Breast density: assessment and clinical implications

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Breast Density: Overview

• Why is breast density important?
• What influences breast density?
• How to assess density on imaging?
• Future developments / automatic quantification
• Take home messages
Breast Density

- Reflects breast tissue composition: Fibroglanular tissue (breast epithelium, connective tissue) attenuates X-rays more than fat
- May obscure breast masses
- Risk factor for interval breast cancer
- Independent risk factor for breast cancer
  - 4-5x greater risk with “extremely dense” compared to “almost entirely fatty” breasts
  - Relative risk in women with extremely dense breast compared to the average women approx. 2.1

Hoh et al. AJR 2014; 203:449–456
Freer. Radiographics 2015;35:302-315
Mammographic Density

- Decrease with increasing age
- Less extensive in women who have given birth
- Declines at menopause
- Inversely associated with body weight
- Genetic factors
- Family history of breast cancer associated with higher mammographic density
- Hormonal therapy ➔ potential target for preventive interventions
  - Combined estrogen and progestin therapy increase density
  - Tamoxifen therapy reduces density

Checka et al. AJR 2012;198:292-295
Breast Density & Age

Checka et al. AJR 2012;198:292-295
55 years-old patient

History of VAB ➔ B3, FEA ➔ surgical excision: benign ➔ follow-up
55 years-old patient

MR-guided VAB → extensive DCIS G3
### Intervall Cancer

Odds ratio for risk of interval breast cancer associated with mammographic breast density among women diagnosed within 24 months of a screening mammogram

<table>
<thead>
<tr>
<th></th>
<th>Interval cancer (n = 149)</th>
<th>Screen-detected cancer (n = 388)</th>
<th>Odds ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%*</td>
<td>No.</td>
</tr>
<tr>
<td>Predominantly fat§</td>
<td>72</td>
<td>19.7</td>
<td>294</td>
</tr>
<tr>
<td>Heterogeneously dense</td>
<td>61</td>
<td>41.2</td>
<td>87</td>
</tr>
<tr>
<td>Extremely dense</td>
<td>16</td>
<td>69.6</td>
<td>7</td>
</tr>
</tbody>
</table>

*For trend*

- Age-adjusted
  - Predominantly fat§: 1.00 (referent)
  - Heterogeneously dense: 2.57 (1.67–3.97)
  - Extremely dense: 7.78 (2.98–20.3)
- Adjusted for covariates‡
  - Predominantly fat§: 1.00 (referent)
  - Heterogeneously dense: 3.02 (1.84–4.95)
  - Extremely dense: 6.14 (1.95–19.4)

*P for trend < .001*
Breast Composition BI-RADS: Mammography

- Four categories (a,b,c,d)
- Visual estimation of content of fibroglandular-density tissue within breast, density classified using densest parts
- Overall assessment of the volume of attenuating tissues in the breast
- To indicate relative possibility that a lesion could be obscured by normal tissue and sensitivity thus compromised
- Quartile ranges of percentage dense tissue (< 25% to 75-100%) of fourth edition not used anymore

*BI-RADS (“Breast Imaging Report and Data System”), ACR, 5th ed. www.acr.org*
Breast Composition: Mammography

<table>
<thead>
<tr>
<th>Breast Composition Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The breasts are almost entirely fatty</td>
</tr>
<tr>
<td>b. There are scattered areas of fibroglandular density</td>
</tr>
<tr>
<td>c. The breasts are heterogeneously dense, which may obscure small masses</td>
</tr>
<tr>
<td>d. The breasts are extremely dense, which lowers the sensitivity of mammography</td>
</tr>
</tbody>
</table>
Breast Composition: Mammography

a. The breasts are almost entirely fatty.

b. There are scattered areas of fibroglandular density.

c. The breasts are heterogeneously dense, which may obscure small masses.

d. The breasts are extremely dense, which lowers the sensitivity of mammography.
## BI-RADS® Atlas: 4th vs. 5th Edition

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Mammography</td>
<td>1. The breast is almost entirely fat (&lt;25% glandular)</td>
<td>a. The breasts are almost entirely fatty</td>
</tr>
<tr>
<td></td>
<td>2. There are scattered fibroglandular densities (approximately 25% - 50% glandular)</td>
<td>b. There are scattered areas of fibroglandular density</td>
</tr>
<tr>
<td></td>
<td>3. The breast tissue is heterogeneously dense, which could obscure detection of small masses</td>
<td>c. The breasts are heterogeneously dense, which may obscure small masses</td>
</tr>
<tr>
<td></td>
<td>(approximately 51% - 75% glandular)</td>
<td>d. The breasts are extremely dense, which lowers the sensitivity of mammography</td>
</tr>
<tr>
<td></td>
<td>4. The breast tissue is extremely dense. This may lower the sensitivity of mammography (&gt;75%</td>
<td>(Quartiles have been eliminated)</td>
</tr>
<tr>
<td></td>
<td>glandular)</td>
<td></td>
</tr>
</tbody>
</table>
Breast Composition: Ultrasound

- Description of overall breast composition for screening only; determined by echogenicity

- 3 US descriptors: correspond loosely to 4 density descriptor of mammography and 4 fibroglandular tissue descriptors at MRI

<table>
<thead>
<tr>
<th>Tissue Composition</th>
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</thead>
<tbody>
<tr>
<td>a. Homogeneous background echotexture-fat</td>
</tr>
<tr>
<td>b. Homogeneous background echotexture-fibro glandular</td>
</tr>
<tr>
<td>c. Heterogeneous background echotexture</td>
</tr>
</tbody>
</table>
Breast Composition: Ultrasound

a. Homogeneous background echotexture-fat
b. Homogeneous background echotexture-fibro glandular
c. Heterogeneous background echotexture

BI-RADS (“Breast Imaging Report and Data System”), ACR, 5th ed. www.acr.org
Breast Composition: MRI

- 4 categories are defined by the visually estimated FGT within the breast (the most FGT used for categorization)

<table>
<thead>
<tr>
<th>Table 3. Breast Tissue — Fibroglandular Tissue (FGT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of Fibroglandular Tissue</td>
</tr>
<tr>
<td>a. Almost entirely fat</td>
</tr>
<tr>
<td>b. Scattered fibroglandular tissue</td>
</tr>
<tr>
<td>c. Heterogeneous fibroglandular tissue</td>
</tr>
<tr>
<td>d. Extreme fibroglandular tissue</td>
</tr>
</tbody>
</table>
Breast Composition: MRI

BI-RADS ("Breast Imaging Report and Data System"), ACR, 5th ed. www.acr.org
Breast Composition: MRI

**Background Parenchymal Enhancement (BPE)**

<table>
<thead>
<tr>
<th>Breast Tissue — Background Parenchymal Enhancement (BPE)</th>
<th>Figure 266 – Minimal.</th>
<th>Figure 267 – Mild.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Minimal</td>
<td></td>
<td></td>
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<tr>
<td>b. Mild</td>
<td></td>
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<tr>
<td>c. Moderate</td>
<td></td>
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<tr>
<td>d. Marked</td>
<td></td>
<td></td>
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<tr>
<td>Figure 268 – Moderate.</td>
<td></td>
<td></td>
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<tr>
<td>Figure 269 – Marked.</td>
<td></td>
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</tr>
</tbody>
</table>

*BI-RADS (“Breast Imaging Report and Data System”), ACR, 5th ed. www.acr.org*
MRI of the breast: FGT & BPE

FGT d

BPE c (moderate)
MRI of the breast: FGT & BPE

FGT c

BPE a (minimal)
FGT & BPE: Hormonal Influence

with HRT

without HRT (2 months later)
Automatic Quantification

• Good radiologists interreader agreement on visual analysis of breast density
• Desire for a more objective reproducible assessment
• Commercially available computer programs
• Calculation of density percentage: determined by dividing the calculated area (or volume) of fibroglandular tissue by the total breast area (or volume)
• No validated cut off values, overestimation of density in small breasts, wide range of densities ➔ “We await publication of robust volume-based breast density data, using validated cut-off points …. before again indicating percentage ranges for BI-RADS terminology.”*

*ACR BI-RADS Atlas, 5th edition, ACR
Breast density: Distribution

Breast density in the U.S. (See pie chart)
- 10% of women have almost entirely fatty breasts
- 10% have extremely dense breasts
- 80% are classified into one of two middle categories

Ho JM. AJR 2014;203:449-456
Fig: www.mcancer.org
Density: Medico-legal Implications

- **“Dense” breast** (as defined by US legislation): include categories “extremely dense” and “heterogeneously dense”: 50%

- 19 US states (Connecticut 2009) have enacted laws that require mammography providers to alert patients in writing of dense breast; advise patients to discuss possibility of additional screening methods ➔ e.g. US, MRI, tomosynthesis

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Dehkordy. JAmCollRadiol 2013;10:899-902
Conclusion

• About 50% of women have “dense breasts”
• Visual assessment of density: a-d (ACR)
• Masking effect ➔ interval cancers
• Density = independent risk factor for cancer
• Patients should (must) be informed
• Supplemental screening modalities
• Currently no consensus/guidelines
• Cost-effectiveness
• Insurance coverage