MRI detection of asymmetric intrauterine growth restriction due to placental insufficiency

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**Purpose:** Intrauterine growth restriction (IUGR) is defined as a fetus that is not maintaining its genetic growth potential *in utero*. This reduced growth is often caused by placental insufficiency resulting in decreased nutrient and oxygen supply to the fetus. To increase the likelihood of survival, fetal adaptations occur, which include brain sparing leading to asymmetric growth restriction, altered fat storage and muscle development, and response to insulin. These adaptations can progress into postnatal life, increasing the offspring’s risk for later life metabolic and cardiovascular disease. The purpose of this work was to utilize MRI in fetal guinea pigs to observe organ development and fat deposition abnormalities in IUGR fetuses.

**Hypothesis:** MRI detects significant differences in organ growth and fat deposition between controls and fetuses exposed to placental insufficiency.

**Methods:** Pregnant guinea pigs were used due to their similarity to humans regarding placental and adipose tissue development during fetal growth. Two maternal groups were scanned near term: a uterine artery ablation (Placental Insufficiency) group (N = 18, 54 fetuses) and a Sham Control group (N = 5, 16 fetuses). T1- and T2-weighted, as well as IDEAL (iterative decomposition of water and fat with echo asymmetry and least squares estimation) water-fat images were acquired at 3 Tesla. These images were used to segment placental, fetal liver, brain, adipose tissue, and total fetal volumes. Liver fat fractions were also determined using proton density fat fraction (PDFF) maps obtained as a part of the IDEAL reconstruction.

**Results:** For this study, an IUGR fetus was defined as one in which the brain to liver volume ratio was > 0.70. As a result, the study population consisted of 10 IUGR and 16 sham control fetuses. The IUGR fetuses had smaller total fetal (p < .001) and placental volumes (p < .05) compared to the sham controls. There was no difference observed in placental volumes when normalized by total fetal volume (p > .05). Normalized by fetal volume, IUGR fetuses had significantly smaller livers (p < .05) but larger brains (p < .001) than the control group. IUGR fetuses had less total adipose tissue normalized to fetal volume than control group (p < .05), but no difference was seen in the proportion of adipose tissue deposited in visceral depots (p > .05). Furthermore, liver PDFF was not significantly different between groups (p > .05).

**Conclusions:** In a small group of animals, we observed significant MRI differences in IUGR guinea pig fetuses *in utero*.