Placental MRI

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Placental MRI

- Why do we care?
  - Fetal implications: “the basis for most perinatal morbidity”
  - Maternal implications
  - Funding $
    - *The Human Placenta Project*
  - NIH has already awarded >$50 million
Placental MRI

- What does it do?
  - Nutrition
  - Gas exchange
  - Waste removal
  - Endocrine function
  - Immune modulator
Placental MRI

• How do we look at it?
  • Clinical: fetal sequences, with thicker slices. No contrast. Bladder full.
    • *SS-FSE T2 (+/- FS T2)*
    • *bSSFP T2*
    • *GRE T1 (either 2- or 3D)*
    • *DWI (as necessary)*
  • Research: f(x)al imaging  *DCE, ASL, BOLD, DWI/IVIM, DTI, MRS*
Placental MRI: Normal

What does it look like?

- Homogeneous
- No previa
- < 4 cm thick
- Uterus an ‘inverted pear’
- No large intraplacental vessels
- **Myometrial stripe intact**
Placental MRI: Abnormal

What does it look like?

COMPOSITION (signal)

- Tumors
- Mesenchymal dysplasia
- Infarct/hematoma
- MAP (accreta spectrum)
- Hypocirculation/IUGR
Abnormal Signal

- Morbidly Adherent Placenta: pathophysiology
MAP

- **US vs. MR in the dx of MAP**
  - **US**
    - Sens/spec = 91/97 \( (D’Antonio \ F \ et \ al. \ UOG \ 2013;42:509-517) \)
  - **MR** when?
    - >24 weeks (Horowitz 2015 AJR)
    - <30 weeks (Ueno Y 2014 Eur Radiol)
    - Sens/spec = 94/84 \( (D’Antonio \ F \ et \ al. \ UOG \ 2014;44:8-16) \)
MAP

• US vs. MR in the dx of MAP

  • US
    • Scoring: **PAI**

  • MR

• PICS = Placental Imaging Combined Score
Abnormal Signal

- Hypocirculation/IUGR
Placental MRI: Function

How do we image?

- Perfusion/blood flow
- O2 transport
- Metabolites

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<table>
<thead>
<tr>
<th>Magnetic resonance imaging technique</th>
<th>Normal pregnancy</th>
<th>Intrauterine growth restriction</th>
<th>Preeclampsia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic contrast-enhanced (DCE)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Arterial spin labeling (ASL)</td>
<td>$F = 176 \pm 91 \text{ mL min}^{-1} 100 \text{ g}^{-1}$</td>
<td>Presence of low perfusion regions of the placenta(^{16})</td>
<td>Increased number of low perfusion regions(^{16})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perfusion = 923 arbitrary units(^{77})</td>
<td>Perfusion = 2359 arbitrary units(^{77})</td>
</tr>
<tr>
<td>Blood oxygen level–dependent (BOLD)</td>
<td>Increased signal intensity in the chorionic plate of the placenta(^{43})</td>
<td>Decrease in R2 across gestational age(^{42})</td>
<td>Decrease in total placenta 24-28%(^{16})</td>
</tr>
<tr>
<td></td>
<td>R2 = 140 msec(^{-1}) at 24-29 wk gestation(^{19})</td>
<td>R2 = 88 msec(^{-1}) (^{143})</td>
<td>Decreased ADC(^{133})</td>
</tr>
<tr>
<td>Diffusion weighted imaging (DWI)</td>
<td>Apparent diffusion coefficient (ADC) $= 1.77 \pm 0.19$ (^{123})</td>
<td>Decreased ADC(^{133})</td>
<td>Decreased in early preeclampsia 26%(^{16})</td>
</tr>
<tr>
<td>Intravoxel incoherent motion (IVIM)</td>
<td>$ADC = 1.46 \pm 0.10 \text{ mm}^{-2} \text{s}^{-1}$ (^{133})</td>
<td>Decreased in total placenta 24-28%(^{16})</td>
<td>Decreased in late preeclampsia 35%(^{16})</td>
</tr>
<tr>
<td>Perfusion fraction f</td>
<td>Estimated 26%(^{34}) to 35.1%(^{77})</td>
<td>Decreased in total placenta 24-28%(^{16})</td>
<td>Decreased in early preeclampsia 26%(^{16})</td>
</tr>
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<td></td>
<td>Decreases 0.6% per week of gestation(^{34})</td>
<td>Decreased in basal plate 37.8%(^{12})</td>
<td>Increased in late preeclampsia 35%(^{16})</td>
</tr>
<tr>
<td>Early pregnancy: 36%(^{16})</td>
<td>Higher in the chorionic plate than in the basal plate(^{34})</td>
<td>Decreased in the basal plate 27% (^{50})</td>
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<tr>
<td>Late pregnancy: 28%(^{56})</td>
<td>Higher in the basal plate than in the chorionic plate(^{34})</td>
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<tr>
<td>In the basal plate: 36%(^{51}) to 40.7%(^{77})</td>
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<tr>
<td>Pseudo diffusion coefficient</td>
<td>$D^* = 57 \pm 41 \times 10^{-3} \text{ mm}^{-2} \times \text{s}^{-1}$ (^{134})</td>
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<tr>
<td>Diffusion coefficient</td>
<td>$D = 1.7 \pm 0.510 \times 10^{-3} \text{ mm}^{-2} \times \text{s}^{-1}$ (^{134})</td>
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<td></td>
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<tr>
<td>Magnetic resonance spectroscopy</td>
<td>Phosphodiester (PDE) $= 28%$ (^{163})</td>
<td>Early preeclampsia(^{12})</td>
<td></td>
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<td></td>
<td>Phosphomonoesters (PME) $= 13%$ (^{103}) and 24%(^{105})</td>
<td>PDE $= 32.9%$</td>
<td></td>
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<tr>
<td></td>
<td>PDE/PME $= 1.1$(^{103})</td>
<td></td>
<td>PDE/PME $= 1.4$</td>
</tr>
</tbody>
</table>

### Table

<table>
<thead>
<tr>
<th>Agent</th>
<th>Placenta (peak) mmol/L</th>
<th>Placenta (10 min) mmol/L</th>
<th>Fetus mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline</td>
<td>Undetectable</td>
<td>Undetectable</td>
<td>Undetectable</td>
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<tr>
<td>Multihance</td>
<td>0.300 ± 0.120</td>
<td>0.243 ± 0.121</td>
<td>0.0093 ± 0.025</td>
</tr>
<tr>
<td>Liposome</td>
<td>0.701 ± 0.104</td>
<td>0.701 ± 0.104</td>
<td>Undetectable</td>
</tr>
</tbody>
</table>
Placental MRI

SUMMARY

• Anatomy: when US insufficient
• MAP
• Function:
  • IUGR
  • CHD
  • Preeclampsia
  • ?