MRI in Obstetrics

M. Cannie, M.D., PhD
1. WHAT IMAGING TO USE DURING PREGNANCY?

2. SAFETY MRI & CONTRAST

3. MRI TECHNIQUE

4. INDICATIONS

5. TAKE HOME MESSSAGES
1. WHAT IMAGING TO USE DURING PREGNANCY?

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WHAT IMAGING TO USE DURING PREGNANCY:

**US**
- Imaging of choice during pregnancy
- ‘cheap’
- safe
- easy
- bed side

- **but** operator dependant

- **and** patient dependant
WHAT IMAGING TO USE DURING PREGNANCY:

RX – Computertomography

- X RAYS
- Radiation foetus/mother
- CNS deformation fetus:
  - > 10 rad
    - mental retardatie, microcefalie
- Gen mutations: 50-100 rad
- > when not urgent > 17 wks

The accepted maximum cumulative fetal dose during pregnancy is 5 rad.
MRI in Obstetrics

WHAT IMAGING TO USE DURING PREGNANCY:

- 1.5 Tesla preference (3T article pig)
- Clinical question foetus: from 20 weeks on
- Clinical question mother: no time limit
- Gadolinium: avoid!
- ‘You only see what you know’
- All kind of pathologies where clinicians ask normally CT scan.
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SAFETY MRI DURING PREGNANCY

- Until now: no harmful effects...
  ...no clear evidence of safety neither...

- Temperature rise in utero (microwave effect)?
  - No for 1.5 T (Levine et al. JMRI 2001)
  - YES for 3 T (Cannie et al. . . .) !!

- Presence of congenital malformations in animal studies?
  - NO (Chew et al. JMRI 2001)

- Alterations in fertility, gestational age, birth weight or delivery mode in human (1.5 T)?
  - NO (Kanal et al. RADIOLOGY 1993)
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WHEN ? HOW ?

- +/- 20 wks pregnant (fetus to small before)
- Sedation 30 min before MRI < 32 WEEKS (flunitrazepam 0.5 mg)
- Decubitus dorsalis or lateralis from 30 wks on: compression VCI
- Buscopan when clinical question concerns abdominal pathology
### What sequences to use for fetal MRI

<table>
<thead>
<tr>
<th>Generic Names</th>
<th>Siemens</th>
<th>Philips</th>
<th>GE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSTSE (Single Shot Turbo Spin Echo)</td>
<td>HASTE/RARE</td>
<td>SSTSE</td>
<td>SSFSE</td>
</tr>
<tr>
<td>SGE (Spoiled Gradient Echo)</td>
<td>FLASH</td>
<td>SPGR</td>
<td>MPGR</td>
</tr>
<tr>
<td>VIGE (Volume Integrated Gradient Echo)</td>
<td>TFE</td>
<td>TFE</td>
<td>TFE</td>
</tr>
<tr>
<td>BGE (Balanced Gradient Echo)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWI (Diffusion Weighted Imaging)</td>
<td>DWI</td>
<td>DWI</td>
<td>DWI</td>
</tr>
<tr>
<td>UGES (Ultra fast Gradient Echo Sequence)</td>
<td>Turbo FLASH</td>
<td>TFE</td>
<td>Field Echo</td>
</tr>
</tbody>
</table>

**Attention:** Use ‘fast’ sequences type SSTSE, Flash, ...
**Example sequences foetale MRI**  
**Siemens, Sonata, 1.5 Tesla machine.**

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Slice thickness (mm)</th>
<th>Echo time (TE;ms)</th>
<th>Repetition time (TR;ms)</th>
<th>Number of slices</th>
<th>Acquisition Time</th>
<th>Matrix</th>
<th>Bandwidth (Hz/Pixel)</th>
<th>Field of view (FOV:mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HASTE</td>
<td>4</td>
<td>80-200</td>
<td>1000</td>
<td>25</td>
<td>27s</td>
<td>179x256</td>
<td>476</td>
<td>309x380</td>
</tr>
<tr>
<td>RARE</td>
<td>4-40</td>
<td>500-1200</td>
<td>&gt;1500</td>
<td>1-25</td>
<td>3.8s -80s</td>
<td>179x256</td>
<td>130</td>
<td>300x300</td>
</tr>
<tr>
<td>VIBE</td>
<td>2</td>
<td>1.59</td>
<td>3.41</td>
<td>64</td>
<td>22s</td>
<td>135x256</td>
<td>500</td>
<td>309x380</td>
</tr>
<tr>
<td>True FISP</td>
<td>5</td>
<td>2.42</td>
<td>4.83</td>
<td>16</td>
<td>13s</td>
<td>167x256</td>
<td>399</td>
<td>309x380</td>
</tr>
<tr>
<td>Turbo FLASH</td>
<td>6</td>
<td>4.89</td>
<td>3000</td>
<td>15</td>
<td>45s</td>
<td>160x256</td>
<td>130</td>
<td>285x350</td>
</tr>
<tr>
<td>DWI (*)</td>
<td>5-10</td>
<td>84</td>
<td>1500</td>
<td>10</td>
<td>1min42s</td>
<td>104x128</td>
<td>1502</td>
<td>309x380</td>
</tr>
</tbody>
</table>

**MRI Imaging Protocol:** adjust according pathology or results initial sequences.  
**DWI can help in specific cases:** f.e. pyelonephritis,…
**MRI Imaging Protocol**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>T2-weighted Half-Fourier Single-shot FSE Sequence</th>
<th>Half-Fourier Single-shot FSE Sequence</th>
<th>T2-weighted Fat-suppressed Imaging*</th>
<th>T1-weighted Imaging*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plane(s) of view</strong></td>
<td>Axial, sagittal, coronal</td>
<td>Axial</td>
<td>Axial</td>
<td>Axial</td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td>Gallbladder to perineum</td>
<td>Pelvis only</td>
<td>Pelvis only</td>
<td>Pelvis only</td>
</tr>
<tr>
<td><strong>Repetition time msec/echo time msec</strong></td>
<td>800–1200/70–90</td>
<td>800–1200/70–90</td>
<td>3500–5000/60–80</td>
<td>2000/1.6 (Turbo flash also uses IR with a 700-msec TI)</td>
</tr>
<tr>
<td><strong>Field of view (mm)</strong></td>
<td>300–440</td>
<td>300–440</td>
<td>400–440</td>
<td>300–440</td>
</tr>
<tr>
<td><strong>Section thickness (mm)</strong></td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>3–4</td>
</tr>
<tr>
<td><strong>Intersection gap (mm)</strong></td>
<td>1</td>
<td>1</td>
<td>1.6</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Fat suppression</strong></td>
<td>None</td>
<td>Chemical shift or IR with TI of 140 msec</td>
<td>IR time of 140 msec</td>
<td>None</td>
</tr>
<tr>
<td><strong>Matrix</strong></td>
<td>256 × 256</td>
<td>256 × 256</td>
<td>256 × 256</td>
<td>256 × 160</td>
</tr>
<tr>
<td><strong>Breathing technique</strong></td>
<td>Respiratory triggered or breath hold</td>
<td>Respiratory triggered or breath hold</td>
<td>Respiratory triggered</td>
<td>Breath hold</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Free breathing</td>
</tr>
</tbody>
</table>

*Note.—FSE = fast spin echo, GRE = gradient echo, IR = inversion recovery, 3D = three-dimensional, TI = inversion time, 2D = two-dimensional.

*Used with one (but not both or all) of the listed sequences.

**MRI Imaging Protocol**: adjust according pathology or results initial sequences.

**DWI can help in specific cases**: f.e. pyelonephritis,…
Fetal orthogonal planes in 3 directions
(head+ body)

T2 WI (HASTE)

Working horse fetal MRI

SSTSE

T1 WI (FLASH)
more sensitive for motion artefacts (= longer acquistion time)
less contrast
use: bleeding, fat component

Others
VIBE, DW, true FISP, RARE, Spectroscopy...

Attention
Use previous sequence as SCOUT IMAGE!!!
MRI in Obstetrics

T2 WI (HASTE)

T1 WI (FLASH)
MRI in Obstetrics

Image quality is crucial!!

HASTE

TSE: acquisition time too long

Fetal motion artefacts +++
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MRI in Obstetrics

- Brain
- Face
- Spine
- Chest
- Abdomen
- Genitourinary

FETUS
Conditions range from minor to life-threatening
MRI in Obstetrics

Combination pathologies: challenge!

Non pregnancy related  Pregnancy related
MRI in Obstetrics

Brain
Face
Spine
Chest
Abdomen
Genitourinary

FETUS
Fetal Brain

STANDARD EVALUATION:

- Biometry
  (MRI of the fetal Brain. Catherine Garel)

- Gyration/Maturation
  (Fogliarini et al. European Radiology 2005)

- Parenchyma

→ Know the gyration pattern in function of gestational age
MRI in Obstetrics

Specifique sequences for specifique clinical questions

- AV malformation-T1-WI
- T1-WI
- T2-WI
- Bilateral occipital ischemic lesion on DWI: encephalitis post ParvoB19
- Peri Ventricular Leukomalacia
- Collaterals in a vein of Galen aneurysm
- Closed lip schizencephaly and PMG-Post natal MRI
Foetal skull ossificiation
Fetale position (pelvis)
3° trimester
--> known limitations ultrasound

US compared with MRI in 214 fetuses with CNS pathology
23 % MRI diagnosis changed
14 % MRI management changed
Mainly : ACC, brain bleeding, migration disorders

Levine et al. Radiology 2003
Ventriculomegaly

✔ US compared with MRI in 147 fetuses with “isolated” ventriculomegaly (mild, moderate and important) on US

MRI 20-24 weeks pregnancy in 99 fetuses
≥ 25 weeks pregnancy in 48 fetuses

17% (25 fetuses) MRI gave extra information
  9% in the 20-24 weeks group
  33% in the ≥ 25 weeks group
  6% in the mild group
  14% in the moderate group
  57% in the severe group

Extra information mainly in case of malformation corpus callosum.

Griffiths et al. AJNR 2010
MRI in Obstetrics

Cytomegalovirus

- US compared with MRI in 38 fetusses with proven CMV infection:
  - MRI at 25 (20-34) weeks pregnancy
  - Extra information in 47% of cases:
    - polar temporal lesions
    - microencephaly
    - cortical anomalies

<table>
<thead>
<tr>
<th>Detection of brain anomalies</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI</td>
<td>92%</td>
</tr>
<tr>
<td>US</td>
<td>38%</td>
</tr>
</tbody>
</table>

Doneda et al. Radiology 2010
The corpus callosum

- Normal
- Hypoplastic
- Agenesis of the corpus callosum
MRI in Obstetrics

ACC + gyration abnormalities

Blake’s Pouch Cyst vs DW

Symptomatic CMV

Teratoma
Principal Diffusion Weighted MRI

- free (Brownian) movements of proton molecules in tissue

- Motions are not really ad random but depending on the tissue characteristics:

  Cell characteristics: cell density, cell volume, cell membranes, architecture tissue

  Vessels: density of vessels, architecture

- Information: ‘apparent diffusion coefficient (ADC).’

- \( \text{ADC}_{\text{low}} \) = restricted diffusion, mostly visible as high signal intensity on native images f.e. Brain Stroke
The Fetal Medicine Foundation Belgium

MRI in Obstetrics

Fetus with TTTS and sIUFD at 24 weeks GA

Righini et al. 2007
Combination pathologies: challenge!

Non pregnancy related

Pregnancy related

MRI in Obstetrics
Abdominal pain during pregnancies = clinical challenge!

- **Evaluation abdomen:**
  
  abdominal organs not in normal position

- **Biochemistry:**

  leukocytosis, physiologic anemia...

- **Radiology Imaging choice:**

  limited: US...
• Have to take care of mother AND child (What is good for the mother is generally good for the fetus)

• De foetus reacts very bad in situations of maternal hypotension, hypovolemia, anemia and hypoxia.

• Multidisciplinary approach!

MRI in Obstetrics
Indications: Obstetric Disorders

Pelvimetry

Risk factors? Maternal and Fetal
Fetal macrosomia (Diabetes) FBV, previous shoulder dystocia
Risk: brachial plexus injuries, asyfyxia fetus

What?
cephalopelvic disproportion: prevent dystocia

Incidence?
- 0.2 to 3 % of all births

Diagnose?
- interest increased again since first description of MR pelvimetry instead of CT pelvimetry
- bone measurement: MRI: 1 % variation
  RX: 10 %
- even possible in obese patients
- no repositioning of patient needed
Indications:
Gynecologic Disorders

Adnexal masses and Torsion

Incidences?
- 2% adenexal masses
- most nonneoplastic cysts
- 3% malignancies (1/5000 pregnancies)
- Adnexal torsion: 1/1800 pregnancies
-- > greater laxity of tissue supporting ovaries and fallopian tube during pregnancy.

Symptoms
- vague abdominal pain
- abdominal distension
- urinary frequency
- Torsion: sudden sharp abdominal pain

Diagnosis
US
MRI
Indications:
Gynecologic Disorders

Ovarian Torsion (teratoma)
Indications: Pancreatobiliary Disease

Acute Pancreatitis / Cholecystolithiasis / Cholecystitis

Incidence?
- Pregnancy promotes cholelithiasis: increased cholesterol synthesis (estrogen) and gallbladder hypomobility (progesterone)
- acute pancreatitis: 0.1-1%
- most in third trimester and postpartum
- usually mild pancreatitis
- pancreatitis in first trimester: fetal wastage
- in third trimester: premature labor

Etiology?
Idem normal adult

Symptoms
Idem normal adult

Diagnosis
US
MRI
Indications: Renal Disorders

Hydro ureteronephrosis and pyelonephritis

Incidence HUN?
- HUN: 70-90% pregnancies
- Acute pyelonephritis: 1-2% pregnancies
→ 25-40% pregnant women with asymptomatic bacteriuria: acute pyelonephritis

Etiology?
- Urinary tract muscle relaxation (progesterone)
- Mechanical compression ureters by fetal skull
- DD pathologic dilatation caused by stone/stricture

Symptoms
- HUN: no symptoms
- Acute pyelonephritis: idem adult

Diagnosis
Urinalysis
US/MRI (when treatment fails)
**Acute Appendicitis**

**Prevalence?**
- Most common nonobstetrical emergency
- Incidence: 1/1000 pregnancies
- More in 2° trimester
- Incidence fetal loss: 1.5% non complicated app
  36% complicated app

**Etiology?**
Idem normal adult

**Symptoms**
- Cave position appendix
- Leukocytosis
- Nausea enemesis

**Diagnosis**
US
MRI

**FIGURE 1.** The growing uterus progressively displaces the appendix in a counterclockwise rotation out of the pelvis into the right upper quadrant.
Acute Appendicitis

MRI

- appendiceal diameter > 7 mm
- appendiceal wand ticker than 2 mm
- Hyperintens signal intraluminal on T2 WI due to fluid or edema
- hyperintense periappendiceal fat stranding and fluid

Spalluto et al Radiographics 2012

DWI
Acute Appendicitis

MRI
- recent study in Radiology
- 2004: MRI is introduced in clinical workup
- Negatieve laparotomie rate 55 % (<2004)
- Negatieve laparotomie rate 29 % (> 2004)

Oto et al. Abdo imaging 2009
Pedrosa et al. Radiology 2006
Radiology 2013
“MRI should be the first imaging test, rather than ultrasound, for pregnant women suspected of having appendicitis, according to a study presented at last week's American Roentgen Ray Society (ARRS) meeting.”

Limitation: real-time imaging by a radiologist.

We can see that the MRI visualization rate of the appendix is much higher than ultrasound, 80% vs 7% (n= +/- 117 pts).
Challenging clinical picture due to altered anatomy and physiology
1. US: imaging of choice for mother and child (cheap, real-time)

2. MRI: gaining interest as imaging in clinical workup of pregnant women

3. The more the experience of radiologist for this pathology the more the indications for fetomaternal pathology. You only see what you know.

4. Big potential in improving the future care of mother and child.
Pregnant women: Multidisciplinary approach!
A GOOD DIAGNOSIS NEEDS A GOOD SCAN

Thank you...