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Key Concepts

- › Both surgery (lumpectomy) and radiation therapy used in breast conservation therapy (BCT) produce changes in the breast
- › These changes must be differentiated from in-breast tumor recurrence (IBTR)
 - Mammographic changes after BCT may include skin edema, parenchymal edema, scar formation, fat necrosis, calcifications
 - Mammographic findings of IBTR can be similar
 - Comparison with previous studies is extremely helpful
 - First mammogram on treated side is generally obtained 6 months after BCT
 - Repeating the mammogram at time when contralateral breast is due allows short-term follow-up and gets both breasts onto same schedule
 - Changes due to BCT generally become less prominent over time (except for initial phase, when edema may mask appearance of cavity), whereas suspicious findings increase
 - Liberal use of image-guided biopsy is encouraged

Background

For many women with newly diagnosed breast cancer, breast conservation is a safe, effective alternative to mastectomy. Breast conservation surgery involves removal of the tumor with a margin of normal breast tissue. In a few patients with very limited disease, the surgical excision alone is adequate local therapy. In the vast majority of patients, surgery

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is followed by breast radiotherapy (the combination is known as breast conservation therapy [BCT]). Radiotherapy is very effective in suppressing in-breast tumor recurrence and is most commonly delivered using conventional whole breast radiotherapy (WB-XRT). Accelerated, partial breast irradiation (APBI) is an alternative form of postsurgical radiotherapy that is currently being studied in clinical trials, and therefore, may be seen with increasing frequency in clinical practice. The overarching goal of breast conservation is to remove the tumor while minimizing chances for an ipsilateral breast tumor recurrence (IBTR).

Breast conservation surgery followed by breast radiotherapy produces changes on both physical examination and on posttreatment breast imaging. Distinguishing these normal treatment-related findings from breast cancer recurrence in the original lumpectomy site or elsewhere in the breast (new primary tumors) is challenging. This chapter will review how mammography, ultrasound, and breast magnetic resonance imaging (MRI) studies reveal normal changes associated with BCT and contrast them to findings associated with IBTR. The purpose of properly recognizing these changes is to avoid unnecessary diagnostic procedures while minimizing a delay in diagnosis of a local recurrence.

Clinical background: Breast conservation surgery (whether described as partial mastectomy, lumpectomy, or quadrantectomy) involves the removal of the breast cancer with a rim of normal breast tissue. The amount of tissue resected depends on the lesion size and location, accuracy of localization, and surgical technique. The breast surgeon may leave metallic clips in the cavity edges to mark the outline of the surgical resection. These are visible on postoperative mammograms and computed tomography (CT) scanning, while less visible on ultrasound and MRI.

Postoperatively, the lumpectomy cavity almost always contains a seroma with or without some element of a hematoma. On palpation, the breast tissue feels boggy and is often tender. In the weeks after surgery, these cavity contents are absorbed or degraded to some degree, leaving fibrin and/or other cellular debris. During this healing process, the breast tissue surrounding the cavity reveals varying degrees of inflammatory changes. Over long periods of time, the cavity gradually decreases in volume until it either forms a chronic seroma or, in most cases, it evolves into a scar composed of dense connective tissue. The size of the biopsy cavity impacts both the clinical and radiographic appearance of the treated breast. Proportionally smaller resections are associated with relatively fewer changes in the overall appearance of the breast, while larger resections can be associated with obvious retraction of the overlying skin, significant volume loss, and a prominent scar on imaging studies. Later, as the breast heals, the edema decreases and the biopsy site becomes less apparent.

If radiotherapy is given, postlumpectomy radiotherapy is normally initiated within 8 weeks of surgery. If chemotherapy is necessary, radiotherapy usually begins many months later, usually within 8 weeks of completing chemotherapy. With either the early postsurgical or later postchemotherapy approach, whole breast radiotherapy may be associated with damage to the lymphatic channels which may lead to breast edema, skin thickening, or increased breast tissue density. Visual inspection of the treated breast commonly shows a well-healed incision, erythema or hyperpigmentation of the breast skin, edema of the areola and nipple, and generalized breast and skin edema. There is later fibrotic healing associated with generalized skin thickening.

With external beam partial breast irradiation (3D conformal radiotherapy), the skin changes are both more focal and more subtle. There are even less apparent skin changes with APBI using brachytherapy and intraoperative (IORT) radiotherapy.

After surgery and radiation therapy, the incidence of IBTR is about 1% per year for invasive breast cancer and is slightly less for ductal carcinoma in situ (DCIS). Women who are at the greatest risk for failure include those who are under 35 years old, women with high-grade DCIS, women with DCIS measuring 2.5 cm or greater in diameter, women treated for infiltrating ductal carcinoma with a large DCIS component, and women with multifocal disease.

Early IBTR in the irradiated breast typically occurs at the site of the original tumor and usually within 6–7 years of treatment. Recurrences at the original tumor site may be due to failure to excise all of the original cancer or microscopic residual tumor deposits that are resistant to radiotherapy and/or systemic therapy. IBTRs that develop later are usually second primary tumors and form elsewhere in the breast. These tumors that develop outside the treated area occur at a slower rate than IBTRs and match the slower, steady incidence of new tumors forming in the contralateral breast.

IBTR is diagnosed most commonly by physical exam as a palpable mass and/or by mammography. About half of the recurrences are detected by physical exam and half by mammography. Palpable recurrences are more frequently invasive cancers and may be displayed on the mammogram as developing densities or masses. Palpable recurrences are often visualized on ultrasound as a mass in continuity with the biopsy scar or may be at a distance from the biopsy site. Mammographically detected recurrences often present as suspicious microcalcifications or masses without an obvious palpable component.

Many women with proven IBTR will proceed to a mastectomy, as lumpectomy and whole breast radiotherapy usually are not repeated due to concerns over complications related to additional radiotherapy and concern over future in-breast recurrence. Nonetheless, in the setting of repeat breast conservation, wire localization and/or bracketing of a recurrent lesion or second primary may be requested if the patient's clinical scenario suggests this management is feasible and potential risks have been explained to, and accepted by, the patient. Repeat breast conservation may become more common due to the availability of APBI and has been explored in a limited fashion in selected patients.

Breast Imaging Following Breast Conservation Therapy

Mammography

Timing: Mammography represents the cornerstone of post-breast conservation imaging. There is wide institutional variation regarding when to obtain the first mammogram. Some institutions perform an “interval” mammogram after the lumpectomy and *before* radiotherapy to ensure that all of the worrisome calcifications or masses associated with a malignancy have been completely excised, particularly in the setting of DCIS. Studies have suggested that this can be associated with a lower rate of later in-breast recurrence. Others suggest that pathology results alone demonstrating tumor-free margins are adequate guidance as to the absence of residual disease after a lumpectomy.

Following radiotherapy, most institutions obtain a new “baseline” diagnostic mammogram of the treated breast after completion of the lumpectomy and breast radiotherapy. This new baseline study is performed approximately 6–8 months after completion of surgery and radiotherapy to allow the breast to heal and to resolve immediate postradiation inflammatory changes. The next mammographic imaging is a bilateral diagnostic mammogram that includes a short-term follow-up of the treated breast and reinstitutes normal annual screening of the untreated breast.

Some practices choose to follow the treated breast every 6 months with mammograms for a period of 2–3 years. Others follow the treated breast and opposite breast annually. In any case, and barring any abnormalities or callbacks, bilateral mammography usually is done annually at a minimum.

There is wide variation on whether these posttreatment mammograms are performed as screening or diagnostic studies. Some facilities choose to perform diagnostic mammography for life. At other institutions after 3–5 years, the patient returns to annual screening mammography for both the treated and untreated breast

Evolution of clinical and mammographic findings after breast conserving therapy: After an open surgical biopsy or lumpectomy, there is commonly focal edema and fluid/hematoma in the surgical site. The physical examination will therefore reveal a red, raised skin incision and the surgical cavity may be palpable due to accumulated seroma and/or blood. An immediate postsurgical mammogram is not normally performed for benign histologic findings. Mammograms are not uncommonly performed after a lumpectomy in the event of tumor at margins and concern over mammographically visible, residual disease. On the mammogram following a lumpectomy, the postsurgical scar is initially a fluid-filled round or oval cavity, sometimes containing air, with edema extending to the skin, with focal skin thickening. There may be residual evidence of the lesion, such as a mass or microcalcifications.

Following definitive excision to tumor-free margins, the changes produced by surgery are later joined by the changes produced by whole breast radiotherapy, such as generalized breast edema. Specific mammographic features of diffuse breast edema include skin and stromal thickening, trabecular thickening in the subcutaneous fat, and diffuse increased breast density. The surgical cavity, seen initially as a fluid-filled mass, may be partially obscured by the surrounding breast edema. With resolution of the surrounding breast edema, the cavity may become more apparent and becomes a spiculated mass as the scar fills in with fibrotic tissue and collagen, but a true scar should not grow in size with time. With time, the breast may form dystrophic breast calcifications and/or further scarring at the lumpectomy site.

Findings of breast edema are most obvious with comparison to the contralateral side or to older mammograms (Fig. 81.1a–d).

For women who are treated with APBI, there are more focal edematous changes and scarring and occasional calcifications around the lumpectomy site while the remainder of the nonirradiated breast is relatively spared.

These normal mammographic changes associated with BCT changes usually decrease over 2.5–3 years or may remain stable. Progression of breast edema after the first postsurgical, postradiation therapy mammogram is abnormal and should be investigated. Aside from radiation therapy, causes for unilateral breast edema include mastitis, obstructed breast lymphatic or venous drainage, and less commonly, inflammatory breast cancer.

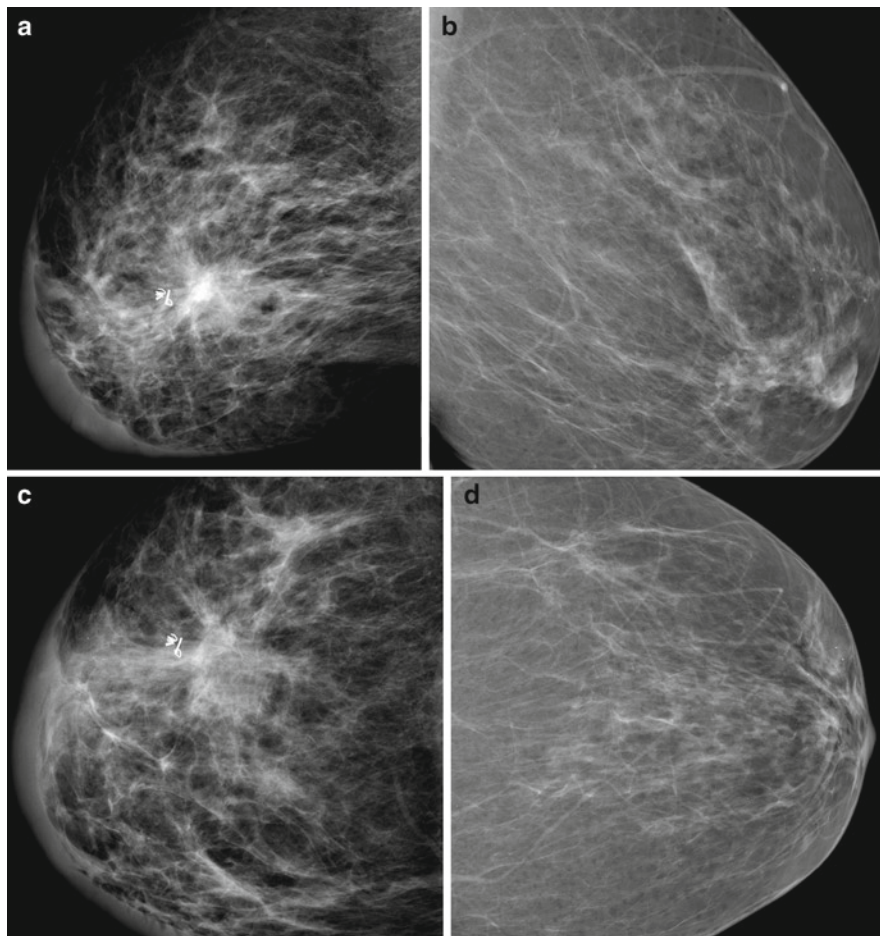


Fig. 81.1 Normal post-breast conservation therapy (BCT) changes. Right and left mediolateral oblique (MLO) (a, b) and craniocaudal (CC) (c, d) mammograms obtained 6 months after right breast lumpectomy and radiation treatment demonstrate diffuse right breast skin thickening, stromal thickening, and trabeculating from edema partially obscuring a seroma immediately posterior to the surgical clips. This is contrasted with the normal left breast

Benign vs. malignant mammographic findings: Commonly encountered benign post-treatment changes on mammography include skin thickening and edema, focal fluid collections representing hematoma or seroma, developing coarse or dystrophic calcifications in or near the surgical bed, and scarring (Fig. 81.2a–d). Breast cancer recurrences may present as pleomorphic calcifications or new or growing masses in or near the lumpectomy bed, prompting biopsy.

Fat necrosis is a benign, nonsuppurative inflammatory process that results from trauma to the breast and is an extremely common finding in the breast conservation setting. Because fat necrosis can produce bizarre calcifications and because pleomorphic

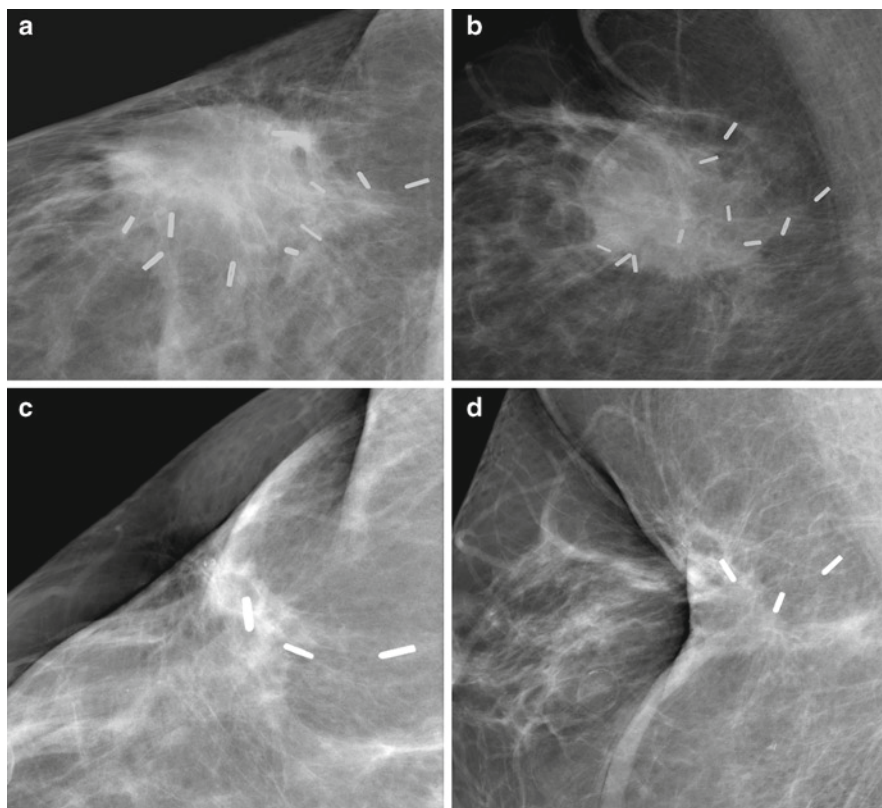


Fig. 81.2 Early and late normal post-lumpectomy changes on mammography. Magnified images from CC (a) and MLO (b) views obtained 6 months after right breast lumpectomy demonstrate expected postsurgical changes of seroma/hematoma and surrounding edema. Magnified images from CC (c) and MLO (d) views obtained 1 year later demonstrate resolution of the fluid collection and edema, with increased scarring and retraction of the surgical site, along with formation of benign calcifications and oil cysts consistent with fat necrosis

calcifications can be a sign of breast cancer, fat necrosis-type calcifications in a prior cancer site can prompt biopsy. On mammography, fat necrosis commonly shows as coarse or dystrophic calcifications, calcified or noncalcified oil/lipid cysts, or even focal asymmetries or masses (Fig. 81.3a, b). During their early stages of formation, it can be difficult to differentiate the benign calcifications of fat necrosis from calcifications forming in cancer. These benign, fat necrosis-associated calcifications later appear as large (>5 mm), lucent centered, egg-shell or rim-like calcifications and form around a fatty center (Fig. 81.3a, b). Unless fat necrosis demonstrates typical dystrophic appearing calcifications or classic findings of a fat-containing mass (Fig. 81.3c, d), the diagnosis of fat necrosis often can only be resolved with core needle biopsy. Fat necrosis may or may not be clinically evident on physical exam as a palpable mass.

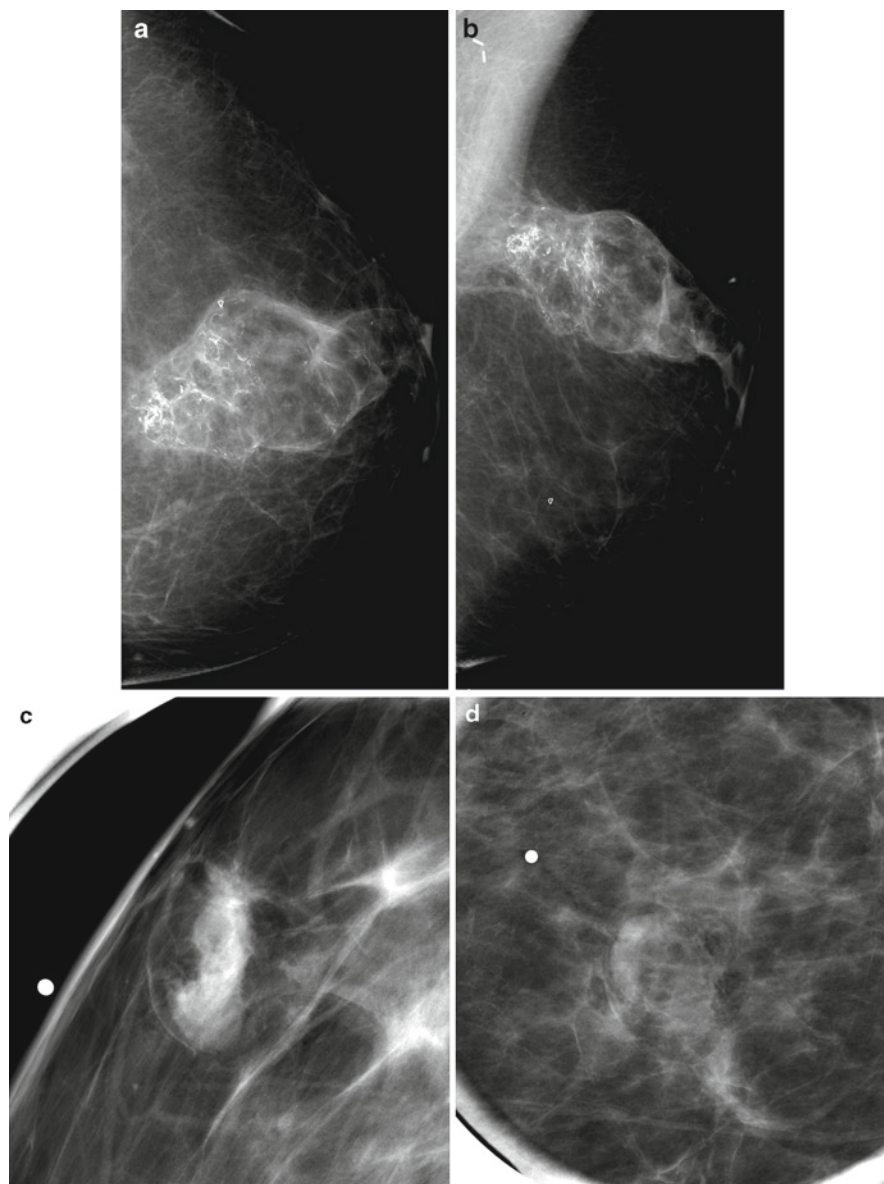


Fig. 81.3 Mammography showing benign findings of fat necrosis. MLO (a) and CC (b) views of the left breast in a patient who underwent remote breast reduction and lumpectomy surgeries demonstrate extensive changes of fat necrosis characterized by calcified and noncalcified oil cysts and architectural distortion at the surgery site. Incidentally noted is a needle biopsy marker clip in the lower outer quadrant and surgical clips in the axilla. Spot magnified medial-lateral (ML) (c) and CC (d) views of a palpable lump demonstrate a circumscribed, fat-containing mass typical of fat necrosis. This type of fatty mass is pathognomonic for benign fat necrosis and does not need biopsy

As in the analysis of any calcifications, developing calcifications should be further characterized with high-quality magnification mammography (Fig. 81.4a–d). Indeterminate calcifications are either closely watched with short interval follow-up diagnostic mammography or biopsied based on the level of suspicion of the interpreting radiologist. Fine,

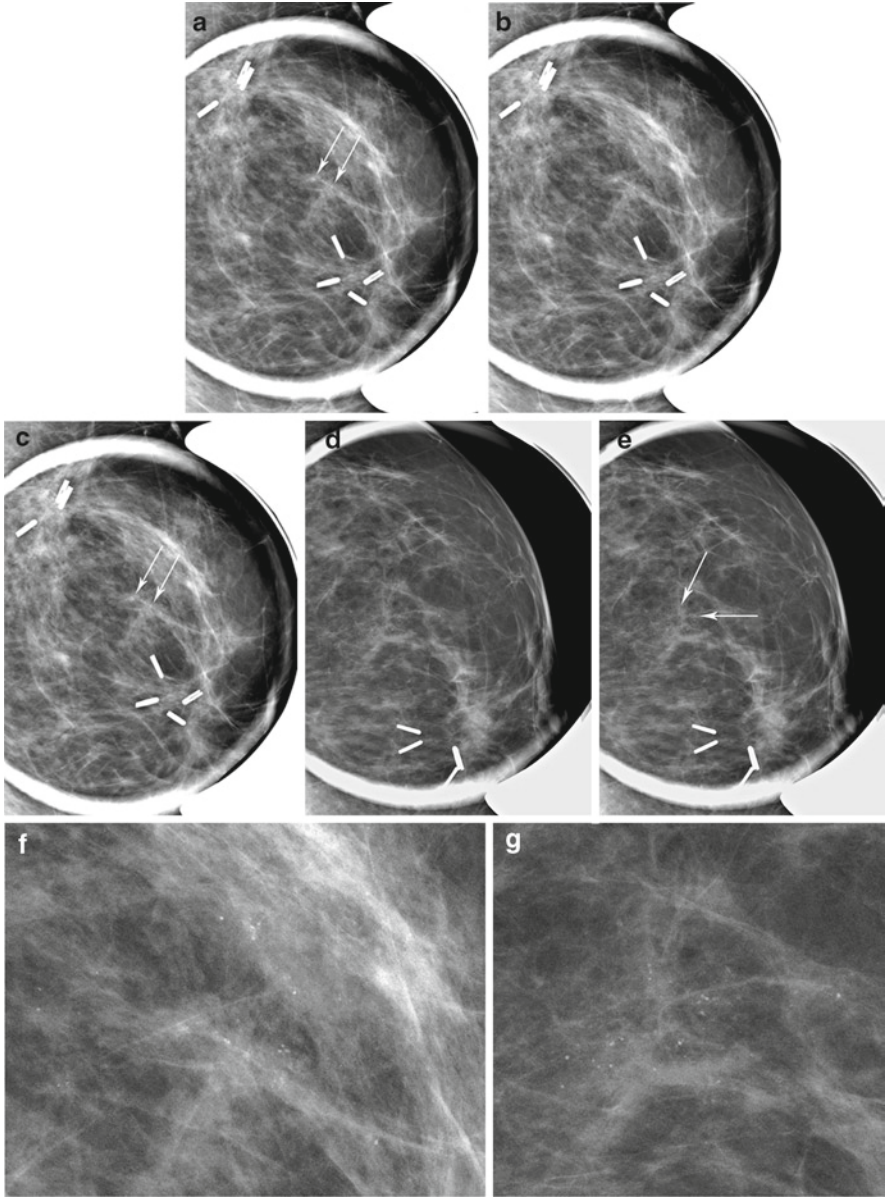


Fig. 81.4 Recurrent ductal carcinoma in situ (DCIS) on diagnostic mammogram. Spot magnification ML (a, b) and CC (c, d) views in a patient who underwent lumpectomies on two separate

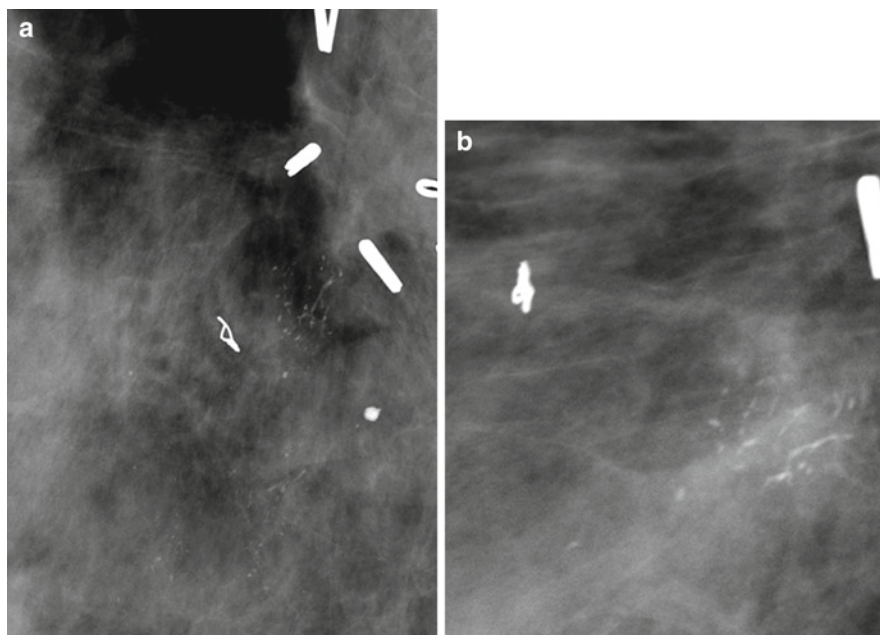


Fig. 81.5 Local recurrence manifested as pleomorphic calcifications on mammogram. Spot magnification ML (**a**) and CC (**b**) demonstrate grouped pleomorphic calcifications at a prior lumpectomy site marked by metallic surgical clips. A stereotactic-guided needle biopsy was performed (note the wire knot-shaped poststereotactic marker) and demonstrated DCIS

linear, branching, and pleomorphic calcifications are highly suspicious and warrant a stereotactic core needle biopsy (Fig. 81.5a, b).

In addition to suspicious calcifications, local breast cancer recurrence can present as a new mass or focal asymmetry on mammography. Mammographic findings considered to potentially represent a significant change are best evaluated when compared to prior mammograms. If the finding is suspicious, it warrants a high-quality diagnostic mammogram dedicated and directed to the abnormality. Spot magnification and/or compression views can often differentiate between superimposition of normal breast tissue and a true new or developing mass (Fig. 81.6a, b).

Focal fluid collections at the surgery site fall within the spectrum of expected postsurgical change and are commonly seen on the initial posttreatment mammogram. These fluid collections often diminish in size or completely resolve over time. In some cases, the seroma remains visible for many years (Fig. 81.7a–d). As the seroma or hematoma resolves, the

Fig. 81.4 (continued) occasions for DCIS demonstrate new, grouped, and heterogeneous calcifications between the two remote lumpectomy sites marked by surgical clips (*arrows*) (**e**). The heterogeneous morphology of these calcifications is better seen on the magnified images of the ML (**f**) and CC (**g**) views. These were biopsied under stereotactic guidance and shown to be a second recurrence of DCIS. The patient subsequently underwent mastectomy

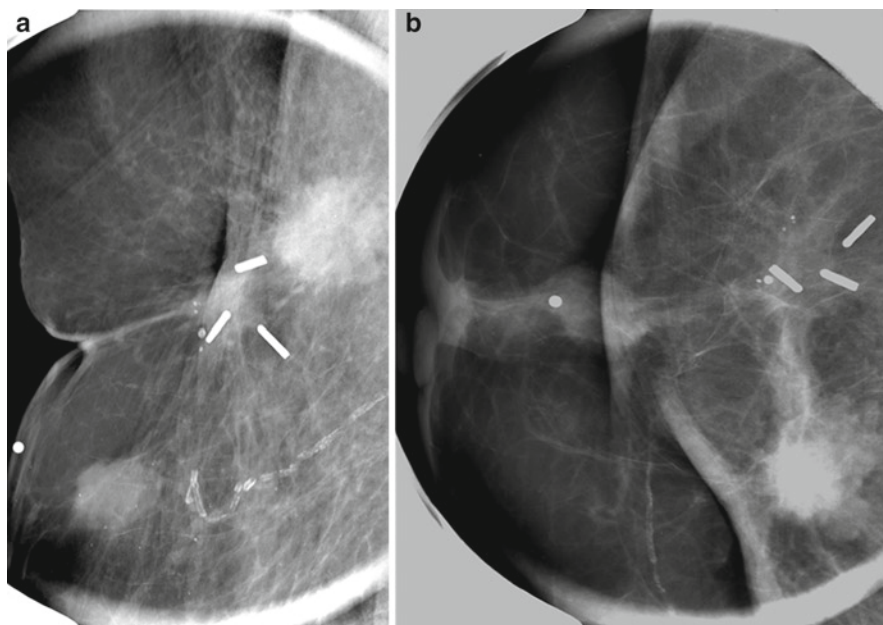


Fig. 81.6 Local recurrence manifested as a mass on mammogram. Spot magnification ML (a) and CC (b) suspicious mammographic masses in and adjacent to the prior lumpectomy site. These are architectural distortion, skin deformity, and retraction in the lumpectomy site, marked by two surgical clips. A BB marker on the skin indicates the site of a palpable abnormality for which the patient was being evaluated. Deep to the BB marker is an indistinct mass and a spiculated mass in the lumpectomy site. Both were evident on subsequent ultrasound, biopsied, and found to be invasive ductal cancers

surgical site often becomes increasingly contracted in appearance, with architectural distortion resulting from the surgical scar. Careful comparison of the patient's subsequent mammograms with the initial posttreatment baseline mammogram helps distinguish benign from malignant changes since benign postbiopsy scars will remain stable for years while cancers will usually grow.

Mammographic findings after APBI: APBI is a new approach to postlumpectomy radiotherapy that is currently being studied in several clinical trials. There are numerous methods for delivering APBI. The four most common methods are: interstitial brachytherapy, intracavitary (balloon) brachytherapy, 3D conformal external beam radiotherapy, and intraoperative radiotherapy. Treatments last 1–5 days and deliver radiotherapy with a much higher dose per fraction (range from 3.45 Gy to 21 Gy/dose) than with conventional whole breast radiotherapy (range from 1.8 to 2 Gy/dose). Encouraging early results suggest APBI may be increasingly used in the future in optimal candidates as a substitute for whole breast radiotherapy. Therefore, it is important to be aware of mammographic findings associated with APBI.

“Characteristic” features of post-APBI mammogram show focal skin thickening and edema in the treatment site with relative sparing of the remainder of the breast, in contrast

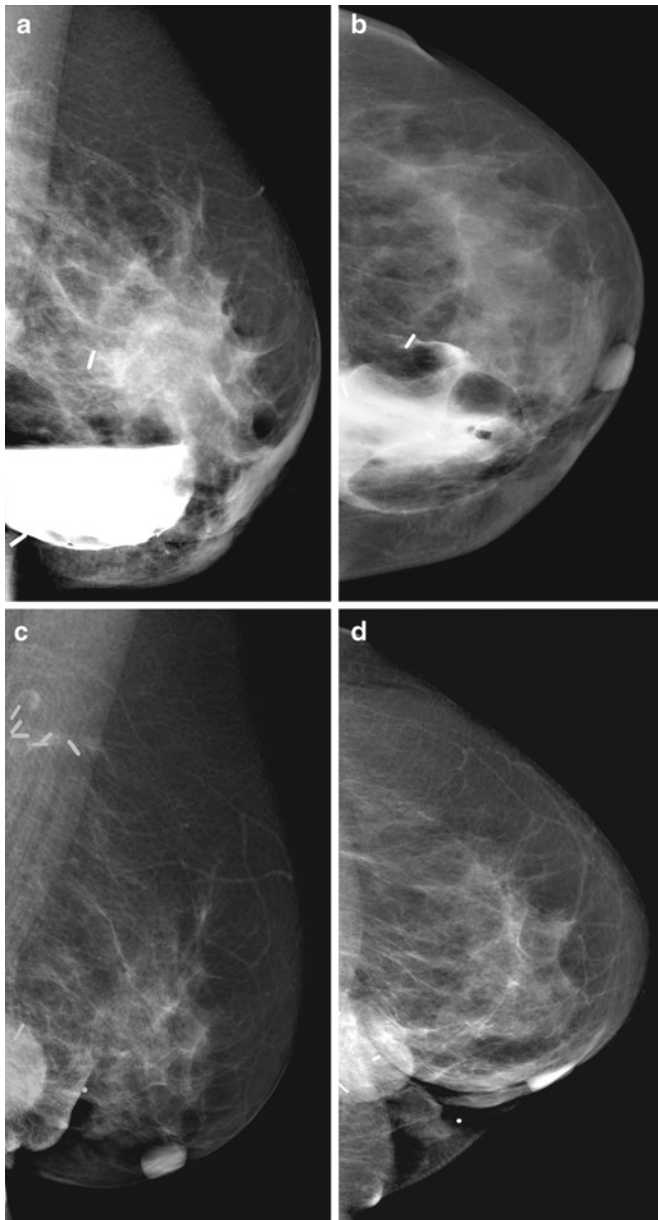


Fig. 81.7 Postoperative seroma/hematoma. MLO (a) and CC (b) mammograms obtained 6 months after left breast lumpectomy and radiation treatment demonstrate a large circumscribed mass in the lower inner quadrant lumpectomy site. The mass contains a fluid–fluid level and is consistent with a postoperative seroma or hematoma. Also evident are findings of edema and skin thickening related to recent radiation treatment. MLO (c) and CC (d) mammograms obtained at follow-up 4 years later demonstrate a persistent, smaller seroma at the lumpectomy site, overall improvement

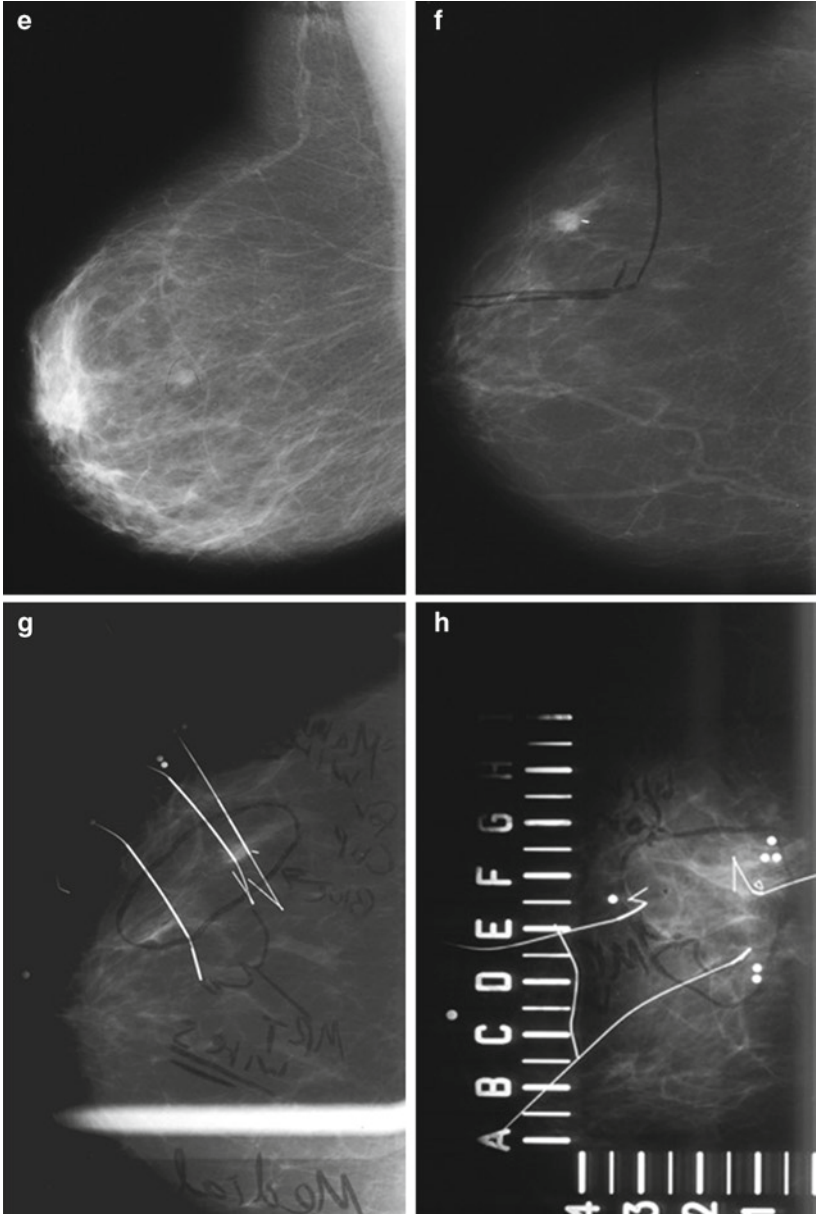


Fig. 81.7 (continued) in the skin thickening, edema, and increased skin retraction. The seroma was palpable, as indicated by the BB marker, and additional workup verified the palpable abnormality was caused by the seroma. (e–j) Mammographic findings after intraoperative radiation therapy for accelerated partial breast irradiation (APBI). (e) Right MLO mammogram shows a small round cancer in the right breast (*circled*). (f) CC mammogram after core biopsy shows the mass in the outer right breast with the marker in it. (g) CC mammogram after the localization shows wires around the mass. (h) Lateral mammogram with the wires in place through an alphanumeric grid shows the wires around the mass. (i) Right MLO mammogram after IORT shows skin thickening

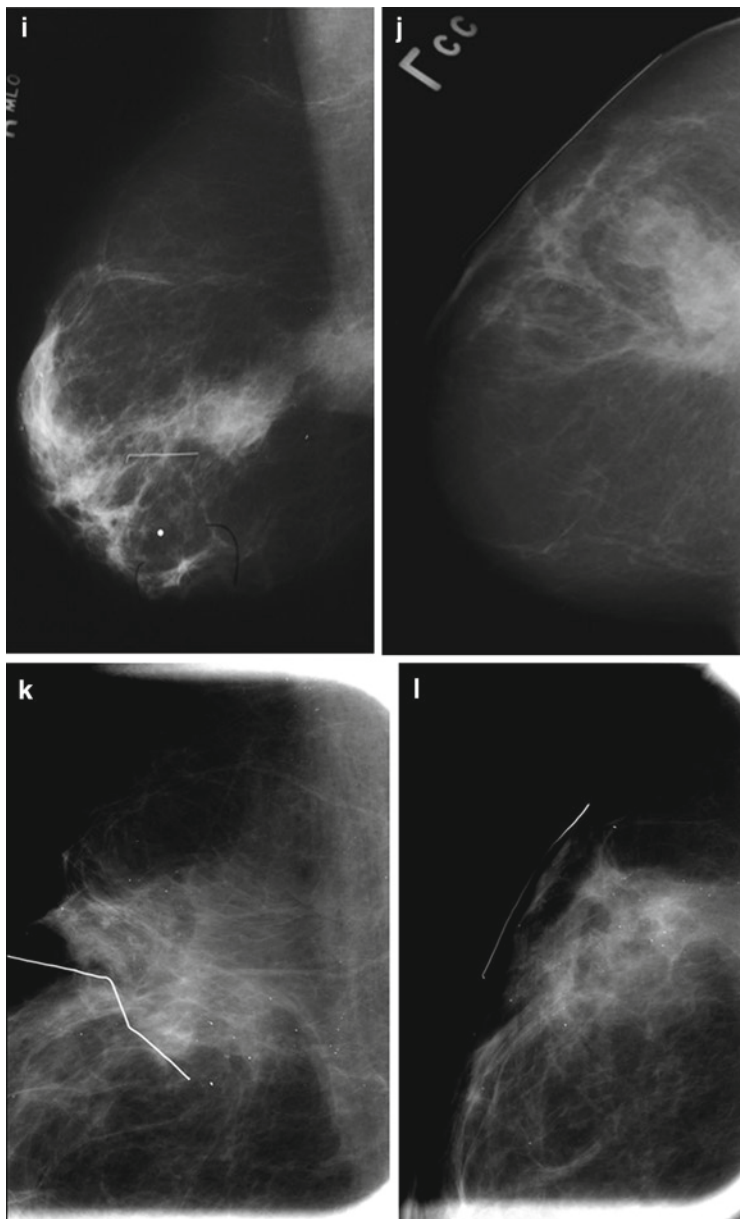


Fig. 81.7 (continued) and a fluid collection extending from the skin surface to the pectoralis muscle. (j) Left CC mammogram shows the seroma and focal skin thickening on only the outer left breast. Note that the medial left breast appears normal and there is no skin thickening, which would ordinarily be seen in whole breast irradiation. (k–l) Typical benign very dense punctate calcifications after IORT. (k) Right MLO magnification mammogram shows a linear scar marker over a postbiopsy scar and extremely dense round calcifications typical for fat necrosis in the IORT biopsy site. (l) Magnification CC mammogram with a linear metallic skin marker over the outer right breast shows the typical scar and dense calcifications

to mammograms obtained after standard whole breast radiotherapy (Fig. 81.7e–j). In general, with APBI there is an increased incidence of asymptomatic fat necrosis manifested by numerous, round, very dense (almost metallic density) microcalcifications in the radiation field surrounding the lumpectomy cavity. It is important to distinguish these calcifications from suspicious pleomorphic microcalcifications to avoid unnecessary biopsies (Fig. 81.7k–l).

Management of abnormal mammographic findings: If a posttreatment mammogram demonstrates a suspicious finding, the radiologist may recommend an ultrasound to further characterize an area of concern. If there is a definitively benign ultrasound correlate for a mass (such as a simple cyst or benign-appearing lymph node), the patient can generally be returned to routine mammographic surveillance. On the other hand, suspicious ultrasound correlates (solid masses) warrant biopsy and are usually amenable to an ultrasound-guided core needle biopsy. If there is a new or otherwise suspicious mammographic finding and the ultrasound is negative, an X-ray-guided stereotactic biopsy can be done of the mammographic finding. If there are still questions about a potentially suspicious mammographic finding and no definitive answer can be made after physical exam, diagnostic mammography, and ultrasound, a breast MRI can sometimes provide additional diagnostic information.

Usually, suspicious findings warrant a diagnostic procedure to establish a histologic diagnosis. The method of needle biopsy such as an ultrasound, stereotactic, or MRI-guided core needle biopsy is determined by the best way the lesion was seen. On occasion, however, a wire-localized surgical biopsy is a better choice. Examples of lesions that are amenable to core needle biopsy include lesions that are well visualized with either ultrasound or mammography and are safely accessible using those procedures. While this recommendation is generally straightforward in an untreated breast, the radiologist must take into account the type of lesion visualized and determine if tissue changes due to surgery and/or radiotherapy may preclude a definitive diagnosis from core needle biopsy sampling in the breast conservation-treated breast.

In some cases, the most appropriate initial biopsy is a wire-guided surgical excision. Lesions that may be better handled by a surgical biopsy are those that are seen only by mammography and are far too posterior in the breast or too faint to be amenable to image-guided core needle biopsy. Lesions that closely abut an implant (placed for to augment breast size after lumpectomy) also may be difficult to approach with core needle biopsies.

Breast Ultrasound

Timing: In the United States, breast ultrasound is rarely used as a screening tool either for the normal breast or following treatment of breast cancer due to a high rate of false positive findings. It is frequently used to provide adjunct information of new abnormalities on physical exam, mammography, or breast MRI.

Screening ultrasound can be particularly problematic in the conservatively treated breast since the normal postsurgical findings of scar, fat necrosis, and fluid collections can all demonstrate suspicious sonographic features and lead to unnecessary biopsies in an otherwise asymptomatic patient. For this reason, breast ultrasound should be limited only

to targeted evaluations of suspicious clinical or imaging findings. If a palpable abnormality unequivocally corresponds to a benign finding on mammography, such as a fat-containing lesion or dystrophic calcification in or near a surgical site, ultrasound can usually be avoided.

Evolution of ultrasound findings over time: On ultrasound, the normal immediate postoperative breast demonstrates the biopsy site and findings of postoperative edema comprised of skin thickening typically >3 mm, trabecular thickening, and blurring of normal breast structures and Cooper's ligaments, with an increased grayness of the normally dark fat. As the edema resolves, the imaging findings associated with edema also diminish or resolve. The breast biopsy cavity is usually found immediately under the skin scar, which shows as a focal thickening. The postoperative seroma or hematoma can have a variable appearance on ultrasound, but is usually shown as a hypoechoic or complex (containing both solid and cystic components) mass which usually decreases in size over time. In some cases, the fluid collection may remain unchanged for years as a long-standing seroma (Fig. 81.8a).

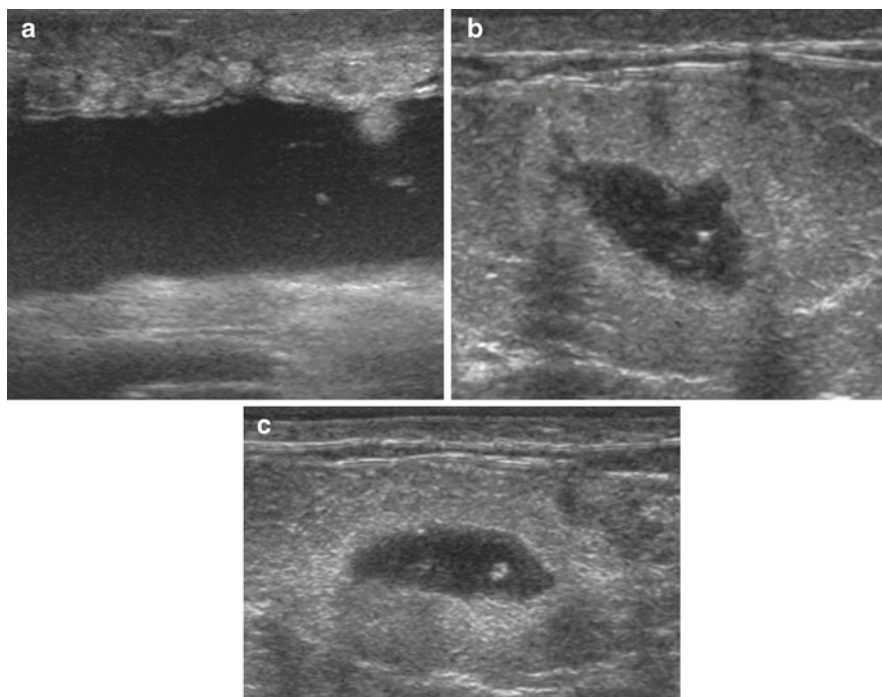


Fig. 81.8 (a) Postoperative seroma on ultrasound (companion image to Fig. 81.6). Ultrasound evaluation of the mammographic mass shown in Fig. 81.6 demonstrates a large, circumscribed fluid collection with some internal debris, consistent with a postoperative seroma or evolving hematoma. (b, c) Fat necrosis on ultrasound. Ultrasound evaluation of the palpable fat-containing mass seen on mammography (companion image to Fig. 81.3c, d) demonstrates an irregular-shaped hypoechoic mass with noncircumscribed margins and contains a round, bright specular reflector. Given its suspicious sonographic appearance, ultrasound-guided core needle biopsy revealed fat necrosis

Areas of fat necrosis can present as a solid or complex mass on ultrasound (Fig. 81.8b, c). Complex (cystic and solid) fat necrosis lesions can evolve into either more solid or more cystic-appearing lesions. Solid fat necrosis lesions have been reported to typically remain solid. These masses can be mistaken for cancer and are a cause for false positive imaging studies prompting biopsy.

Later, the fluid absorbs and the biopsy scar becomes hypoechoic, can be spiculated, and produces acoustic shadowing, indistinguishable from a primary breast cancer. Breast biopsy or lumpectomy scars seen on ultrasound are notorious for simulating breast cancer and causing unnecessary biopsies. The way to avoid biopsy is to be aware of the surgical location, know the normal evolution of the normal scar, know that the ultrasound-detected biopsy scar is within the surgical bed, and show that the “scar” is remaining stable over time.

Major distinguishing features of benign vs. malignant ultrasound lesions: Most post-treatment ultrasound changes are expected to decrease in size over time. Any lesion that is felt to be new or increasing in size by either clinical or imaging assessment should be viewed with suspicion, unless it corresponds to a definitively benign mammographic lesion, such as fat necrosis. On ultrasound, the surgical scar at the lumpectomy site typically produces extensive shadowing and is indistinguishable, in many cases, from shadowing produced by a malignancy. A mammogram obtained with marker placed on the skin immediately over the ultrasound finding should show that the “scar” correlates with the mammographic scar and can be left alone.

Recurrent breast cancer at or near a lumpectomy site can be seen as a hypoechoic, solid, or complex mass adjacent to the shadowing surgical scar, often with noncircumscribed margins and extensive posterior acoustic shadowing (Fig. 81.9a, b). If the postbiopsy scar gets bigger, or if the edges start to become rounder and the “scar” grows, the finding is worrisome for cancer. Also, masses that are not *in* the biopsy scar bed are very concerning for cancer. Specifically, since the surgeon typically produces only one biopsy cavity, any “scar” outside that biopsy cavity is worrisome for a true mass and might be cancer, warranting biopsy.

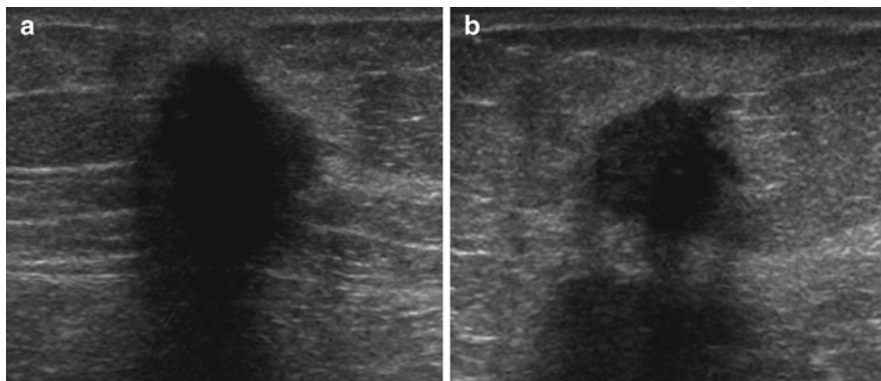


Fig. 81.9 Recurrent cancer on ultrasound (companion image to Fig. 81.5). Ultrasound evaluation of one of the suspicious masses shown in Fig. 81.5 demonstrates a hypoechoic mass in the long (a) and transverse (b) orientations in the upper inner quadrant. The mass demonstrates suspicious features of noncircumscribed margins and posterior acoustic shadowing. This was biopsied and found to be invasive ductal carcinoma

Management of abnormal ultrasound findings: Although mammograms have usually been performed by the time an ultrasound is requested, suspicious ultrasound findings may require a repeat mammogram with a marker on the skin overlying the ultrasound finding to see if the finding can be explained by benign etiologies. This is particularly true with benign but developing areas of fat necrosis. Suspicious ultrasound-detected masses usually necessitate biopsy unless the mammogram can correlate a specific, definitively benign diagnosis for the mass and thereby avoid an unnecessary biopsy. On the other hand, suspicious physical exam findings should prompt biopsy if the ultrasound is normal, especially if the palpable area is obscured by extensive shadowing produced by the surgical scar. Specifically, the decision to biopsy a very suspicious palpable mass based on the physical examination findings should be based on clinical grounds alone, regardless of a negative imaging workup.

If a suspicious abnormality is well seen on ultrasound, such lesions may be sampled relatively easily with percutaneous fine needle aspiration and/or core needle biopsy. However, the decision should be made as to whether core biopsy is likely to lead to a firm diagnosis, given the prior surgery and radiotherapy. Ultrasound-guided core biopsy is an excellent way to evaluate complex masses that may represent the remnant of the biopsy cavity, as well as solid or complex masses on imaging or clinical exam that represent fat necrosis. After a core biopsy, if the histologic results from the image-guided procedure are equivocal or discordant, an ultrasound-guided wire-localized breast biopsy can be done.

Magnetic Resonance Imaging

Timing: Breast MRI is normally not utilized for routine post-BCT imaging as it is not considered an appropriate routine screening tool for women at average risk for a new breast cancer. Furthermore, given the relatively low rate of in-breast tumor recurrences after successful BCT (approximately 15% at 20 years of follow-up), the benefits of routine breast MRI in these patients would not outweigh the down sides, including false-positive findings and increased cost of care. There are certain situations, however, in which the routine use of post-BCT breast MRI would be appropriate. Women with a proven BRCA mutation are at increased risk for breast cancer in both the untreated and treated breast, prompting the American Cancer Society to recommend annual breast MRI in addition to mammography in women who are at 20–25% lifetime risk for breast cancer. Another potential situation for which there may be some benefit from annual post-BCT breast MRI is in women whose index breast cancer was seen only on breast MRI. There is ongoing discussion regarding the use of MRI in this latter setting.

Evolution of breast MRI findings after BCT: On MRI the surgical cavity is displayed as a nonenhancing fluid-filled structure, representing the seroma or hematoma, with an enhancing thin rim and should correspond with a mammographic mass. This fluid collection may diminish or completely resolve over time, but in some cases, remains indefinitely. It is common to observe a thin circumferential rim enhancement around this fluid collection which is most prominent during the immediate postoperative period, representing the healing scar tissue. The kinetic curve of the post-biopsy scar shows an initial rapid enhancement with a late plateau or washout phase, indistinguishable from breast cancer. For this reason, it is difficult to exclude residual cancer along the periphery of the seroma or

hematoma, especially in the setting of known positive margins after excision. Nonetheless, MRI can be a useful tool to identify residual disease, especially in patients in whom there is a considerable discrepancy between preoperative clinical/imaging findings and histopathology. Any focal, nodular enhancement along the periphery or away from the surgery site is viewed with suspicion. If it is felt that the finding might be visible by ultrasound, the finding would warrant further evaluation with a “second look” ultrasound in an appropriate clinical setting. Postexcision scarring enhancement persists for up to 18 months and should then typically subside and eventually should not demonstrate enhancement.

Postradiation treatment changes typically present as diffuse skin thickening and enhancement along with diffuse parenchymal enhancement of the treated breast compared to the contralateral untreated breast, and has been shown to persist for up to 3 months after treatment. Over time, these findings diminish, and the irradiated breast often evolves to demonstrate less background physiologic enhancement relative to the contralateral untreated breast.

In patients undergoing APBI, the breast edema is more focal than with whole breast irradiation, and elsewhere, the breast skin and tissue appears normal, much like the normal postoperative breast after a benign breast biopsy.

Major distinguishing features of MRI-detected benign vs. malignant lesions: Recurrent invasive cancers appear as an enhancing mass in or near the biopsy site in the first few years, but can occur anywhere in the breast. Invasive breast cancers are usually irregular or spiculated masses, with a kinetic curve showing a rapid initial enhancement and a late phase washout or plateau. Cancers recurring as DCIS may be more difficult to identify for three reasons. First, since DCIS may not produce characteristic rapid enhancement and late plateau or washout kinetic curve types, DCIS may be detected based on morphology alone such as nonspecific focal, segmental, or regional pattern of clumped enhancement. This type of enhancement can be hard to distinguish from the normal background enhancement pattern of fibrocystic change. Secondly, chemotherapy can change the enhancement pattern of neoangiogenic tumor vessels, making the enhancement kinetics of tumors take on the kinetics of normal breast parenchyma. This means that the normally suspicious kinetic curves that show cancers as different from normal background tissue are no longer apparent even if there is invasive cancer or the type of DCIS that initially shows suspicious kinetic curves. Third, some DCIS is MRI-occult, that is, it is only detectable by suspicious calcifications on mammography. This underscores the need for ongoing diagnostic mammography in the breast conservation patient since DCIS may present only as faint, suspicious calcifications on the mammogram.

Diffuse skin enhancement and thickening is expected in the recently postirradiated breast (Fig. 81.10), but these changes should diminish over time. If breast edema suddenly occurs or increases without a reasonable cause, it should be considered clinically suspicious or unusual given the clinical time frame, and skin punch biopsy may be warranted. When prior MR exams are available for comparison, any new or developing suspicious findings such as masses or nonmass-like enhancement warrant further evaluation or biopsy (Fig. 81.11).

As with mammography and ultrasound, benign fat necrosis can present as an enhancing solid or complex mass on MRI with a rapid wash-in and washout on kinetic curves and mimic a recurrent breast cancer. For equivocal cases, the suspect mass can be evaluated on

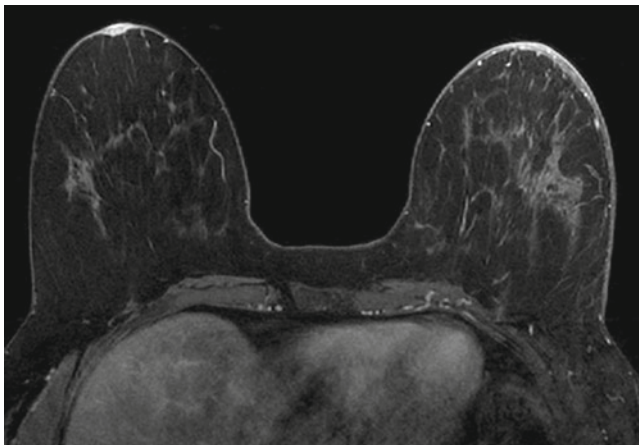


Fig. 81.10 Normal post-BCT changes on breast magnetic resonance imaging (MRI). Axial postcontrast T1-weighted image with fat suppression demonstrates typical post-BCT treatment changes in the left breast. There is diffuse skin thickening and enhancement, increased parenchymal trabeculation, and a nonenhancing fluid collection consistent with seroma/hematoma in the outer left breast (compare with the normal right breast)

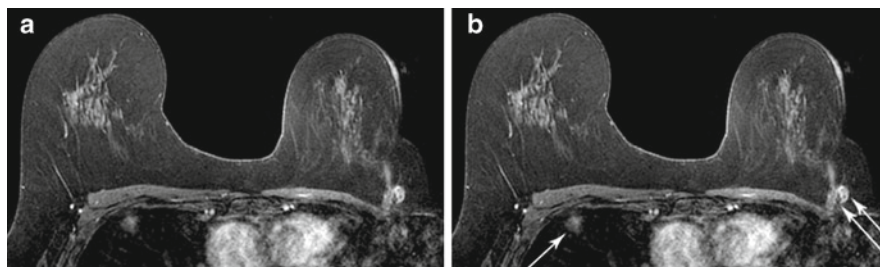


Fig. 81.11 (a, b) Recurrent cancer on breast MRI. Axial postcontrast T1-weighted image with fat suppression in a woman with a history of remote left breast lumpectomy and radiation demonstrates a left axillary tail enhancing mass (*arrows*), subsequently biopsied under ultrasound guidance and found to be a recurrent invasive ductal carcinoma. Incidentally noted is a right anterior lung base enhancing mass (*double arrows*), later determined to represent metastatic disease

specific pulse sequences designed to evaluate for the presence of fluid and fat (T2- and nonfat-suppressed T1-weighted sequences, respectively). These sequences can be extremely helpful in distinguishing benign cysts (fluid-containing) or fat-containing lesions from malignancy. Similarly, since a normal lymph node enhances rapidly and washes out just like a cancer, evaluation of the lymph node on all sequences will show that it has fat in its hilum on the nonfat-suppressed T1-weighted sequences, will be high signal and show a fatty hilum on the T2-weighted fat-suppressed noncontrast sequences, and will have a smooth margin and typical “Pac-man” shape with a fatty hilum.

“Second look” studies for borderline or suspicious breast MRI findings: Mammography is usually performed before breast MRI, but if there are no recent mammograms (within 6 months) of abnormal MRI, mammography should be obtained to help gauge the extent of disease for suspicious MRI findings. For example, if there is an MRI finding suspicious for invasive breast cancer, the mammogram may be able to identify the breast cancer and show calcifications representing DCIS around the invasive cancer that are not seen by the MRI. Approximately 25% of DCIS lesions are detectable only by mammography as pleomorphic calcifications and certainly could accompany any suspicious MRI-detected invasive breast cancer. While it may be a moot point to identify the extent of recurrent disease in a patient with an IBTR heading for a mastectomy, larger lesions, or lesions near the skin, might prompt technical alterations in how the mastectomy is performed, specifically with regard to overlying skin.

Ultrasound also is commonly used for a “second look” of MRI findings. Ultrasound is commonly used to determine if a lesion seen on MRI can be visualized by ultrasound, if it can be recognized as a typically benign finding (such as fat necrosis or benign lymph node), and whether it can be visualized for ultrasound-guided biopsy.

If suspicious MRI findings are not seen on mammography or ultrasound, an MRI-guided core needle biopsy or MRI-guided wire localized excisional biopsy should be pursued, unless suspicion is sufficiently low to warrant a short interval follow-up. The same considerations regarding core biopsy vs. open biopsy apply to MRI as with other imaging tests. If there is significant concern that an MRI-guided needle biopsy may yield nondiagnostic or inconclusive results, proceeding directly to an MRI-guided wire localized surgical procedure may be in the patient’s best interests even if it may not appear initially to be the least invasive resolution to explain the abnormality seen on imaging .

Conclusions

The conservatively treated breast normally contains baseline abnormalities on breast imaging, such as edema, scar, and calcifications that can mimic cancer. Although recurrences in the breast are relatively uncommon, they could become a local wound care problem, might be associated with metastatic disease, and could even lead to distant metastases, and therefore, should be diagnosed promptly. An overly cautious approach, however, can lead to many false positive findings and unnecessary biopsies. As with any challenging diagnostic scenario, the ability of the breast imager and breast clinician to successfully distinguish subtle differences between benign and malignant findings on posttreatment breast imaging is of tremendous benefit to patients and colleagues who provide care for these patients.

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