Breast Imaging 2020
Latest radiology terms

• **Tomosynthesis** (DBT / 3D mammography)
• **Contrast enhanced mammography** (CEDM / CESM)
• **Ultrasound** - Elastography
• **Ultrasound** – Automated Breast Ultrasound (ABUS)
• **MRI** - Diffusion Weighted Imaging (DWI) and Apparent Diffusion Coefficient (ADC)
• Quantitative vs qualitative (subjective vs objective)
• Artificial Intelligence – deep learning etc
Mammogram – latest developments ..

• Digital Breast Tomosynthesis / 3 D mammography
• Contrast enhanced mammography
Digital Breast Tomosynthesis – DBT – 3D mammograms

- Volume scan with multiple slices – can scroll through
- Diminishes the restrictions of dense tissue
- Increases SENSITIVITY
- Increases SPECIFICITY
Dual Energy / Contrast Enhanced Spectral Mammography (CESM)

• Same mammogram machine
• IVI iodinated contrast
• Low energy and higher energy x-rays – subtraction.
• Enhancing masses stand out
• High sensitivity and specificity
• Quicker, cheaper and more tolerable than MRI
CESM

- Low energy mammogram + High energy mammogram + IV iodine contrast
- Subtraction leaves an image where the enhancing mass or non mass tissue stands out and background tissue is absent
Ultrasound

• Screening
• Diagnostic
• Not diminished by dense breasts
• Good for invasive cancer, poor for DCIS
• Felt to have relatively poor specificity ie too many false positives .... borderline (BIRADS 3 and 4a) masses
• Operator dependant, not easily reproducible
• New tools help reduce false positives
Ultrasound – New innovations:

- Elastography
- (doppler)
- Automated Ultrasound of the Breasts - ABUS
Elastography

• Evaluates stiffness of tissue – mass and tissue around mass
• Cancers – stiff.
• Benign mass – soft
• Two types: Strain and Shear wave
• Strain – Qualitative. Shear Wave – Quantitative and Qualitative
Elastography

• Helps decision making on borderline lesions
• Birads 4a (2 – 10%) converted to Birads 3 (≤3%)
• Birads 3 converted to Birads 4a
Strain elastography

- Light pressure on probe
- Blue – soft
- Green – stiffer
- Red - stiffest
Shear Wave Elastography

- Probe sends a sonar pulse into breast
- Blue – soft
- Yellow – stiff
- Must assess edge/surrounding tissue
- Quantitative values:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Benign</th>
<th>Malignant</th>
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<tbody>
<tr>
<td>Maximum Elasticity</td>
<td>&lt; 30 – 45 kPa</td>
<td>&gt; 80 – 150 kPa</td>
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<tr>
<td>Mean Elasticity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elasticity Ratio</td>
<td>&lt;1.95 – 3.5</td>
<td>&gt; 11</td>
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</tbody>
</table>
Strain Elastography

Shear Wave Elastography
Shear wave elastography

Qualitative

Quantitative
Automated Breast Ultrasound - ABUS

- Large sonar paddle attached to an arm
- Operated by sonographer
- Entire breast scanned in two directions – volume scan
- Radiologist scrolls through entire scan – improve productivity
- Screening
ABUS
MRI

- Most sensitive modality
- Specificity much improved
- Morphological and functional
- Selects for most biologically aggressive cancers
- Mostly not diminished by dense breasts
- Disadvantages: too many false positives, expensive, time consuming, IV gadolinium
Enhancement on MRI

- Initial and delayed curves – how fast contrast (gadolinium) it washes in and out
- Rapid initial uptake – more likely to be cancer
- Delayed enhancement
- Persistent (blue) – benign
- Plateau (yellow) – indeterminate
- Washout (red) – malignant
Enhancement
**Diffusion Weighted Imaging – DWI**

**Apparent Diffusion Coefficient - ADC**

- Non contrast MRI sequence that measures movement of water molecules within a lesion
- Apparent Diffusion Coefficient – reflects diffusion. Derived from DWI
- Cancers: Bright on DWI, Dark on ADC
- In breast cancer, ADC is king
- ADC is predominantly quantitative
- Very good at differentiating cancer from benign tissue
DWI / ADC\textsuperscript{11,12,13}

- Low ADC values – cancer
- High ADC values – benign
- Helps with equivocal lesions.
- Potential for non contrast scanning
- Response to neoadjuvant chemotherapy
DWI/ADC - Qualitative

- DWI - Cancers bright
- ADC – Cancers dark
ADC - Quantitative

• Average ADC > $1.5 \times 10^{-3}$ mm$^2$/s  benign
• Average ADC < $1 \times 10^{-3}$ mm$^2$/s  malignant
Case

- 50 yr old woman screening mammogram
Abbreviated Breast MRI

- Screening
- Remove unnecessary sequences
- Decrease scan time
  - more comfortable
  - cheaper
The radiologist’s role in Breast Oncology

• Diagnosis
• Staging (MRI)
• Monitoring response to therapy
• Follow up
Pre-treatment MRI staging

- Primary cancer Size – surgical, radiation and neoadjuvant planning
- Extent - intraductal component (DCIS) and satellite lesions
- Solitary / Multifocal / Multicentric / Bilateral
- Invasion of skin / nipple / chest wall
- Residual disease post surgical or vacuum biopsy
- Lymph node involvement
- Extramammary findings
Staging: Extent
Staging: Extent of DCIS
Staging: multifocal / multicentric
Staging: bilateral
Lymph nodes

- High NPV - If no LNs on MRI, almost 100% accuracy
- Good at assessing symmetry
- Helps with determining LN burden
Role of radiologist: monitoring response

Neoadjuvant chemotherapy:
• Non endocrine tumors
• Locally advanced
• Axillary LN metastases
Monitoring response - ultrasound

- Measure volume of tumors
- Comparison of volumes
- Assessment of axilla
- After every two to three cycles of chemotherapy.
- Biopsy markers are essential
- Not as effective for poorly defined/diffuse lesions
After 4 cycles

After 8 cycles

73% reduction
Monitoring response - MRI

• Assesses morphology and physiological features
• Particularly if diffuse, multiple, uncertain response
• Morphology – size
• Physiology – enhancement characteristics + Diffusion (ADC)
• Baseline pre-treatment scan (staging) + Early scan (early response) + Late scan (?PCR)
Monitoring response to NAC

Qualitative
Quantitative: 3D volume
Monitoring response to NAC
Follow Up post cancer treatment

ESMO:\:
• Clinical follow up every 3 – 4 months for 2 years, then 6 monthly for years 3 -5.
• Annual mammogram(patients with residual breast tissue) + possibly MRI in young patients

Our procedure:
• 6 monthly imaging follow up for 2 years: Luminal cancers
• 6 Monthly follow ups for 3 – 5 years: TN and Her-2 cancers
• Mammograms in patients with residual breast tissue
• Ultrasounds in all patients – assess breasts, chest wall and axillae
• Role of MRI (patients with residual breast tissue) – new recommendations from ACR and ASBrS: Annual MRI in patients younger than 50 and/or with dense breast tissue
?recurrence
Images: problem solving
References:


