Breast Density Measurement

South West London Breast Screening Service SWLBSS
Ms. Elizabeth Muscat Specialist Advanced Practitioner

Why, What and How
Introduction

• Why Breast Density?
• What is measured on Mammography?
• How is it measured?
• Observed outcomes.
• Implications in Clinical use.
• Conclusions and future considerations.
Breast Density and Breast Cancer Risk

• Breast Density affects the risk of breast cancer mortality in two ways:
  a. It is a recognised Independent Risk Factor for breast cancer and
  b. and it affects sensitivity and specificity of mammography

• Breast Density decreases with age

• Breast Cancer Risk increases with age

Does breast density play an early role in the development of breast cancer?
Breast Density as an Independent Risk Factor

• Breast Density is consistently associated with increased risk of Breast Cancer.

• It is associated with over a four fold (4.64) increase in the risk of breast cancer in women with 75% or more density and over twice (2.92) for those with 50-74% density.

• Breast Density has a more significant relative risk of breast cancer than family history (two first degree relatives).

• Only age and BRCA carrier status are associated with higher relative risks of breast cancer.
Breast Density Masking Effect

- Sensitivity decreases with increasing Breast Density, studies on film-screen mammography established that sensitivity decreased from 86% to 62%.
- Breast Density leads to an increase in the number of interval cancers.
- Digital Mammography has an improved sensitivity in dense breasts, 87% compared to 62%.

Freer et al, Mammographic Breast Density: Impact on Breast Cancer Risk and Implications for Screening Radiographics 2015
What is Breast Density

- Breast Density on Mammography is a measure of the amount of radiopaque supportive stroma and functional parenchyma elements (fibro-glandular tissue) compared to the radiolucent component (adipose tissue).
- X-Ray is less likely to penetrate fibro-glandular tissue and this appears bright or white on mammography.
- Breast Density on Mammography has no association with firmness of breast tissue at clinical breast examination.
Breast Density: adipose vs stroma & epithelium

(a) Photomicrograph (original magnification, ×50; hematoxylin-eosin [H-E] stain) of a breast biopsy specimen shows normal mature adipocytes, which account for radiolucent areas seen at mammography (not shown).

(b) Photomicrograph (original magnification, ×100; H-E stain) of a breast biopsy specimen in a different patient shows normal ducts, with ductal epithelium and stromal elements that account for radiopaque areas seen at mammography (not shown).
Breast Density: radiolucent vs radiopaque

*Dense tissues attenuate x-ray more than fat and thus show higher signal intensity than fat on mammography.*
Breast Density Classification

Qualitative

- Different parenchymal patterns were first described by Leborgne in 1953
- Qualitative classification by Wolfe in 1976
- Quantitative (subjective) classification by Boyd in 1980
- Qualitative classification by Tabar in 1997
- BIRADS scheme in 2000, last updated to the 5th edition in 2013

- Positive association with risk of breast cancer
- Reduced reproducibility and intra- and inter-reader variability
Breast Density Classification
Quantitative area-based

• Semi- or Fully- automated techniques
• Percentage Mammographic Density (PMD) calculated as the ratio of the dense tissue and the total breast area multiplied by 100
• Better reproducibility than qualitative visual techniques
• Time consuming and still show intra- and inter- user variability
• Two dimensional measurement of three dimensional features
Breast Density Classification
Visual vs Volumetric

Illustration of how breast density can be under- or over-estimated by visual/area-based approaches. E.U. Ekpo et al Radiography 21 (2015) 324 -333 pg 328
Breast Density Classification
Quantitative volumetric

• Fully automated volumetric breast density assessment without human intervention

• Breast density measurement can be viewed directly and immediately on image display systems (PACS)

• Software packages installed between the acquisition and display systems
Automated breast density measurement

- **Patient Name:** Patricia Roberts
- **Patient ID:** A1234
- **Patient DOB:** 01/01/1970
- **Accession #:** 12347
- **Study Date:** 01/01/2014

**Table: Automated Breast Density Measurement**

<table>
<thead>
<tr>
<th>Volume of Fibroglandular Tissue (cm³)</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.9</td>
<td>46.0</td>
<td></td>
</tr>
<tr>
<td>Volume of Breast (cm³)</td>
<td>459.6</td>
<td>494.6</td>
</tr>
<tr>
<td>Volumetric Breast Density (%)</td>
<td>8.9</td>
<td>9.3</td>
</tr>
</tbody>
</table>

**Average radiation dose per image, using patient's density results:** 1.7 mGy

**Average pressure applied using compression force/contact area:** 10.3 kPa

**Higher volumetric density of left or right breast:** 9.3%

**Scale showing volumetric breast density thresholds and ACR breast density categories**

**VDG/AI:** Volumetric density grade using automated imaging techniques
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The breast is almost entirely fat (&lt;25% glandular)</td>
<td>a. The breasts are almost entirely fatty</td>
</tr>
<tr>
<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>3. The breast tissue is heterogeneously dense, which could obscure detection of small masses (approximately 51% - 75% glandular)</td>
<td>c. The breasts are heterogeneously dense, which may obscure small masses</td>
</tr>
<tr>
<td>4. The breast tissue is extremely dense. This may lower the sensitivity of mammography (&gt;75% glandular)</td>
<td>d. The breasts are extremely dense, which lowers the sensitivity of mammography</td>
</tr>
<tr>
<td></td>
<td>(Quartiles have been eliminated)</td>
</tr>
</tbody>
</table>
Observed outcomes

- 73,703 screened
- 8,286 assessed
- 4,197 biopsy
- 1,272 cancer
Ranked data
women screened (n=73,703)
by volume of:
fibroglandular tissue (FGV)
non-dense and
whole breast (BV)
Ranked data women screened (n=73,703) density (FGV/BV = VBD%) and Volpara grade
Ranked data quartiles
women screened (n=73,703)

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
</table>

[Graph showing ranked data quartiles, with shaded areas indicating the distribution of women screened]
### Dataset 2013 – 2016

<table>
<thead>
<tr>
<th>Fibroglandular volume</th>
<th>Total cases</th>
<th>Screened</th>
<th>Assessed</th>
<th>Biopsy</th>
<th>Cancer</th>
<th>Cancer / bx %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases with Volpara data</td>
<td>73 703</td>
<td>8 286</td>
<td>4 197</td>
<td>1 272</td>
<td>30.31%</td>
<td></td>
</tr>
<tr>
<td>1 (4%)</td>
<td>4 118</td>
<td>177</td>
<td>95</td>
<td>28</td>
<td>29.47%</td>
<td></td>
</tr>
<tr>
<td>2 (50%)</td>
<td>38 308</td>
<td>4 453</td>
<td>2 210</td>
<td>657</td>
<td>29.72%</td>
<td></td>
</tr>
<tr>
<td>3 (32%)</td>
<td>22 347</td>
<td>1 434</td>
<td>711</td>
<td>229</td>
<td>32.21%</td>
<td></td>
</tr>
<tr>
<td>4 (14%)</td>
<td>8 939</td>
<td>606</td>
<td>321</td>
<td>65</td>
<td>20.25%</td>
<td></td>
</tr>
</tbody>
</table>

| Fibroglandular volume | No Volpara data | 3833 | 1 987 | 615 | 615 |

### Volpara Grade 5th ed

<table>
<thead>
<tr>
<th>Fibroglandular volume</th>
<th>18 469</th>
<th>1 011</th>
<th>423</th>
<th>129</th>
<th>30.50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fgv a</td>
<td>18 295</td>
<td>1 035</td>
<td>533</td>
<td>175</td>
<td>32.83%</td>
</tr>
<tr>
<td>Fgv b</td>
<td>18 516</td>
<td>1 016</td>
<td>523</td>
<td>144</td>
<td>27.53%</td>
</tr>
<tr>
<td>Fgv c</td>
<td>18 423</td>
<td>1 391</td>
<td>731</td>
<td>209</td>
<td>28.59%</td>
</tr>
<tr>
<td>Fgv d</td>
<td>3833</td>
<td>1 987</td>
<td>615</td>
<td>615</td>
<td>615</td>
</tr>
</tbody>
</table>
## Dataset 2013 – 2016
as a percentage of women screened

<table>
<thead>
<tr>
<th>Volpara Grade</th>
<th>Assessed (% screened)</th>
<th>Biopsy (% screened)</th>
<th>Cancer (% screened)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>4.30%</td>
<td>2.31%</td>
<td>0.68%</td>
</tr>
<tr>
<td>V2</td>
<td>5.83%</td>
<td>2.83%</td>
<td>0.84%</td>
</tr>
<tr>
<td>V3</td>
<td>6.42%</td>
<td>3.18%</td>
<td>1.02%</td>
</tr>
<tr>
<td>V4</td>
<td>6.78%</td>
<td>3.59%</td>
<td>0.73%</td>
</tr>
<tr>
<td>Fgv a</td>
<td>5.47%</td>
<td>2.29%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Fgv b</td>
<td>5.66%</td>
<td>2.91%</td>
<td>0.96%</td>
</tr>
<tr>
<td>Fgv c</td>
<td>5.49%</td>
<td>2.82%</td>
<td>0.78%</td>
</tr>
<tr>
<td>Fgv d</td>
<td>7.55%</td>
<td>3.97%</td>
<td>1.13%</td>
</tr>
</tbody>
</table>
Breast density by age with cancers
Number Screened, by age and density

Volumetric breast density

Fibroglandular volume
Cancer detection by:

- density and age

as a percentage of women screened
Assessed, Biopsy, Cancer, Intervals as % of number women screened
Interval cancers 2013 – 2016

- 159 identified
- 90 have Volpara data on most recent screen
- Analysed by age and Volpara at most recent screen
Density of screen detected and interval cancers

Fibroglandular volume vs. Volumetric Breast Density
Interval cancer as rate of women screened
Number of interval cancers
Most recent screen 2013 – 2016

Volumetric Breast Density

Fibroglandular volume
Conclusions

• Using FGV to look at risk with density gives data which fits with predictions
• As older women are more likely to have non-dense breasts, screening has a greater benefit to the population in women with non-dense breasts compared to women with dense breasts (as we overcome the masking effect)
• Interval cancers occur in breasts of all densities dense > non-dense

Does breast density play an early role in the development of breast cancer?
Are cancers higher grade in fatty breasts?
Thank you
lizmusc@hotmail.com