Beyond Mammograms

The Role of CT and MR in Breast Cancer Diagnosis

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Menu of Tests

• **Mammography:**
  Can rule IN cancer, but can not rule it OUT.
• **Ultrasound**
• **CT scan (w/ and w/o contrast)**
• **MRI (w/ and w/o Gd contrast)**
• **Ultrasound- or MR-guided biopsy and wire localization**
• **Bone radionuclide scan**
• **Lymphscintigraphy**
Menu of Tests

- **Mammograms**: hi sensitivity, low specificity, many needless biopsies of benign lesions. Spot compression, magnification, and angle views improve specificity. Dense breasts decrease sensitivity and specificity.
- **Ultrasound**: solid vs. cystic nature, guiding biopsy procedures.
- **CT scan**: Lesions close to the chest wall. Contrast enhancing lesions suggest malignancy.
- **MRI**: Increased contrast of tissues, multiple views, less ionizing radiation, use of contrast enhancement time course to differentiate benign from malignant lesions, detects lesions close to chest wall and occult breast lesions, higher sensitivity but still poor specificity.
- **Staging**:
  - **Bone radionuclide scan** (Tech99m-methylene diphosphonate) + **Spine MRI**: for eval of bone metastases.
  - **CT Torso and Abdomen** for additional mets (liver, abdomen, lung).
  - **Lymphscintigraphy**: radionuclide injection into breast parenchyma pre-op to radio-label sentinel LNs for targeted biopsy during surgery.
Anatomy

- Fatty tissue
- Gland lobules: acini and ductules
- Suspensory (Cooper’s) ligaments
- Inflammatory Lesions:
  - Abscesses
- Cysts
- Benign Lesions:
  - Fibroadenoma
  - Papilloma (intraductal)
- Malignant lesions:
  - Primary (intraductal, invasive, paget’s disease)
  - Secondary
  - Lymphoma
  - Sarcoma

http://www.schering-diagnostics.de/scripts/patients/mri/photogallery/content.php
Patient 1

- 56 y/o female p/w 7 month history of worsening upper-mid back pain and recent fatigue.
- Yearly MGs, last one 10 mons ago, negative.
- Initial eval: neg CXR and Thoracic spine xray.
- Lab studies: elevated LFTs.
- Liver U/S was ordered.
Pt1: Liver Ultrasound

- Diffusely heterogenous liver with multiple masses, largest measuring 2.5 cm.
- Several soft tissue nodules (not seen here) outside the liver likely represent enlarged abdominal lymph nodes.
- DDX includes metastatic dz to liver.
**Pt1: CT scan Liver**

Liver lesions, pre-contrast

**DDX:**
- METASTATIC DZ: hypodense lesions with peripheral enhancement
- Primary liver tumors
- Benign lesions: cysts, cavernous hemangiomas, FNH.

Liver lesions, post-contrast

Many lesions of varying sizes with low attenuation centrally, possibly due to central necrosis.

Largest lesion in posterior R lobe.
Pt1: CT scan Torso

Pre-contrast

Post-contrast

2.3x1.1cm enhancing nodular lesion in lower medial quadrant of L breast.

Probably primary breast cancer that metastasized to liver.
Pt1: CT scan Bony Window
Pt1: CT scan Bony Window

- Multiple lytic bony lesions in thoracic spine (previous slide), sacrum, and L. iliac wing.
- Concerning for osseous metastatic disease.
Pt1: Mammogram

BB on nipple
BB on palpable lump in lower inner quadrant
Heterogenously dense breast tissue with 2 cm ill-defined mass under lump-marking BB.
BIRADS-5 highly suspicious

L breast CC

PACS, BIDMC
<table>
<thead>
<tr>
<th>Assessment category</th>
<th>Recommendation</th>
<th>Probability of malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Negative</td>
<td>Routine follow-up</td>
<td>0 percent</td>
</tr>
<tr>
<td>2: Benign</td>
<td>Routine follow-up</td>
<td>0 percent</td>
</tr>
<tr>
<td>3: Probably benign</td>
<td>Short interval follow-up</td>
<td>&lt;2 percent</td>
</tr>
<tr>
<td>4: Suspicious</td>
<td>Consider biopsy</td>
<td>2 to 75 percent</td>
</tr>
<tr>
<td>5: Highly suggestive of malignancy</td>
<td>Appropriate management</td>
<td>&gt;75 percent</td>
</tr>
<tr>
<td>0: Incomplete</td>
<td>Further imaging evaluation</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**BI-RADS**: Breast Imaging Reporting and Data System
Pt1: Breast Ultrasound

L breast transverse view

Ill-defined hypoechoic mass with shadowing, at 8 o’clock on L breast.
(1.9x1.4x1.8cm)

Ultrasound-guided core biopsy

Biopsy needle
Pt1: Bone Scan

Abnormally increased uptake throughout the spine, multiple ribs, the sternum, proximal L femur and somewhat in the L pelvis. Consistent with bony metastases.
Pt1: Diagnosis & Staging

• Core Biopsy of L breast mass: infiltrating ductal carcinoma
• Stage IV Breast Cancer
• Patient received chemotx and hormonal Rx.

STAGE GROUPINGS

- Stage 0 — Tis N0 M0
- Stage I — T1 N0 M0 (including T1mic)
- Stage IIA — T0 N1 M0; T1 N1 M0 (including T1mic); T2 N0 M0
- Stage IIB — T2 N1 M0; T3 N0 M0
- Stage IIIA — T0 N2 M0; T1 N2 M0 (including T1mic); T2 N2 M0; T3 N1 M0; T3 N2 M0
- Stage IIIB — T4 Any N M0
- Stage IIIC — Any T N3 M0
- Stage IV — Any T Any N M1
Pt1: Breast Lesion Post-chemotherapy

Post-contrast CT scan of Torso.

L breast lesion smaller in size after 3 months of treatment.
Pt1: Liver Mets Post-chemotherapy

Post-contrast CT scans of Liver after 3 months of treatment.
Numerous small hypodense lesions present throughout, with decrease in size and number of the lesions, esp. of large R posterior lobe lesion.
Pt1: Bony Mets Post-chemotherapy

Lytic and more sclerotic appearing bony metastatic lesions after 3 months of treatment seen on bony window of CT scan of Torso (upper left) and Pelvis (lower right).
Pt1: Bone scan Post-chemotherapy

Decrease in radioactive signal uptake of several previously seen abnormally high uptake bony lesions within thoracic spine and ribs as well as L pelvis.
CT scan in Breast Cancer Diagnosis

- Not routinely used for breast cancer screening or diagnosis.
- Can be useful for contrast-enhancing lesions and lesions close to chest wall.
- Routinely used to assess for chest, liver, pelvic and bony metastases and follow-up post-treatment.
Patient 2

- 70 y/o male p/w R breast periareolar thickening with nipple retraction.
- FNA performed.
- Pt referred for MG, US, and US-guided core biopsy.
Pt2: Mammogram

BB on R nipple
2 cm irregular mass in R breast below nipple, which is inverted.

BIRADS-5 highly suspicious
Pt2: Breast Ultrasound

Hypoechoic mass with irregular borders, taller than wide, extending from nipple posteriorly, with question of invasion of pectoralis major muscle.

Pt referred for MRI to assess for pectoralis invasion.
Pt2: Breast MRI

R breast Axial T1W
Pre-contrast

R nipple
Spiculated breast mass
R Pectoralis major muscle

R breast Axial T2W
Pre-contrast

PACS, BIDMC
Pt2: Breast MRI

R breast Axial FS T1W Pre-contrast

R breast Axial FS T1W Post-contrast

R nipple
Spiculated breast mass
R Pectoralis major muscle

PACS, BIDMC
Pt2: Breast MRI

R breast Sagittal
FS T1W
Pre-contrast

R breast Sagittal
FS T1W
Post-contrast

20x19x16mm spiculated, contrast-enhancing mass deep to R nipple. Extends to depth of 3mm into R pectoralis major muscle. Highly suggestive of malignant lesion.
Pt2: Diagnosis and Therapy

- FNA result c/w ductal proliferative lesion with atypia.
- R breast core biopsy: Carcinoma, favoring breast primary.
- Pt underwent R total mastectomy, R pectoralis resection and sentinel LN dissection.
- Path results: 2.6cm invasive ductal CA, low-grade, invading into skeletal muscle and overlying dermis. 10 neg LNs.
- Staging: T2N0MX (Stage IIA)
- Post-op tx: adjuvant chemotx + xrt.

Pt 2 Pre-op lymphscintigraphy scan: radioactive tracer injected into breast mass, tracking into lymphatics and giving high signal uptake in sentinel LN (arrow).
Breast MRI- technique

- Breast Surface Coil
- Contrast agent (Gadolinium)
- Temporal Resolution: image within mins of Gd injection.
- Spatial Resolution: FS, large volume coverage.
- Temporal vs. Spatial Resolution

http://www.imaging.robarts.ca/~brutt/Research/microvascular.html
Signal Intensity Time Course

- Time–signal intensity curve types:
  - Type I: steady enhancement (Most benign lesions)
  - Type II: plateau
  - Type III: washout (Most malignant lesions)

- $\frac{[S_{lc} - S_I]}{S_I}$ = Relative Signal Intensity
- N/PFC = Fibrocystic changes

Screening and Diagnosis with MRI

- Less ionizing radiation.
- Higher sensitivity and lower specificity than mammography.
- Can better detect tumors close to chest wall and invasion of pectoralis muscle.
- Currently being evaluated for screening high-risk populations (BRCA1/2 carriers, strong family hx).
- Downsides: expense, availability, limited specificity, inability to detect microcalcifications.
Patient 3

- 34 y/o female w bilateral saline breast implants (5 yrs ago) p/w pea-sized lumps in both breasts.
- MG at OSH is neg bilaterally.
- U/S at OSH:
  - 4x3mm solid nodule behind R nipple
  - 3.4 mm solid nodule behind L nipple
- Pt referred for an MRI.
Pt3: Breast MRI

Solid retroareolar solid lesions seen on OSH U/S not seen on MRI.

Small oval well-demaracted mass detected in upper inner R breast on MRI, undetected on MG or U/S.

Mass enhanced with Gd contrast, as in R image.

Saline Implants

Small Oval Mass
Pt3: Breast MRI
Signal Intensity-Time Curve

Signal Intensity-Time Course:
Type I steady enhancement
Benign Lesion: most likely Fibroadenoma.

R breast Axial Subtraction image
Small oval mass in R inner breast, marked by small circle with 1.
Pt3: Implant Valves

Same patient presents 1 year later with differently located small breast lumps detected on routine PE.

A repeat U/S below shows these lumps, which probably corresponded to previously ultrasounded solid retroareolar lesions, to be the implant valves (arrows), seen clearly on sagittal view MRI on the right.
References

- Up-to-Date® 2005, Diagnostic evaluation and initial staging work-up of women with suspected breast cancer.
- Up-to-Date® 2005, TNM staging classification for breast cancer.
- Up-to-Date® 2005, Screening for breast cancer.
- http://www.imaging.robarts.ca/~brutt/Research/microvascular.html
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