

Title:

IVIM MRI finds markers of increased perfusion in abnormally adherent regions of the placenta in placenta accreta spectrum disorder

Purpose or Case Report:

Intravoxel incoherent motion (IVIM) MRI uses multiple diffusion-weighted acquisitions to probe microvascular blood flow and molecular motions. Here, we evaluated if IVIM MRI of the placenta can differentiate regions of normal placental development versus abnormal placental adherence in the context of placenta accreta spectrum disorder (PASD).

Methods & Materials:

Pregnant patients (n=25) with a postnatal histopathologic diagnosis of PASD who were imaged between 2/2021 and 5/2023 were retrospectively analyzed. Diffusion-weighted MRI data were collected at 1.5T with $b = [0, 10, 25, 50, 100, 200, 400, 800, 1000]$ s/mm². Regions of interest (ROIs) were defined throughout the placenta by an expert radiologist (experience=13 years). Within the ROIs, the IVIM parameters were computed on a voxelwise basis using a three-step fitting approach to a bi-exponential model: $S(b)/S_0 = (1-f)e^{-bD} + fe^{-bD^*}$ where $S(b)/S_0$ is the normalized DW-MRI signal intensity, f the volume fraction of blood within a voxel (increased f suggests hypervascularity), D^* the displacement of water molecules in the intravascular space (increased D^* may suggest of faster blood flow), and D the water displacement in the intracellular space (akin to the apparent diffusion coefficient). The IVIM parameter mean was determined in normal and abnormally adherent regions of the placenta for each patient. Paired t-tests were used to evaluate differences between normal and abnormal placental regions. Two-way ANOVAs were used to evaluate differences between pathologically defined PASD grades.

Results:

The average gestational age at MRI was 27 ± 3 weeks. Postnatal histopathology revealed that six patients had PASD grade 1, seven had grade 2, and 12 had grades 3a-e. Areas of concern for abnormal placental adherence had a higher perfusion fraction and increased D^* compared to the regions of normal placenta ($p=0.00001$, $p=0.022$, respectively), suggesting hypervascularity and increased local blood flow. There was no observed difference of molecular diffusion coefficient ($p=0.09$) nor of IVIM parameter between groups defined by PASD grade.

Conclusions:

IVIM MRI may be a useful quantitative metric, providing mechanistic insight into differences of normal implantation versus regions of suspected abnormal placental adherence. Increased f and D^* in the areas of concern for abnormal invasion suggest increased local microvascular blood flow