CEST MRI of Human Liver at 3T

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Introduction:

Liver is a vital organ that regulates many key metabolites in the body. Various MR techniques including contrast-enhanced MRI, MR elastography, diffusion-weighted (DW) imaging, and MR perfusion imaging have been utilized to monitor different liver diseases. A number of metabolites containing –OH, -NH and –NH2 groups with chemical exchange saturation transfer (CEST) effects have been shown to change in liver diseases. However, CEST MRI of liver *in-vivo* is vulnerable to motion artifacts. In this preliminary study, we have implemented a CEST FLASH (Fast Low Angle SHot) imaging sequence at 3T clinical scanner, with which artifact-free CEST images can be acquired in a single breath hold. CEST Z-spectral asymmetry profile from the normal human liver has been characterized. CEST MRI of liver may open a new way to look in to the liver disease onset and progression.

Methods:

We have developed a CEST FLASH imaging sequence for liver imaging using pre-saturation Hanning-windowed RF pulse train (Peak B1 300Hz and duration 200ms) followed with FLASH gradient echo readout. The imaging parameters were: single shot acquisition with 192 echoes per TR (5s) in the centric order, slice thickness = 5mm, short TR=5.5ms, TE =2.6ms, field of view =300*300 mm^2, matrix size =192*192. The total imaging time for a pair of CEST images (S+ and S-) with saturation at positive and negative frequencies is about 10s, which is within a single breath hold. The saturation pulse train consisted of four 50ms long pulses with 0.2ms delays between each segment. Three normal healthy volunteers (27-35 years old) with informed written consent underwent liver CEST imaging at 3T clinical MR scanner using body array RF coils. CEST contrast was calculated as 100%*(S- - S+)/S- pixel by pixel. The Z-spectra were generated over a frequency range of ±5.0ppm with 0.25ppm step size. This study was conducted under an Institutional Review Board (IRB) approved protocol.

Results:

The CEST Z-spectral asymmetry curve from the liver of a healthy volunteer (Figure 1A) shows a broad CEST effect from 1ppm to 3ppm. The CEST effect at ~1ppm is possibly due to the glycogen present in the liver as reported[1]. An axial anatomic image of the liver is shown in Figure 1B. CEST contrast map at 3ppm is shown in Figure 1C. Liver tissue shows significantly high CEST contrast (>15%) at 3ppm probably due to the presence of metabolites with exchangeable –NH2 protons, such as free amino acids (AAs) and proteins in the liver.

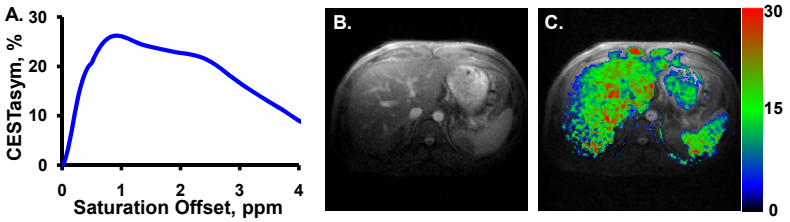

Figure 1. A. Z-spectrum CEST asymmetry curve of liver in-vivo shows CEST effect ranged from 1ppm to 3ppm. B. CEST image at -3ppm. C. CEST map at 3ppm.

Conclusions:

We have implemented a CEST FLASH imaging sequence at 3T clinical scanner, with which artifact-free liver CEST images can be acquired in a single breath hold. CEST Z-spectrum asymmetry profile from the normal human liver has been characterized and shows broad CEST effect from 1 to 3ppm range. The contributions to the liver CEST effect from liver methabolites are under investigation. Once established, CEST MRI of liver may open a new way to look in to the liver disease onset and progression.

Acknowledgements:

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Reference:

1. van Zijl, P.C., et. al., Proc Natl Acad Sci U S A 104, 4359-4364 (2007).