Fetal and Placenta Imaging and Spectroscopy at 21.1 T

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Introduction

This report outlines the continuing effort to gain *in vivo* information on the maternal/fetal interface. Using the 21.1 T system, increased sensitivity and information from a multitude of techniques, such as chemical exchange saturation transfer (CEST) and localized magnetic resonance spectroscopy (MRS), can be beneficial. However, fetal and placenta imaging in a vertical magnet is associated with many challenges, such as motion artifacts, limiting data repeatability. The current work focuses on implementing new acquisition schemes or post processing methods to limit these artifacts.

Experimental

All MRI experiments were performed with the 21.1 T magnet at the NHMFL, and all work has been conducted in accordance with the FSU Animal Care and Use Committee. MRI glucoCEST by oversampling: Pregnant CD-1 mice at day 16-17 of gestation received a cannula in the lateral tail vein for *in situ* injection of 4-mg D-glucose/g body weight. The animals were placed in the magnet under anesthesia and centered in the coil for fetal imaging. A single 1-mm thick axial slice was placed at a position where as many fetuses and placentas could be seen simultaneously. A modified turbo spin echo sequence was used for all CEST acquisitions, and each offset was acquired in one shot (6 s). CEST was performed by repeating seven off-resonant pulses (0.8-1.4 ppm) to capture the majority of glucoCEST contrast, resulting in a 90-min scan. Injection of glucose occurred at 8 min following start of the acquisition. Data were processed in MatLab for visualization of the dynamic CEST contrast. Fetal and placental MRS: Using a localized relaxation enhanced MRS sequence [1,2], a voxel was placed in either fetal brain or placenta. TR was 2.5 s, and 4000 points were acquired using 128 averages. All spectra were processed with 20-Hz apodization and zero filling to 16k points in JMRUI [3].

Results and Discussion

Fig. 1 shows the dynamic CEST contrast in a placenta after glucose injection. Top graph shows the raw data while the bottom graph shows the relative change to initial baseline. A clear increase in glucose CEST contrast can be seen a few minutes after the injection. Outliers can be seen during the acquisition (red arrows), which likely originate from motion artifacts. **Fig. 2** shows a spectra from the placenta. The spectra show distinct peaks at the resonances consistent with literature [3].

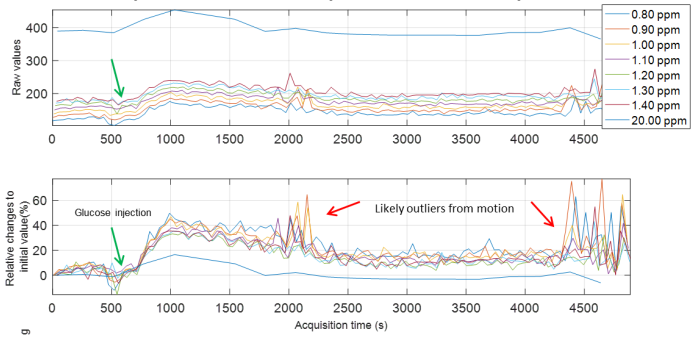

Fig.1 CEST signal over the 90-min scan. Relative changes (lower graph) show increasedglucose CEST signal after glucose injection (green arrow)

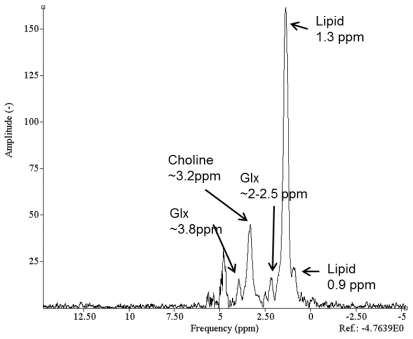

Fig. 2 Fetal spectra showing distinct peaks consistent with literature.

Conclusions

Our data show that it is possible to acquire fetal and maternal (placenta) *in vivo* MRI and MRS data with high SNR to gain crucial information of the fetal/maternal interface at 21.1 T. Current efforts are underway to improve repeatability by mitigating motion distortions proven to be prominent in abdominal imaging of animals positioned vertically.

Acknowledgements

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References

[1] Shemesh, N., *et al.*, Nat Commun., **17(5),** 4958 (2014).
[2] Abad, N.. *et al.,* Magn Reson. Med., **79**, 1266-1275 (2018).
[3] Stefan, D., *et al.,* Meas Sci and Tech, **20**, 104035 (9pp) (2009).