et al. Magn Reson Med 65(6):1620-1629, 2010.
5. Zu Z et al. Magn Reson Med 66(4):1100-1108, 2011.