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Imaging surveillance after breast conservative surgery and reconstruction  

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59yo; 10/2001 BCT of left side, radiation, chemotherapy, 5 years tamoxifen, cosmetic reduction mastoplastic of right side
Framing – why talking on this topic?

- Individual variations in risk of recurrent breast cancer
- Individualized risk stratification
- Risk communication
- Revined surveillance strategies
- Improving early detection and diagnosis of recurrence
Key concepts

- Surgery and radiation therapy used in breast conservation therapy (BCT) produce typical tissue reactions.
- Major changes after BCT may include skin and parenchymal edema, fluid collection, scar formation, fat necrosis, and calcifications.
- These changes can look like and must be differentiated from in-breast tumor recurrence (IBTR).
Aim of imaging methods

- Reflecting a normal time dependent course of benign treatment associated changes

- Detecting in-breast tumor recurrence (IBTR), lymph node relapse, chest wall recurrence, contralateral cancer, distant metastasis

- Increasing patient benefits, reducing biopsy rate, revealing cost effectiveness
Preoperative US-guided marking of the lesion, segmental resection
Benign tissue reactions following SURGERY
Local repair by scar after BCT

- exsudation
- resorption
- proliferation
- devascularization
- retraction

6 – (12) months

fluid collection
granulation tissue
scar
T1 Ductal Cancer

6 mon after BCT

Scar - indistinct demarcation

12 mon after BCT

Scar - increased retraction
Seroma/hematoma in US

Time dependent decrease of diameter

Maximal Diameter (cm)

Months after Radiation Therapy

Development of scar tissue

US morphology

Tissue background of fat

Fluid collection → Granulation tissue → Scar
BCT 11 years ago

Old scar left upper quadrant
Golden rule: go back to older images and try proofing stability over time.

50 years old patient; BCT 2003

More spiculations

Same appearance

Current Previous year Two years ago
Benign tissue reactions following RADIATION
Increased vasopermeability

weeks

Edema

6 – 12 months

Diffuse fibrosis

Diffuse tissue reaction after radiation therapy

Edema < 6 mon
Fibrosis > 6 mo

6 mo

12 mo
Edema (< 6 mon) / Fibrosis (> 6 mon)

- Skin thickening
- Thickened Cooper’s ligaments
- Increased echogenic speckles
- Indistinct border between hyperechoic fibroglandular tissue and isoechoic fat

Scar and diffuse edema 6 mo after BCT; fundam. US
Time dependent tissue reactions

Development of edema in MR after BCT

Morakabati-Spitz et al.: Radiology 2003
Time dependent tissue reactions

Development of edema in MR after BCT

Chronic inflammation

Edema

Excision site 12 mo after excision of recurrent DCIS

Lipoid necrosis 12 mo after re-excision site of old scar (BC 2002)

Complex causes of high T2 signal
Histological chronic inflammation showing intensive late Gd enhancement.
Mammographic changes

Time dependent course

Frequency of contralateral cancer varies between
- 3% in MR screening at time of cancer diagnosis
- 4% after median 4.5 years of follow-up

Frequency of complications after BCT

- Lipoid necrosis 10%
- Lymph cyst 4%
- Granuloma 3%
- Mastitis <1%
Diagnosis of In-Breast Recurrence
<table>
<thead>
<tr>
<th>Imaging Signs</th>
<th>Modality</th>
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<tr>
<td>Progressive mass</td>
<td>Mx, US, MR</td>
</tr>
<tr>
<td>New developing calcifications</td>
<td>Mx</td>
</tr>
<tr>
<td>Localized hypervascularisation</td>
<td>Doppler</td>
</tr>
<tr>
<td>New Gd enhancement</td>
<td>MR</td>
</tr>
<tr>
<td>Newly developing signs of diffuse edema</td>
<td>Mx, US, MR</td>
</tr>
</tbody>
</table>

- Progressive mass: Mx, US, MR
- New developing calcifications: Mx
- Localized hypervascularisation: Doppler
- New Gd enhancement: MR
- Newly developing signs of diffuse edema: Mx, US, MR
Hypervascularization up to 6 mo after BCT is normal

Hypervascularization after 12 mo is suspicious
Based on the results of preoperative US, one study showed that approximately 16% of women who had undergone preoperative US had changes in treatment plans set by mammography alone (29).

Moreover, US has drawn attention as a useful surveillance imaging method in addition to mammography in women who have been treated for breast cancer. US detects ipsilateral recurrent or contralateral metachronous breast cancers with higher sensitivity (91–97%) (Table 2) than that of palpation or mammography, which have sensitivity values of 45.5–79% and 45–87%, respectively (5, 8, 28, 30-32). Adding US to mammography in the American College of Radiology Imaging Network (ACRIN) 6666 trials yielded an additional 1.1–7.2 cancers per 1000 high-risk women, of which 53% of the 2637 enrolled women had a personal history of breast cancer (27). Other than the breast, US is an excellent modality to evaluate chest wall and axillary areas, which cannot be easily approached by mammography.

One of the most common sites for post-treatment breast cancer recurrence is the chest wall (Fig. 2), either from direct extension of the tumor, indirect extension via interpectoral nodes, or from undissected lymphatics (32). Approximately 10–35% of patients who have been treated for breast cancer have a metastasis in the axillary, internal mammary, and supraclavicular nodes (33, 34). Among the occult regional recurrences after surgical treatment for

![Fig. 2. 44-year-old woman who had undergone modified radical mastectomy of left breast due to invasive ductal carcinoma.](image)

Ultrasonography (US) performed 30 months after surgery (A) revealed 11-mm hypoechoic lesion located within skin layer (arrow). US-guided fine needle aspiration was performed on this lesion, and cytology result was positive for metastatic carcinoma from breast. Breast magnetic resonance imaging (B) showed enhanced nodule in left chest wall (arrow) correlating to proven malignant mass.

### Table 2. Diagnostic Performances of Mammography, Ultrasonography, and MRI in Post-Treatment Surveillance of Breast Cancer Patients

<table>
<thead>
<tr>
<th></th>
<th>Mammography</th>
<th>Ultrasonography</th>
<th>MRI</th>
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<tbody>
<tr>
<td></td>
<td>Ipsilateral</td>
<td>Contralateral</td>
<td>Ipsilateral</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>8–72.7%</td>
<td>8.2–90%</td>
<td>43–91%</td>
</tr>
<tr>
<td>Specificity</td>
<td>61.1–95.5%</td>
<td>31–95.1%</td>
<td>99.0%</td>
</tr>
<tr>
<td>PPV</td>
<td>14.7%</td>
<td>8.6–26.3%</td>
<td>25.0%</td>
</tr>
<tr>
<td>NPV</td>
<td>99.2%</td>
<td>99.2–99.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td>95.0%</td>
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</table>

Note. — NPV = negative predictive value, PPV = positive predictive value

<table>
<thead>
<tr>
<th>Modality</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
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<tbody>
<tr>
<td>US</td>
<td>0.8570 (0.8040–0.8990)</td>
<td>0.9620 (0.9540–0.9700)</td>
</tr>
<tr>
<td>CT</td>
<td>0.8480 (0.8110–0.8810)</td>
<td>0.7530 (0.6920–0.8070)</td>
</tr>
<tr>
<td>MRI</td>
<td>0.9500 (0.9230–0.9700)</td>
<td>0.9290 (0.9020–0.9500)</td>
</tr>
<tr>
<td>SMM</td>
<td>0.9000 (0.8530–0.9370)</td>
<td>0.7980 (0.7150–0.8660)</td>
</tr>
<tr>
<td>PET</td>
<td>0.9530 (0.9370–0.9650)</td>
<td>0.8630 (0.8240–0.8950)</td>
</tr>
</tbody>
</table>

MRM at 3 Tesla

61 years old, Latissimus flap, contralateral T1a + fibroadenoma
Screening for Recurrences after BCT
Is there a role for MRI?

- N= 466 patients with BCT; follow-up for a median of 5.4 ys
- Ipsilateral breast recurrences in eight patients (1.7%) with a mean diameter of 1.6 cm
- Contralateral cancers developed in 11 patients (2.3%) with a mean diameter of 1.5 cm
- Annual screening MRI (2570 MRIs) would have incurred cost and would have been unlikely to improve overall survival

Where should we go to?
**Revined surveillance strategies**

Is there any role for MRI?

<table>
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<th>European Guidelines</th>
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<tr>
<td>IBUS, DEGUM, ÖGUM, SGUM, S-3</td>
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**High risk of recurrence**

- > 20% live time risk
- > 15-20% live time risk

additional MR additional MR ?
As mammography enables detection of an early asymptomatic recurrence, early intervention or treatment is also possible (Fig. 1) (9, 21, 22). Several recent studies have demonstrated that early detection of a recurrence in asymptomatic patients during post-treatment follow-up improves survival (4, 22, 23), supporting the role of routine mammography for post-treatment surveillance of breast cancer. Based on a literature review, Houssami and Ciatto (4) reported that the proportion of ipsilateral breast recurrences detected on mammography is 50–80%, and mammography detects 45–90% of contralateral metachronous breast cancers. Paszat et al. (22) reported that surveillance mammography is associated with a significant reduction in the hazard for death related to breast cancer. Similarly, surveillance mammography helps detect asymptomatic tumor recurrence, resulting in improved patient survival, but most recommendations are based on consensus rather than evidence supported by RCTs. In another study, the proportion of ipsilateral breast recurrences detected with mammography was 8–51% of lesions detected on mammography only, but approximately three-fifths of the participating hospitals perform mammography surveillance at 6-month intervals for 2 to 5 years in patients with breast conservation surgery (24). Such semiannual mammographic surveillance allows the detection of a significantly higher proportion of cancer recurrences at an earlier stage than that of annual treatment. The surveillance program would be intended to detect second breast cancers at an early stage when curative intervention is possible. Up to now, mammography has been the only evidence-based imaging modality with demonstrated efficiency for detecting asymptomatic tumor recurrence or a second breast cancer in women who have been treated for primary breast cancer (2, 4, 11-17). Ultrasonography (US), magnetic resonance imaging (MRI) and 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET) have been utilized in many institutions to increase detection of second cancers at an early stage.

### Imaging Modalities

**Mammography**
Screening mammography for women with an average risk of breast cancer results in early detection of breast cancer, leading to reduced mortality and improved patient outcome. Many case-controlled or non-randomized controlled trial (RCT) studies show a 20–30% reduction in breast cancer mortality after screening (18, 19). Hence, we assume that women with an elevated risk for breast cancer, including those who have already been treated for primary breast cancer, may benefit even more from screening mammography.

### Post-Treatment Surveillance Recommendations for Women Treated for Primary Breast Cancer

<table>
<thead>
<tr>
<th>Year</th>
<th>History &amp; Physical Examinations</th>
<th>Mammography</th>
<th>Other Studies</th>
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</thead>
</table>
| American Society of Clinical Oncology (11, 58) | Every 3–6 months for first 3 years  
Every 6–12 months for years 4–5  
Annual follow-up thereafter | Posttreatment mammography  
1 year after initial mammography  
At least 6 months after completion of radiation therapy  
Yearly mammography evaluation, unless otherwise indicated | Chest radiography, bone scans, liver US, CT, PET, MRI, or other laboratory tests: not recommended in otherwise asymptomatic patient with no specific findings on clinical examinations |
| National Comprehensive Cancer Network | Every 4–6 months for 5 years, then annually | Mammography every 12 months | MRI considered in women with lifetime risk of second primary breast cancer greater than 20%  
Other tests not recommended |
| European Society of Medical Oncology (1) | Every 3–4 months for first 2 years  
Every 6 months from year 3–5  
Annual follow-up thereafter | Ipsilateral (after BCS) & contralateral mammography every 1–2 years | MRI may be indicated for young women with dense breasts, genetic or familial predispositions  
Other laboratory or imaging tests not recommended in asymptomatic patients |
| National Institute for Clinical Excellence | Regular check-up, determined by physician or patient | Annual mammography | Other additional studies not routinely recommended |

**Note.**— BCS = breast conserving surgery, CT = computed tomography, MRI = magnetic resonance imaging, PET = positron emission tomography, US = ultrasonography.
Risk stratification based on predictive factors

Meta-analysis for local recurrence after BCT

- extended T2- tumor
- high grading
- tumor involved margins
- multicentricity
- extensive intraductal component
- lymphovascular invasion
- age < 35 year-old
- elevated risk in 21-gene recurrence score (oncotype)

What else can you recommend?

Five servings of fruit and vegetables and exercised 30 minutes have a day had significantly improved cancer-free survival.
Have fun!
Take Home Message 1

Respect
time dependent
benign tissue reactions!
Strong architectural distortions of the augmented breast: MR-Mammography!
Take Home Message 3

For high risk patients and when in doubt: puncture it out!
Thank you for your attention!