Name: Zungho Zun

Organization: Children's National Hospital

Abstract title: Measurement of blood oxygenation of the fetal brain using MR quantitative susceptibility mapping

Background: Quantitative susceptibility mapping (QSM) is a non-invasive MR imaging technique for measuring tissue magnetic properties. QSM is typically used to study iron deposition myelination, and hemorrhage in the brain. When susceptibility is measured in a large intravascular space such as superior sagittal sinus, it may be used to quantitatively estimate blood oxygenation of the whole brain.

Objective: The goal of this study is to demonstrate the feasibility of measuring blood oxygenation of the fetal brain non-invasively using QSM MRI.

Study Design/Methods: A healthy pregnancy was studied under a protocol approved by our institutional review board. QSM was performed using a 3D single-echo echo-planar imaging sequence with flow compensation on a GE MR750 3 T scanner using an 8-channel cardiac coil. Imaging parameters include TE = 50 ms, TR = 98.4 ms, FOV = 36 x 36 cm, matrix size = 256 x 128, and 30 slices with slice thickness of 3 mm. Pregnant woman was instructed to perform a breath-hold for the total scan time of 12 s. QSM reconstruction was performed using the approach of morphology-enabled dipole inversion (MEDI). Susceptibility was measured and averaged in the superior sagittal sinus across three consecutive slices. Blood oxygenation was calculated from measured susceptibility using $\Delta\chi = \Delta\chi do\ (1\text{-}Y)\ Hct$ where $\Delta\chi$ is the susceptibility of the vein, $\Delta\chi do$ is the susceptibility of fully deoxygenated blood, Y is oxygenation, and Hct is hematocrit. $\Delta\chi do$ was assumed to be 0.27 ppm, and hematocrit was estimated using the linear regression equation hematocrit = 22.9% + gestational age x 0.5%.

Results: Reasonable image quality of QSM data without severe motion artifacts was obtained. Average measurement of susceptibility in the superior sagittal sinus was 0.06 ppm. Hematocrit was estimated to be 38.6 % with gestational age of 31 3/7 weeks. With these values, blood oxygenation was found to be 42%. This is somewhat lower than oxygenation of the adult brain measured by 15O positron emission tomography, which is approximately 60%. However, lower oxygenation of the superior sagittal sinus may indicate oxygen-deprived state even in a normal pregnancy, and is corroborated by lower oxygenation of arterial blood in the fetus compared to adults.

Conclusions: We demonstrated the feasibility of performing QSM to estimate blood oxygenation of the fetal brain. Fetal QSM may provide a new, non-invasive means of evaluating ischemia of the fetal brain during pregnancy.