Research at a Glance

Robust preprocessing for stimulus-based functional MRI of the moving fetus

What’s known:
Research scientists are increasingly using in vivo functional magnetic resonance imaging (fMRI) to deepen their understanding of fetal brain development in healthy pregnancies and pregnancies complicated by such conditions as fetal growth restriction or congenital heart disease. fMRI is noninvasive and, because it does not rely on radiation, poses no risk to the mother or developing fetus. It detects blood oxygen level-dependent (BOLD) changes in the MRI signal that accompany changes in brain activity. Such fMRI images can provide an early warning of fetuses who are at risk for brain injury. The BOLD signal, however, can be degraded by the independent and collective movements of the mother and fetus.

What’s new:
A Children’s National Health System research team led by Wonsang You, a research associate in the Developing Brain Research Laboratory, worked out complex mathematical algorithms to account for independent fetal and placental motions, to erase those noise artifacts, and to validate the accuracy of the technique. They optimized motion correction and performed it separately in each phase and each region of interest, even as each phase and organ experienced different types of motion. They also examined oxygen transport in a small sample of healthy fetuses and pregnancies complicated by congenital heart disease (CHD), finding the degree of fetal motion increases slightly during hyperoxia in fetuses with CHD and showed higher variance. “[T]his work makes an important technical advance for robust preprocessing in stimulus-based functional neuroimaging studies of the fetal brain and placenta, and lays the foundation not only for noninvasive functional assessment of fetal brain-placenta unit, but also for enabling early detection of impaired fetal brain-placenta circulation,” according to You and colleagues.

Questions for future research:

Q: What is the optimal strategy to eliminate signal degradation during fMRI caused by the heart rate and breathing?

Q: While oxygen saturation rates differed between the placenta and fetal brain in normal pregnancies compared with fetuses diagnosed with CHD, are such differences also seen in pregnancies complicated by fetal growth restriction (FGR)?

Q: How does longer-term maternal hyperoxia affect fetal brain development in high-risk pregnancies, such as fetal CHD or FGR?