MRI of the Female Pelvis: When, Why and How?

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MRI of the Female Pelvis: When, Why and How?

- Large anatomic coverage
- Multiplanar capability of MRI
- Superior soft tissue contrast
- Detailed anatomic information
- Functional information
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MRI of the Female Pelvis: When?

- Problem solving: Indeterminate adnexal mass at US.
  - Ovarian vs pedunculated leiomyoma
  - Solid vs complex cystic
  - Neoplastic vs non-neoplastic
  - Benign vs malignant
    - MRI: Changes Rx.
      in up to 25% of cases

Khaspher A, ...., Reinhold C. Radiographics 2012; 32:1047
Ovarian Mass vs Pedunc. Leiomyoma?

Identify ovaries / splaying myometrium
Complex Cystic vs Solid?

Endometrioma

Khaspher A, ...., Reinhold C. Radiographics 2012; 32:1047-64
Neoplastic vs Nonneoplastic

No Doppler flow

T1W C+

T2W

Borderline Serous Cystadenoma
Hydrosalpinx – Multiple Planes

Ax T2W

Cor T2W
Adnexal Mass Character: Why?

- Optimal patient management
  - No further follow-up
  - Clinical / imaging follow-up
  - Surgical approach
    - Laparoscopy
    - Laparotomy

ESUR Guidelines for Characterization of the Indeterminate Adnexal Mass
Spectrum: Benign to Malignant

Benign

Borderline

Malignant
MRI of the Female Pelvis: When?

- Problem solving: Benign uterine disease characterization
  - Adenomyosis vs leiomyomas
  - Adenomyosis vs endometriosis
  - Cystic adenomyosis vs MDA vs hemorrhagic leiomyoma
  - Leiomyoma vs sarcoma

- Rx. Planning for leiomyomas
Adenomyoma

- Circumscribed mass of adenomyosis
- Mass effect
- Ill-defined borders
- Round / elliptical shape

Reinhold C et al. Radiology 1996; 199:151
Tamai K et al. Radiographics 2005; 25:21
Adenomyosis vs Leiomyoma
Adenomyosis vs Endometriosis

Subserosal Endometriosis
DDX Cystic Adenomyosis – T2

Hemorrhagic myom. mass

- **Leiomyoma**
  - Thin rim
  - Heterogen.

- **Cystic adeno.**
  - Two cornua
  - Thick rim
  - Homog. content

- **Hematometra**
  - Single cornua
Leiomyoma vs Sarcoma

- B1000 ↓
- ADC ↑
- Lower cellularity
- Liquefactive necrosis / fluid

MRI of the Female Pelvis: When?

- **Modality of choice**
  - MDA, complex anomalies
  - Pelvic floor dysfunction
  - Periurethral / vaginal pathology
  - Gynecological malignancies
    - Initial staging
    - Assessment of Rx. response

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Septate

Fundal dip ≤ 1cm

Bicornuate
Septate

Bicornuate

Fundal dip ≤ 1 cm
Bicornuate

Didelphys

Communicating horns

Cx  Cx
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<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB1 / IIA1</td>
<td>&lt; 4 cm</td>
</tr>
<tr>
<td>IB2 / IIA2</td>
<td>&gt; 4 cm</td>
</tr>
<tr>
<td>IIB</td>
<td>Parametrial invasion</td>
</tr>
<tr>
<td>IIIA</td>
<td>Lower 1/3 vagina</td>
</tr>
<tr>
<td>IIIB</td>
<td>Sidewall, hydronephrosis</td>
</tr>
<tr>
<td>IVA</td>
<td>Bladder, rectal mucosa</td>
</tr>
<tr>
<td>IVB</td>
<td>Extension beyond pelvis</td>
</tr>
</tbody>
</table>

Revised FIGO 2009

Cervical Ca
Why ?: Determination of Tumour Size

- Greatest tumour dimension
  - MR >> CT / CE

- Tumour delineation
  - CT: 35-73%
  - MR: 80-94%

- Increased precision of targeted RadRx.

Okamoto Y et al. Radiographics 2003; 23:425-445
Prasad TV et al. IJMR 2014; 139:714-719
Mitchell D.,…Reinhold C. et al. JCO 2006 ACRIN/GOG Multicenter Study
Why ?: Stage IB vs IIB

Confined to cervix

Parametrial invasion

Complete disruption of FS

Cervical Ca
Vaginal Invasion- Stage IB vs IIA
Stage IVA: Bladder Mucosal Involvement

2 Patients, Gr. 3 SCC

Sag T2
Early Response: DWI

Post Rx – 2 mos


Cervical Ca
Low perfusion with DCE-MRI predicts poor local tumor control in SCC of the cervix

53 y.o., G3 SCC. Radical TAH & BSO with vault brachytherapy

1/2009 – highly cellular but low blood flow

7/2009 – venous invasive recurrence

Courtesy of Prof. Anwar Padhani

Cervical Ca
Endometrial Ca - Prognosis

- Depends on a number of factors
  - Tumour Stage (FIGO)
    - Depth of myometrial invasion
    - Cervical stromal invasion
    - Nodal status
  - Tumour Histology
    - Tumour Grade
    - Cell type
    - Lymphovascular space invasion
Why ?: Prognosis Stage

- Our role as MR imagers:
  - Establish local disease extent
  - MR can accurately depict depth of myometrial invasion
    - Correlates with LN mets and overall patient survival

- MR incorporated as STD pre-op tool
  - Better risk assignment and surgical planning

Stage IA

Report: Inner myometrial invasion
Path: Grade 1-2 endometrioid ca.

Low Risk
Stage IB

Report: Outer myometrial invasion
Path: Grade 3 endometrioid ca

Cervix: Tunnel clusters
Computed Image Analysis

75-year-old woman
LVSI (-) Deep MI (-)

85-year-old woman
LVSI (+) Deep MI (+)
Radiogenomics – The Future!

- The current method of using single site of biopsy for analyzing genetic expression leads to an incomplete portrait of the disease due to intratumour heterogeneity.

- Radiogenomic data from spatial and temporal mapping of whole tumour regions may replace multiple repeated biopsies.

Gerlinger et al. NEJM. 2012
Integration:
Phenotypic heterogeneity associated with histological and/or genomic heterogeneity in HGSOC
How ?: MR Imaging Protocol

- **Patient preparation:**
  - Fasting minimum 4 hrs.
  - Empty urinary bladder

- **Antispasmodic**
  - 40 mg IM/IV buscopan
  - 1 mg IM/IV glucagon

- **Multicoil array**
  - In-FOV SAT bands
  - Critical at 3T

*Rafat Zand K, Reinhold C et al. JMRI 2007; 26:480-97*
How ?: MR Imaging Protocol

- Localizer – 3 Plane T2W
- Coronal large FOV SSSFSE
- Multiplanar HR T2W
- Axial T1W (IP, OP)
- 2D/3D fat SAT T1W
- Optional
  - DCE (perfusion)
  - Peristalsis (SSFSE)
  - DWI

Survey all corners!
MR Imaging Protocol

- High resolution images
- FOV 20 cm, 3-4mm
- T2W FSE
  - Axial, sagittal
  - Axial obl (long-axis)
  - Cor obl (short-axis)
  - Matrix 512 x 256
MR Imaging Protocol

- **Axial SGE to renal hilum**
  - Lymphadenopathy

- **Peristalsis sequence**
  - **DDx true JZ thickening vs peristalsis**
    - Menstrual phase
    - Periovulatory phase
  - **SSFSE over 3 mins.**
    - TR 4000ms
    - 5 mm sections
    - Matrix 256 x 192
    - Cine 12-15x

*Nakai A, Reinhold C et al. JMRI 2013; 38:161-7*
MR Imaging Protocol

- Dynamic 3D FSGR, F Sat - 3 runs
  - Gyn malignancies
    - Staging and follow-up
  - Adnexal mass characterization

- DWI Multiple B values, min (B 500, B 1000)
  - FOV 20 - 36
  - Matrix 128x128
  - NA 6

T2 FSE  T1 C+  B1000  ADC
Take Home Points

- MR imaging plays an important role in the evaluation of the female pelvis
  - Problem-solving modality
  - Modality of choice

- MR imaging protocol
  - High resolution anatomic images
  - Functional imaging