Metastatic breast cancer
The workup and radiologic characteristics of liver and skeletal metastases

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Patient AK 53F with palpable mass in right breast: mammogram CC view

- Spiculated mass
- Benign macrocalcification (oil cysts)
- Biopsy clip from prior biopsy
- Surface sticker to mark a mole
Patient AK Spiculated breast mass on MLO view

Spiculated 2.5 x 1.5 cm mass in right outer central quadrant at posterior depth. BIRADS 4C with biopsy recommended.
Ill-defined hypoechoic mass anterior to pectoralis muscle. The fibers of the muscle are not visualized due to distal shadowing. Biopsy revealed invasive ductal carcinoma. The patient underwent staging workup, a mastectomy, and began surveillance.
Mammogram is the only imaging modality indicated in surveillance

Local recurrence: Tx → mammogram → q6-12 mo + History PE

Distant recurrence: No imaging or lab studies indicated.* Recurrences are most commonly heralded with symptoms (60%) > PE (30%) > tests 10%. Diagnosis then accomplished by tests that are guided by presenting symptom complex.

* Two RCTs have shown no significant difference in overall survival of women with metastatic breast cancer who received standard surveillance versus intensive surveillance (standard + CXR + RN bone scan).

Quon A and Gambhir SS, 2005; Rosselli M et al., 1994; The GIvIO Investigators, 1994
### Common sites of breast metastasis

<table>
<thead>
<tr>
<th>Site</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Bone</td>
<td>38%</td>
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<tr>
<td>Lung/pleural</td>
<td>18%</td>
</tr>
<tr>
<td>Chest wall/skin</td>
<td>16%</td>
</tr>
<tr>
<td>Nodes</td>
<td>14%</td>
</tr>
<tr>
<td>Liver</td>
<td>6%</td>
</tr>
<tr>
<td>Breast</td>
<td>2%</td>
</tr>
<tr>
<td>CNS</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
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Our patient was one year s/p mastectomy when she presented with lower back pain. A MRI spine was obtained for evaluation.
MRI spine showed no pathology on spine, but incidentally showed a 2 cm high signal liver lesion on this axial T2-weighted image.
Patient AK Further characterization of solitary liver lesion on CT

Hypoattenuating lesion within segment VI without significant arterial or venous enhancement. The attenuation of the lesion is greater than that of simple fluid.

DDx solitary liver lesion:
- Malignant: metastatic cancer, primary hepatic cancer (e.g. HCC)
- Benign: cysts, hemangioma, focal nodular hyperplasia, hepatic adenoma, abscess
Patient AK Definitive dx with US-guided biopsy revealed malignancy

Sag: 2.2 x 1.6 x 2.2 cm hypoechoic, targetoid lesion in segment VI

Core needle biopsy positive for malignant cells, c/w metastatic adenocarcinoma. The patient was begun on an experimental chemotherapy protocol with slight increased growth of the liver lesion.
Companion patient
Let’s look at another case with a different presentation of liver metastasis
Patient 1  51F two years s/p mastectomy p/w abdominal distension: US

The liver has increased heterogeneity and is hyperechoic compared to the kidney, which is abnormal. This is suggestive of fatty infiltration (remember fat is hyperechoic).

To better characterize the increased heterogeneity, a CT with contrast was obtained.
Patient 1 Hypervascular liver lesion on axial CT with contrast

4.5 x 2.5 cm peripherally enhancing hypodensity on mixed and venous phase. There is fatty infiltration of the liver (the liver is abnormally hypoattenuated compared to the spleen).
Patient 1 CT shows other interesting findings worrisome for metastasis

- Thickened duodenal wall
- Omental caking and enhancement

US-guided bx of liver lesion revealed poorly differentiated carcinoma c/w breast origin.

These radiologic findings (tumor in liver, omentum, bowel wall) suggest peritoneal carcinomatosis.

The patient promptly began chemotherapy with resolution of ascites, decrease of the liver lesion and peritoneal involvement.
## Menu of tests for the workup of suspected liver metastasis

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
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</table>
| US            | - Transabdominal US less sensitive compared to MRI or CT. May miss lesions < 1 cm  
                - Intraoperative US most sensitive imaging technique to diagnose liver metastases |
| CT with contrast | - Most accurate, readily available technique to identify liver metastases  
                     - Should include both arterial and venous phases                      |
| MRI           | - May be easier to see mets better on MR compared to CT due to ability to evaluate abnormal soft-tissue structures  
                     - Useful to delineate vascular involvement                                |
Patients AK & 1 Radiologic features of liver metastases on US, CT, MRI

US
• Hypoechoic rim and internal heterogeneity

CT
• Classically a hypervascular lesion that rapidly enhances on arterial phase with central hypoattenuation

MRI
• Low signal area on T1
• Moderately high signal on T2
Metastatic breast cancer to the skeleton
How breast cancer looks when it involves the bone, the most commonly affected organ
Why does breast cancer metastasis to bone?

- Complications: bone pain, pathologic fractures, epidural spinal canal compression
- Breast metastasis: 80% predominantly osteoclastic, 20% osteoblastic

Why is bone a preferential site?

Seed and soil hypothesis

Seed

Tumor cells with various adhesive molecules that bind corresponding receptors in marrow and bone matrix

Soil

Bone microenvironment contains GF released and activated during bone resorption

Seed and soil hypothesis

Growth factors (GF)

Roodman GD, 2004
The mechanism of osteoblastic metastasis is not known. It is important to note that bone destruction is mediated by osteoclasts and NOT directly by tumor cells.

Let's look at three example cases of what breast cancer looks like when it involves the bone.

Roodman GD, 2004
Patient 2 87F ten years s/p tx, p/w back pain and imbalance: axial CT

Expansile, lytic lesion in spinous process of T5 and right T11 vertebral body extending into spinal canal.

This was further characterized with a MRI spine.

DDx multiple lytic lesions:
- Metastatic disease, esp. breast
- Multiple myeloma
- Lymphoma
- Paget’s disease (lytic phase)
- Brown tumor
- Osteosarcoma
- Chondrosarcoma
Patient 2 Epidural spinal cord compression on sagittal MRI spine

- Spinal cord compression at T5
- Pathological fracture associated with T11
Patient 2 The ESCC was relieved with laminectomy: CT s/p surgery

The patient received Decadron and is now s/p T5 posterior laminectomy with air in surgical area. The spinous process of T5 has been removed (*). The pathology returned c/w metastatic breast cancer to spine.
Patients 3 & 4
Let’s look at other patients with different manifestations of bone metastasis
Patient 3 57F fifteen years s/p mastectomy, p/w back pain: frontal radiograph

Left: Lytic/sclerotic lesion of left ilium. Biopsy revealed adenocarcinoma c/w original breast cancer.

Right: Post radiation treatment. Lesion is now sclerotic and contains “good” woven bone.

Post-treatment

Sclerotic lesion
Sclerotic lesion in spine
Pedicle not seen, suggesting another focus of involvement

Courtesy of Dr. Hall
There are no focal abnormalities, but notice the diffusely sclerotic bones with loss of cortico-medullary differentiation.
Patient 4 Diffuse osteosclerosis on abdomino-pelvic plain films

Diffuse osteosclerosis is also noted in the spine and pelvis. Let’s review the differential diagnosis for diffuse osteosclerosis.

Courtesy of Dr. Hall
Differential for diffuse osteosclerosis

- Renal osteodystrophy
- Marrow packers: prostate/breast carcinomatosis, sclerotic MM, myelofibrosis, sickle cell, thalassemia
- Poisoners: fluorosis, vitamin D, milk-alkali syndrome
- Hypothyroid
- Osteopetrosis

A radionuclide bone scan was obtained, which narrowed the differential.
Patient 4 Super scan on RN bone scan suggests breast carcinomatosis

Bone scan with areas of focal uptake. Notice that the kidneys are not visualized.

This super scan, in the context of the other imaging findings and the patient’s history, suggests breast carcinomatosis.

Courtesy of Dr. Hall
Summary

• Mammography is the only imaging modality indicated in surveillance. There is no role for routine use of other studies to evaluate distant recurrence.

• US, CT with contrast, and MRI are often used to detect and evaluate a solitary liver lesion.

• Osteolytic breast metastasis, which predominates in 80% of cases with breast metastasis to the bone, is a vicious cycle of growth factor release and stimulation of tumor growth.

• Metastatic disease is most commonly heralded with symptoms. Workup is based on the constellation of presenting symptoms.

• We reviewed the various radiologic characteristics of breast metastasis to the liver and bone.


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