Breast Cancer: Other Imaging Modalities

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Lecture Outline

• I - Screening
• II - Diagnosis and Staging
• III - Therapy Response
Breast Cancer: Staging

<table>
<thead>
<tr>
<th>Tumor (T)</th>
<th>T1 &lt;2cm</th>
<th>T2 ≥2cm and &lt;5cm</th>
<th>T3 ≥5cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>I</td>
<td>IIIA</td>
<td>IIIA C</td>
</tr>
<tr>
<td>T2</td>
<td>IIIA</td>
<td>IIIB</td>
<td>IIIA C</td>
</tr>
<tr>
<td>T3</td>
<td>IIIB</td>
<td>IIIA</td>
<td>IIIA C</td>
</tr>
</tbody>
</table>
Breast Nodal Groups

N0 — Metastasis not present

N1 — Metastasis to movable ipsilateral axillary lymph nodes

N2 — Metastasis to ipsilateral axillary lymph nodes fixed or matted (N2a), or in ipsilateral internal mammary nodes in the absence of axillary node metastases (N2b)

N3 — Metastasis to ipsilateral infraclavicular lymph nodes (N3a), or in ipsilateral internal mammary lymph nodes and in the presence of axillary lymph node metastases (N3b), or metastasis in ipsilateral supraclavicular lymph (N3c)

<table>
<thead>
<tr>
<th>T1</th>
<th>N0</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>IIA</td>
<td>IIB</td>
<td>IIIA</td>
<td>IIIC</td>
</tr>
<tr>
<td>T3</td>
<td>IIIB</td>
<td>IIIA</td>
<td>IIIA</td>
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</table>
## NCCN Guidelines Version 3.2015
### Invasive Breast Cancer

#### CLINICAL STAGE

<table>
<thead>
<tr>
<th>Stage</th>
<th>T1, N0, M0</th>
<th>or</th>
<th>Stage IIA</th>
<th>T0, N1, M0</th>
<th>T1, N1, M0</th>
<th>T2, N0, M0</th>
<th>or</th>
<th>Stage IIIB</th>
<th>T2, N1, M0</th>
<th>T3, N0, M0</th>
<th>or</th>
<th>Stage IIIA</th>
<th>T3, N1, M0</th>
</tr>
</thead>
</table>

#### WORKUP
- History and physical exam
- CBC, platelets
- Liver function tests and alkaline phosphatase
- Diagnostic bilateral mammogram; ultrasound as necessary
- Pathology review
- Determination of tumor estrogen/progesterone receptor (ER/PR) status and HER2 status
- Genetic counseling if patient is high risk for hereditary breast cancer
- Breast MRI (optional), with special consideration for mammographically occult tumors
- Fertility counseling if premenopausal
- Assess for distress (See NCCN Guidelines for Distress Management)

For clinical stage I-IIIB, consider additional studies only if directed by signs or symptoms:
- Bone scan indicated if localized bone pain or elevated alkaline phosphatase
- Abdominal ± pelvic diagnostic CT or MRI indicated if elevated alkaline phosphatase, abnormal liver function tests, abdominal symptoms, or abnormal physical examination of the abdomen or pelvis
- Chest diagnostic CT (if pulmonary symptoms present)

If clinical stage IIIA (T3, N1, M0) consider:
- Chest diagnostic CT
- Abdominal ± pelvic diagnostic CT or MRI
- Bone scan or sodium fluoride PET/CT (category 2B)
- FDG PET/CT (optional, category 2B)
PET/CT has a role to play - stage IIIA and above
Major issue:
- Access and affordability

- Population 1.4 billion
- 170 PET/CTs
Other imaging modalities play the dominant role in breast cancer imaging.
Other imaging modalities play the dominant role in breast cancer imaging

An Overview
US Preventative Task force Recommendations 2009 & 2013

- No routine screening age 40-49
- Bi-annual screening age 50-74
What are the issues?

- Too many false positives with few significant cancers detected (risk benefit ratio)

- Potential for over diagnosis (cancers that probably are not harmful but treated aggressively)

- Mammography is fraught with false negatives – misses clinically significant cancers (15% missed)
What are the issues?

- Patients with dense breasts and post surgical breast, the sensitivity is even lower
Digital Mammography Tomosynthesis (DMT)

- Approved by FDA 2011
- A method of imaging breast in 3D than in 2D
- Image slices are 1 mm thick
- Advantages:
  - Better sensitivity
  - Fewer Recalls
  - Potential for lower dose
Digital Mammography Tomosynthesis (DMT)
DMT – Dense Breast

Palpable Cancer Obscured by Dense Tissue

Radiol Clin N Am 2014; 52: 499-518
Breast Cancer Diagnosis - Ultrasound

- Investigate Palpable abnormalities
- Characterization of lesions seen in mammography
- Method of percutaneous biopsy
- No Radiation

High frequency transducer (12MHz)
Breast Cancer Diagnosis - Ultrasound

- Access
- Easy to perform
- Cost

Tissue Diagnosis
• A physiologic approach to breast cancer detection

• DM, DMT, US – specificity is not optimum leading to unwarranted biopsies
Only 15-30% of breast biopsies result in diagnosis of breast cancer

The issue is differentiating benign versus malignant lesions
Breast Cancer Diagnosis - BGI

- 99mTc Sestamibi 10mCi
- Images obtained in the traditional mammographic views – MLO and CC
- 100,000 counts per image
- Approximately 40 min for entire study
• The sensitivity is about 90% of lesions > 1 cm and about 80% for lesions < 1 cm
• Specificity is > 90%
• Complementary to anatomic studies
• The sensitivity is about 90% of lesions > 1 cm and about 80% for lesions < 1 cm
• Specificity is > 90%
• Complementary to anatomic studies
  • Dense breast
  • Anatomically questionable lesions requiring biopsy
Breast Cancer Diagnosis - BGI

IDC & DCIS

Radiol Clin N Am 2010; 48: 1055-1074
Breast Cancer Diagnosis – BGI Biopsy
MRI          Pathology             PEM

Images Courtesy Naviscan
Imaging DCIS with PEM & MRI

**History:** 58 y/o post menopausal woman with bilateral implants presenting with suspicious calcifications on right found to be DCIS.

**Findings:** MRI: No abnormal enhancement in the region of calcifications: BI-RAD 3 Probably benign finding for additional findings.

PEM: 1 cm nodular focus of FDG uptake seen on PEM in region of DCIS.

**Pathology:** Right breast segmental mastectomy: 7mm high grade DCIS

Images Courtesy Naviscan
• BGI is similar to PEM with lower cost
• Complementary to anatomic imaging modalities for breast cancer detection
• A problem solving tool
Breast Cancer Diagnosis - MRI

• High spatial resolution
• Good temporal resolution
• High signal to noise ratio
• Bilateral breast coverage

A

B

1T 3T

Radiol Clin N Am 2014; 52: 547-572
Key pulse sequence: multiphase 3D gradient echo sequence

Sub millimeter in plane spatial resolution

Temporal resolution of 1-3 min: morphology and time enhancement pattern of lesions
Breast Cancer Diagnosis - MRI

Key pulse sequence: multiphase 3D gradient echo sequence

Sub millimeter in plane spatial resolution

Temporal resolution of 1-3 min: morphology and time enhancement pattern of lesions

1T

3T

Radiol Clin N Am 2014; 52: 547-572
• Suggested Pulse Sequences
  • T1 weighted non fat saturated
  • T2 weighted fat saturated / STIR
    • To separate cyst versus solid lesions
  • 3D GRE T1 weighted with fat suppression and with and without contrast
    • Once before contrast and multiple times after contrast
    • To identify vascular bed and enhancing lesions
Breast Cancer Diagnosis - MRI

- Suggested Pulse Sequences
  - 3D GRE T1 weighted with fat suppression and with and without contrast
    - Gd chelate contrast 0.1mmol / Kg with 20 ml saline flush
  - Bilateral acquisition in prone position
Breast Cancer Diagnosis - MRI

- **T1 sequence non fat saturated**
- **T2 sequence fat saturated**

Radiol Clin N Am 2014; 52: 547-572
Breast Cancer Diagnosis - MRI

3D Gradient Echo Sequence without contrast

3D Gradient Echo Sequence with contrast – first contrast series - IDC

Radiol Clin N Am 2014; 52: 547-572
MIP reconstructed from the entire set of subtracted images of left breast
MRI – Lesion Enhancement Pattern

Type 1: Lowest
Type 2: 40 - 70%
Type 3: 60 - 80%

% suspicion for malignancy

% Enhancement

0%  50%  100%  150%

0  90  180  270  360 Time seconds

Type 1
Type 2
Type 3

Radiol Clin N Am 2014; 52: 547-572
MRI – Lesion Enhancement Pattern

% suspicion for malignancy

Type 1: Lowest
Type 2: 40 - 70%
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Signal Intensity

Fast
Medium
Slow

Initial Rise
Delayed Phase

Type 1, Persistent
Type 2, Plateau
Type 3, Washout
Left breast mixed IDC + ILC and metastatic lymph node
MRI

• Two important features
  • Margins of a lesion
  • Kinetics
• Biopsy is recommended if the morphology is suspicious, regardless of kinetics
Axillary Nodal Staging

• For clinically palpable nodes, ultrasound is used for biopsy and tissue diagnosis

• If no clinically palpable nodes, sentinel node lymphoscintigraphy + ALND remain the standard
• SPECT/CT Improves specificity and anatomic location

Moncayo VM et al. Semin Nucl Med 43:281-293
Therapy assessment: MRI Vs PET/CT

Pooled Results: MRI – Sensitivity 0.88 and specificity 0.55
PET/CT – Sensitivity 0.71 and Specificity 0.77
MRI

- MRI and PET/CT have similar accuracy for therapy assessment
- Role of scinti-mammography and PEM – not sufficient data at this stage, possibly in future?
CT and Bone scan will remain the dominant imaging modalities for systemic disease detection and therapy assessment.

- Due to access issue and cost for PET/CT – worldwide.

- NaF PET/CT vs Bone scan.
Breast Cancer: Other Imaging

- Mammography, Ultrasound and MRI are the imaging modalities for primary breast tumor detection, diagnosis and for early staging (Stage I-II)

- Scintimammography may play adjunct role to reduce false positives before biopsy procedure & for detecting lesions in dense breasts

- Lymphoscintigraphy is the imaging standard for axillary nodal staging
For NAC therapy assessment, MRI as accurate as PET/CT

Systemic staging and therapy assessment (stage III and IV) – chest CT, abdominal CT and bone scan play the dominant role, though PET/CT may be more accurate - due to access and cost - worldwide
Thank you

- Diana Paez
- Thomas Pascual
- Enrique Estrada
- Other IAEA staff
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