Non mass enhancement (NME) in MRI

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Acknowledgments: With special thanks to Bianka Freiwald
Non-Mass Enhancement (NME)

- **NM(L)E**: An enhancing area distinct from surrounding parenchyma, no space-occupying mass, interspersed with non-enhancing fatty or glandular tissue.
- Typically no correlate on T2w images.
- **BI-RADS lexicon 4\textsuperscript{th} edition, 2003**: 
  - Non-mass-like enhancement (NMLE)
  - Including Background Parenchymal Enhancement (BPE)
- **BI-RADS lexicon 5\textsuperscript{th} edition, 2013**: 
  - BPE excluded
  - Some terms removed, descriptors refined

Giess et al. Radiographics 2013;33:1343-1360

BI-RADS ("Breast Imaging Report and Data System"), ACR, 5th ed. www.acr.org
Histopathology of NME

- **Malignant**
  - DCIS
  - Diffuse invasive carcinoma, often lobular Ca
- **Benign**
  - Mastopathic changes, adenosis, fibrocystic changes
  - Inflammation
  - Hormonal changes
  - Pseudoangiomatous stromal hyperplasia
  - Postoperative changes

Giess et al. Radiographics 2013;33:1343-1360

Histopathology: S. Stadlmann, KSB Baden
Non-Mass Enhancement (NME)

Distribution modifiers

• **Focal area** (< 25% of quadrant, fat or normal glandular tissue interspersed between the enhancing components)
• **Linear** (enhancement in a line, may be branching)
• **Segmental** (triangular, apex pointing to nipple, suggests ductal enhancement)
• **Regional** (encompasses more than a single duct system)
• **Multiple regions**
• **Diffuse** (distributed randomly throughout the breast)
Non-Mass Enhancement (NME)

Internal enhancement
- **Homogeneous**: confluent, uniform enhancement
- **Heterogeneous**: random pattern, separated by areas of normal parenchyma or fat
- **Clumped**: cobblestone enhancement
- **Clustered ring***: rings of enhancement clustered around the ducts

*Tozaki M et al. AJR 2006;187:313-321

BI-RADS (“Breast Imaging Report and Data System”), ACR, 5th ed. www.acr.org
Clustered Ring Enhancement

Clustered ring enhancement thought to be a useful sign to differentiate benign and malignant lesions

Figs & Tables: Tozaki M et al. AJR 2006;187:313-321
## BI-RADS® Atlas: 4th vs. 5th Edition

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Mass-Like Enhancement/Internal Enhancement/Stippled, Punctate</td>
<td>Non-Mass-Like Enhancement/Internal Enhancement/Stippled, Punctate eliminated (what used to be called stippled enhancement now is recognized to be a pattern of RPE)</td>
</tr>
<tr>
<td>Not in previous version</td>
<td>Non-Mass Enhancement/Internal Enhancement Patterns/Clustered Ring</td>
</tr>
</tbody>
</table>

www.acr.org
Breast Composition: MRI

Background Parenchymal Enhancement (BPE)

<table>
<thead>
<tr>
<th>Background Parenchymal Enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Minimal</td>
</tr>
<tr>
<td>b. Mild</td>
</tr>
<tr>
<td>c. Moderate</td>
</tr>
<tr>
<td>d. Marked</td>
</tr>
</tbody>
</table>

Figure 266 – Minimal.

Figure 267 – Mild.

Figure 268 – Moderate.

Figure 269 – Marked.

BI-RADS (“Breast Imaging Report and Data System”), ACR, 5th ed. www.acr.org
BPE versus NME

• Picture Frame Pattern: Healthy tissue in the lateral, medial, posterior-inferior portions commonly enhances from peripheral to central areas

• affected by menstrual cycle
  ➔ schedule MRI during days 7-15

• Multiple similar regions of enhancement, in any distribution, are more characteristic of benign proliferative changes or hormonal BPE

• Regional BPE – false positive interpretations, overlap with NME
BPE versus NME

- 48 years-old patient
- dense breasts
- mastodynia
- induration of both breasts
- negative family history
BPE versus diffuse NME

Histopathology: S. Stadlmann, KSB Baden
Non-Mass Enhancement (NME): Focal

< 25% of quadrant, fat or normal glandular tissue interspersed between the enhancing components

B3 Classification: breast parenchyma with duct ectasia, intraducal hyperplasia, secret retention and extravasation (mucocele-like-lesion), periductal fibrosis
Non-Mass Enhancement (NME): Linear

papillary neoplasia B3
Non-Mass Enhancement (NME): **Linear**

*enhancement in a line, may be branching*

high grade DCIS G3
Non-Mass Enhancement (NME): Segmental

triangular, apex pointing to nipple, suggests ductal enhancement

39 y, bloody nipple discharge
Non-Mass Enhancement (NME): Segmental

Histopathology: S. Stadlmann, KSB Baden
Non-Mass Enhancement (NME): Segmental

74 years, history of ovarian Ca, lump left breast

Left: multifocal invasive Ca (pT2)
Right: DCIS with 2 mm invasive component (pT1a)
Non-Mass Enhancement (NME): Regional

42 years, DCIS
NME: Multiple Regions
NME: Multiple Regions

invasive ductal Ca

invasive ductal Ca with neuroendocrine differentiation & peritumoral DCIS
Non-Mass Enhancement (NME): Diffuse

Distributed randomly throughout the breast

Multicentric, poorly differentiated invasive ductal carcinoma with peritumoral DCIS and lymphangiosis carcinomatosis of the left breast
Clinical Significance of NME

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Benign (n = 26)</th>
<th>Malignant (n = 35)</th>
<th>$p^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution modifiers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductal</td>
<td>4 (15)</td>
<td>7 (20)</td>
<td>NS</td>
</tr>
<tr>
<td>Focal area</td>
<td>7 (27)</td>
<td>5 (14)</td>
<td>NS</td>
</tr>
<tr>
<td>Regional</td>
<td>5 (19)</td>
<td>4 (11)</td>
<td>NS</td>
</tr>
<tr>
<td>Segmental</td>
<td>0</td>
<td>19 (54)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Multiple regions</td>
<td>3 (12)</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Diffuse</td>
<td>7 (27)</td>
<td>0</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>Internal enhancement</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homogeneous</td>
<td>2 (8)</td>
<td>1 (3)</td>
<td>NS</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>7 (27)</td>
<td>24 (69)</td>
<td>0.003</td>
</tr>
<tr>
<td>Stippled, punctate</td>
<td>13 (50)</td>
<td>0</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Clumped</td>
<td>4 (15)</td>
<td>10 (29)</td>
<td>NS</td>
</tr>
<tr>
<td>Clustered ring enhancement</td>
<td>1 (4)</td>
<td>22 (63)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

Tozaki M et al. AJR 2006;187:313-321
Clinical Significance of NME

<table>
<thead>
<tr>
<th>NMLE Feature</th>
<th>No. of Patients</th>
<th>No. of Patients with Cancer</th>
<th>PPV†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focal area</td>
<td>27 (26.5)</td>
<td>3</td>
<td>0.111 (0.024, 0.292)</td>
</tr>
<tr>
<td>Linear</td>
<td>12 (11.8)</td>
<td>2</td>
<td>0.167 (0.021, 0.484)</td>
</tr>
<tr>
<td>Ductal</td>
<td>10 (9.8)</td>
<td>5</td>
<td>0.500 (0.187, 0.813)</td>
</tr>
<tr>
<td>Segmental</td>
<td>20 (19.6)</td>
<td>2</td>
<td>0.100 (0.012, 0.317)</td>
</tr>
<tr>
<td>Regional</td>
<td>23 (22.6)</td>
<td>1</td>
<td>0.043 (0.001, 0.219)</td>
</tr>
<tr>
<td>Multiple regions</td>
<td>6 (5.9)</td>
<td>0</td>
<td>0 (0, 0.459)</td>
</tr>
<tr>
<td>Diffuse</td>
<td>4 (3.9)</td>
<td>0</td>
<td>0 (0, 0.602)</td>
</tr>
<tr>
<td><strong>Degree of symmetry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not applicable</td>
<td>2 (2.0)</td>
<td>0</td>
<td>0 (0, 0.842)</td>
</tr>
<tr>
<td>Symmetric</td>
<td>10 (9.8)</td>
<td>0</td>
<td>0 (0, 0.308)</td>
</tr>
<tr>
<td>Asymmetric</td>
<td>90 (88.2)</td>
<td>13</td>
<td>0.144 (0.079, 0.234)</td>
</tr>
<tr>
<td><strong>Internal enhancement characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homogeneous</td>
<td>19 (18.6)</td>
<td>1</td>
<td>0.053 (0.001, 0.260)</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>40 (39.2)</td>
<td>3</td>
<td>0.075 (0.016, 0.204)</td>
</tr>
<tr>
<td>Stippled or punctate</td>
<td>13 (12.8)</td>
<td>0</td>
<td>0 (0, 0.247)</td>
</tr>
<tr>
<td>Clumped</td>
<td>23 (22.6)</td>
<td>7</td>
<td>0.304 (0.132, 0.529)</td>
</tr>
<tr>
<td>Reticular or dendritic</td>
<td>7 (6.9)</td>
<td>2</td>
<td>0.286 (0.037, 0.710)</td>
</tr>
</tbody>
</table>

* Data in parentheses are percentages.
† Data in parentheses are 95% CIs.

Mahoney et al. Radiology 2012;1:51-58
PPV of segmental & linear enhancement?

- n=1003 patients (24 with DCIS)
- **Segmental or linear enhancement**
  - 50/1003 (5%, 17 DCIS, 33 benign)
  - DCIS
    - 17/24 patients (71%),
    - in 4/17 mammography normal
  - Specificity 96% (826/859)
  - **PPV 34% (17/50)**
    - (PPV 26%, Libermann, AJR 2003)

- Overall prevalence of this pattern low, high specificity, moderate PPV

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DCIS & BI-RADS Enhancement Characteristics


n=361 patients, 64 DCIS

<table>
<thead>
<tr>
<th>Feature</th>
<th>DCIS only</th>
<th>Invasive only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>9 (14.1%)</td>
<td>79 (78.2%)</td>
</tr>
<tr>
<td><strong>NMLE</strong></td>
<td>38 (59.4%)</td>
<td>16 (15.8%)</td>
</tr>
<tr>
<td>Focus</td>
<td>8 (12.5%)</td>
<td>3 (3.0%)</td>
</tr>
<tr>
<td>None</td>
<td>9 (14.1%)</td>
<td>3 (3.0%)</td>
</tr>
</tbody>
</table>

NMLE: Non-mass like enhancement
Take Home Message: NM(L)E

• Challenging finding in breast MRI interpretation
• BI-RADS 4th edition: BPE excluded ⇒ schedule MRI during days 7-15
• NME: low to intermediate PPV for malignancy
• Description ⇒ readers experience, interobserver variability
• NME viewed as suspicious:
  • linear, ductal or segmental distribution
  • clumped or clustered ring enhancement internal distribution patterns
  • NME correlating with concerning mammographic or sonographic findings
• Short-term-interval follow-up versus biopsy