

Nonconventional MRI for Fetal Imaging

P. Ellen Grant, MD

Beyond Fast T2 Imaging

Although in most centers fast T2 imaging such as T2 HASTE or SSFSE have remained the primary pulse sequence utilized in fetal MR imaging for a decade, they leave much to be desired. The fast acquisition minimizes motion artifact but this comes at a cost of tissue contrast and sensitivity to many abnormalities. As a result more centers are routinely adding other pulse sequences that may require longer acquisition times but add the potential for increased detection of pathology. These sequences include:

1. T2* imaging to detect blood products
2. T1 imaging to detect methemoglobin or malformations such as Tuberous Sclerosis Complex
3. MRS to detect lactate as well as assess Cho, Cr and NAA levels
4. DWI to detect metabolic compromise/evolving tissue injury
5. CINE sequences to assess fetal movement

A few centers are also attempting to obtain additional information with more advanced neuroimaging such as

1. DTI to assess white matter coherence and perform tractography
2. Resting state or auditory fMRI
3. Perfusion imaging with ASL

Post Processing Advances

Much of the current research in fetal imaging lies in the arena of post processing. Multiple centers are developing methods to combine multiple fast T2 sequences acquired in 3 orthogonal planes to create volumetric data sets with minimal motion artifacts. In addition segmentation algorithms to assess volumetric growth and measures to assess cortical folding are emerging.

Other post processing modifications are aimed at multiple acquisitions of MRS, fMRI or DTI data with rejection of motion degraded images to improve data quality.

Sequence Development

Small FOV imaging may allow higher resolution fetal MR imaging. Motion mitigated sequences are under development at multiple centers for children after delivery but successful methods for fetal motion mitigation have not yet been published but remain an area of high potential.

3T Imaging

Imaging fetuses at 3T is currently not standard of care. However to take advantage of emerging technology, tying fetal imaging to 1.5T will severely limit the potential of fetal MR imaging. Concerns regarding heating and dielectric effects will be discussed.

Coil Development

Few centers are currently involved in coil development for the gravid abdomen. However with the emergence of 128 channel systems at 3T and the success of novel high density phased array cardiac coils suggest that similar arrays designed for the gravid abdomen may provide the SNR and acceleration factors to improve all pulse sequences.

In summary, we are at the beginning of advanced fetal neuroimaging with the goal to develop the technology necessary to make fetal neuroimaging equivalent in quality to postnatal imaging.