Preoperative breast MRI: What are the best indications

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Clinical Lecturer and Consultant Breast Radiologist
Early subtracted maximum intensity projection (MIP)
1 grade 2 ILC, 1 fibroadenoma

Multicentric grade 3 IDC + high grade DCIS
Number of Breast MRI’s performed each year at the Royal Marsden

<table>
<thead>
<tr>
<th>Year</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>(80)</td>
</tr>
<tr>
<td>2007</td>
<td>(151)</td>
</tr>
<tr>
<td>2008</td>
<td>(232)</td>
</tr>
<tr>
<td>2009</td>
<td>(196)</td>
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<tr>
<td>2010</td>
<td>(267)</td>
</tr>
<tr>
<td>2011</td>
<td>(337)</td>
</tr>
<tr>
<td>2012</td>
<td>(465)</td>
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</table>
Magnetic resonance imaging of the breast: Recommendations from the EUSOMA working group

Francesco Sardanelli a,*, Carla Boetes b, Bettina Borisch c, Thomas Decker d, Massimo Federico e, Fiona J. Gilbert f, Thomas Helbich g, Sylvia H. Heywang-Köbrunner h, Werner A. Kaiser i, Michael J. Kerin j, Robert E. Mansel k, Lorenza Marotti l, Laura Martincich m, Louis Mauriac n, Hanne Meijers-Heijboer o, Roberto Orecchia p, Pietro Panizza q, Antonio Ponti r, Arnie D. Purushotham s, Peter Regitnig t, Marco Rosselli Del Turco t, Fabienne Thibault u, Robin Wilson v
Sensitivity and Specificity of breast MRI

<table>
<thead>
<tr>
<th>Author</th>
<th>Pooled weighted estimates of sensitivity and specificity from meta-analyses looking at primary staging of breast cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitivity (%)</td>
</tr>
<tr>
<td>Medeiros et al. 2011</td>
<td>90</td>
</tr>
<tr>
<td>Peters NH et al. 2008</td>
<td>90</td>
</tr>
</tbody>
</table>

Clinical Indications for Breast MRI

1. To delineate the extent of disease within the breast
Clinical Indications for Breast MRI

1. To delineate the extent of disease within the breast
2. As a problem-solving tool and in discordant imaging findings
Clinical Indications for Breast MRI

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2. As a problem-solving tool and in discordant imaging findings
3. To monitor response to neoadjuvant chemotherapy
Clinical Indications for Breast MRI

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4. Screening high risk women
Clinical Indications for Breast MRI

1. To delineate the extent of disease within the breast
2. As a problem-solving tool and in discordant imaging findings
3. To monitor response to neoadjuvant chemotherapy
4. Screening high risk women
5. To assess integrity of breast implants
Invasive Lobular Cancer

Asymmetric density in right breast

MRI demonstrates multifocal disease
Dense Mammographic Breast Tissue

Mediolateral oblique (MLO) projection
Craniocaudal (CC) projection
Dense Mammographic Breast Tissue

T2W image

T1W enhanced subtracted image
Occult Disease

Enlarged right axillary node

MRI showing occult malignancy in right breast
Monitoring Response to Chemotherapy

Pharmacokinetic parameter

$K_{\text{trans}}$

Initial area under the gadolinium curve

$\text{IAUGC}$
High Risk Women

- **T2W image**
- **T1W enhanced subtracted image**
- **Post contrast high resolution image**
High Risk Women

$DWI \; b=1150 \; image$

$ADC \; map$

$DWI = \text{Diffusion Weighted Imaging}$

$ADC = \text{Apparent Diffusion Coefficient}$
Implant Integrity

*T2W*

Silicone specific sequence

**Complete intracapsular rupture**

**Axillary nodal silicone granulomata**
How to Perform Breast MRI

- Preparation
  - Patient positioning and comfort
  - Coil design
  - Day 6-16 of menstrual cycle

- IV Gadolinium contrast (MultiHance – DETECT study)

- Fat suppression

Martincich L et al. Radiology 2011;258(2):396-408
How to Perform Breast MRI

- Anatomical sequences
  - T1W
  - T2W
  - Post contrast T1W high resolution fat suppressed

- Dynamic contrast enhanced sequence
  - Temporal resolution < 60 seconds
  - Sequential acquisitions for 5-7 minutes
Breast Coils

Standard breast coil

Breast biopsy coil

MRI-guided breast biopsy
Day 6-16

DCE-subtracted image showing little background parenchymal enhancement

DCE-subtracted image showing marked stippled background parenchymal enhancement
Day 6-16

Background enhancement with benign type I enhancement curve

Focal enhancement with malignant type III enhancement curve
Reporting Breast MRI

- Morphological Assessment
  - Mass (>5mm)
  - Non mass-like enhancement

- Dynamic contrast-enhanced curve analysis
Signal Intensity Curves

Type II + Type III = 91% malignant cases
Type I = 83% benign cases

Breast MRI at 3.0T

- Increasingly available
- Higher specificity than at 1.5T (93.9%)
- Depicts smaller tumours (up to 4 mm)
- Improved diagnostic confidence
<table>
<thead>
<tr>
<th>Advantages of 3T scanning</th>
<th>Disadvantages of 3T scanning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved signal-to-noise ratio (SNR)</td>
<td>Inhomogeneity of the magnetic field $B_0$ and $B_1$</td>
</tr>
<tr>
<td>Better spatial resolution and thinner slices</td>
<td>Increase in Specific Absorption Rates (SAR)</td>
</tr>
<tr>
<td>Faster scanning times</td>
<td>Increase in artifacts</td>
</tr>
<tr>
<td>Improved fat suppression</td>
<td></td>
</tr>
</tbody>
</table>
Breast MRI at 3.0T

Failed fat suppression in the right breast

Homogeneous fat suppression in both breasts

Azlan CA et al. Magnetic Resonance Medicine 2012;67(2):531-540
Diffusion Weighted Imaging (DWI)

- Easily and quickly accomplished on modern scanners
- Non-invasive non-contrast technique
- No ionising radiation
- Sensitive
- Quantitative information
DWI of the Breast

Mammography

Diffusion Weighted Image at $b=1150$

Apparent Diffusion Coefficient (ADC) map

Ultrasound

MRI
**DWI**

- $b = 0$
- $b = 100$
- $b = 700$
- $b = 1150$

$ADC = \text{Apparent Diffusion Coefficient}$

$ADC$ map
ADC values and Cellularity

Malignant lesions
(0.9 – 1.61)*

Benign lesions
(1.41 – 2.01)*

Normal fibroglandular tissue
(1.51-2.37)**

Apparent Diffusion Coefficient Value (ADC) x 10^{-3} mm²/s

Thank you very much for your attention
Multimodality Breast Imaging
Detection, Diagnosis, Management
Image-guided Interventions