16 The Postoperative Breast

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Introduction

Surgical interventions in the breast include excisional biopsy, lumpectomy, mastectomy, reduction, and augmentation. There are expected benign postsurgical changes following these interventions. These benign imaging findings may overlap with radiographic features of malignancy or obscure tumor recurrence. Awareness of normal postoperative imaging changes correlated with prior procedural history and time that has elapsed since those procedures is important for increasing accurate early detection of breast cancer or tumor recurrence in patients with history of breast cancer. This chapter will describe expected benign postsurgical findings and abnormal findings concerning for recurrence.

Terminology

The terms excisional biopsy, wide excision, tumorectomy, lumpectomy, and segmental mastectomy are interchanged in the literature. For the purposes of this chapter, excisional biopsy will refer to surgical excision of a benign finding, biopsy-proven atypia, or lobular neoplasia. Lumpectomy will refer to the surgical removal of malignancy. Mastectomy will refer to the surgical removal of the entire breast tissue. Excisional biopsies involve a skin incision and dissection through breast parenchyma to remove a volume of tissue containing an abnormality that is usually localized preoperatively with a wire. A lumpectomy involves the removal of a malignancy with a rim of sufficient adjacent normal tissue so that there is no cancer at the margin of the surgical specimen. Lumpectomies usually involve a larger volume of tissue than excisional biopsy.

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Post-excisional Biopsy

Although becoming less frequent with the increased use of minimally invasive image-guided biopsy, many patients used to undergo surgical excisional biopsy for further evaluation of indeterminate or suspicious findings on breast imaging. Currently, in the rare instances when a target cannot be accessed by image guidance or when the patient is unable to tolerate image-guided biopsy, excisional biopsy remains an alternative. In addition, excisional biopsies are performed on patients who have a history of biopsy yielding atypia or lobular neoplasia to evaluate for possible upgrade to in situ or invasive carcinoma.

Mammograms are rarely performed in the weeks following excisional biopsy. Usually a mammogram would only be performed if there is concern that a targeted lesion was not actually removed. The use of specimen radiography and accurate preoperative wire localizations limits the need for early postoperative mammogram. Typically a patient will undergo their first mammogram 6 months to 1 year after surgery. The imaging findings on the first postexcisional biopsy mammogram range from imperceptible to moderate architectural distortion. Precise preoperative wire localizations with the wire placed no more than 5–10 mm from an abnormality allow for minimal volume of tissue to be removed at the time of biopsy which minimizes the long-term changes to the breast. Immediately following biopsy, seromas and hematomas are common within the biopsy cavity. Over the following months, the fluid collections are reabsorbed and replaced with fibrosis and scarring. By the time the patient undergoes a 12-month postsurgery mammogram, it is estimated that 50–55 % of patients will heal with no scar or architectural distortion in the underlying breast parenchyma [1].

Sometimes, the only sign of intervention will be a subtle decrease in breast volume when compared with the prior mammogram or slight asymmetry in the breast parenchyma pattern compared to the contralateral breast (Fig. 16.1). In the remaining cases, excisional biopsy sites may demonstrate skin thickening, parenchymal distortion, spiculation, and,

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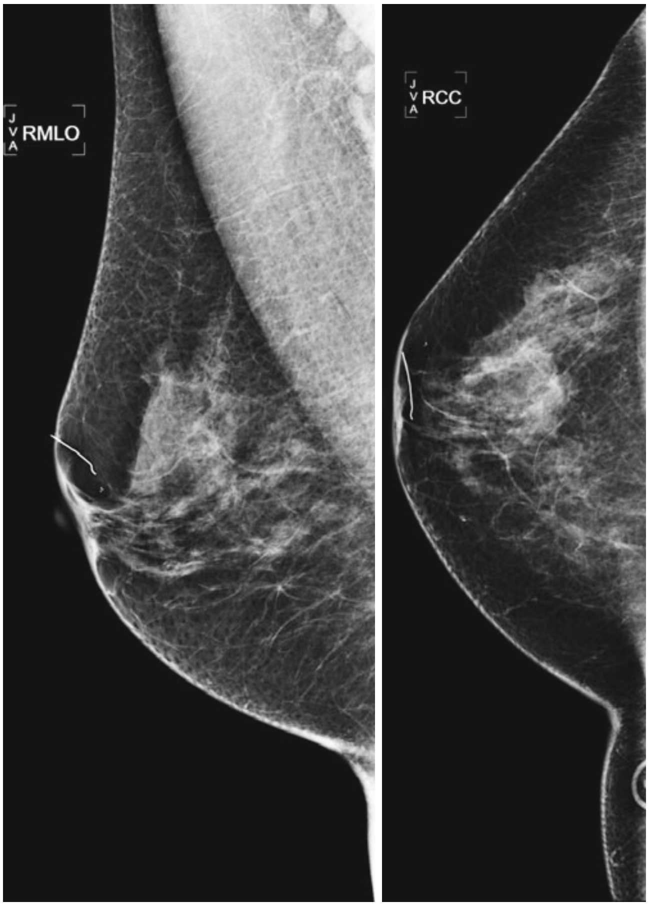


Fig. 16.1 Status post-excisional biopsy for ADH. Minimal postsurgical changes are present in the anterior upper central right breast

rarely, a persistent seroma cavity that presents as a round or oval mass (Figs. 16.2a, b, 16.3a, b, and 16.4). These findings may remain stable or slowly evolve over time gradually becoming less prominent (Fig. 16.5a–f). Coarse fat necrosis calcifications may develop gradually on follow-up exams. Variation in the amount of persistent change following biopsy is secondary to varying amount of tissue removed at the time of surgery and varying postoperative course that may include hematoma formation or infection that can produce longer term changes. A pitfall to be mindful of in the follow-up imaging of a postsurgical mammogram is the potential for parenchymal asymmetry in the breast that has not had surgery to be mistaken for disease in the contralateral breast. The apparent asymmetry is the result of the absence of tissue that has been surgically removed on the side of surgery.

Given that both scarring and carcinoma can present as spiculated masses on imaging, clinical history, physical exam, and comparison with prior studies are essential for appropriate management. When there are no prior mammograms available for comparison and when a history of biopsy is not provided, the differential diagnosis should include malignancy, radial scar, and prior trauma in addition to post-biopsy changes. Since there is a possibility for malignancy, if no prior studies are available, additional evaluation with diagnostic imaging is warranted. Technologists should obtain a thorough history of dates of prior surgical biopsies before performing imaging and marking scars in the skin to help avoid confusion. Applying a linear metallic scar marker on the skin can assist in explaining nearby architectural distortion. Some facilities place scar markers routinely while others only place them if there is uncertainty of postsurgical change correlating with a biopsy site. The skin incision can be distant from the postsurgical change, and sometimes it is more helpful to correlate with a preoperative mammogram, if available, as the mammogram will demonstrate the site of original mammographic abnormality where the postsurgical changes would be expected. Architectural distortion distant from a skin marker should be considered suspicious, particularly if the finding is new from prior exams. Review of the patient's pertinent history and symptoms will assist in increasing accuracy.

While post-biopsy imaging findings require careful evaluation, the challenge of distinguishing post-biopsy change from malignancy is usually more limited than in the post-lumpectomy mammogram given that the risk for malignancy at a site of recent benign biopsy is lower than that of a biopsy performed in a patient with known history of malignancy, particularly in the first few years following biopsy. In a prospective study by Slanetz, mammograms of 1,997 patients presenting for screening were reviewed. One hundred and seventy-three patients reported a prior history of benign biopsy. Fourteen percent (24) of the 173 patients had mammographic evidence of biopsy on the mammogram. Although 5 % (9) of the 173 post-biopsy patients were recalled for additional imaging, none of the recalls were due to confusion or diagnostic concern at the biopsy site. The rate of recall was similar to that of the group without prior history of biopsy. The study concluded that changes from previous excisional biopsy for benign breast problems are uncommon and rarely pose a diagnostic dilemma in interpretation of routine screening mammograms [2]. If there is any concern on the first exam after benign biopsy, a short-term follow-up mammogram can be performed in 6 months. Any increase in calcifications, architectural distortion, or increasing asymmetries on follow-up should prompt biopsy (Fig. 16.6a–d).

In some cases, surgical excisional biopsy of an indeterminate or suspicious clinical or imaging finding is performed, rather than image-guided biopsy, and cancer is found at the time of surgery. The margins of the surgical sample are often positive and the patient needs to return to surgery for re-excision and possible axillary evaluation. In these cases, a pre-lumpectomy diagnostic mammogram with spot magnification views of the lumpectomy bed is recommended to evaluate for incompletely resected tumor. Comparison with pre-biopsy mammogram is essential to assess extent of the original disease. Correlation with the pathology report describing what aspect of the biopsy cavity has positive mar-

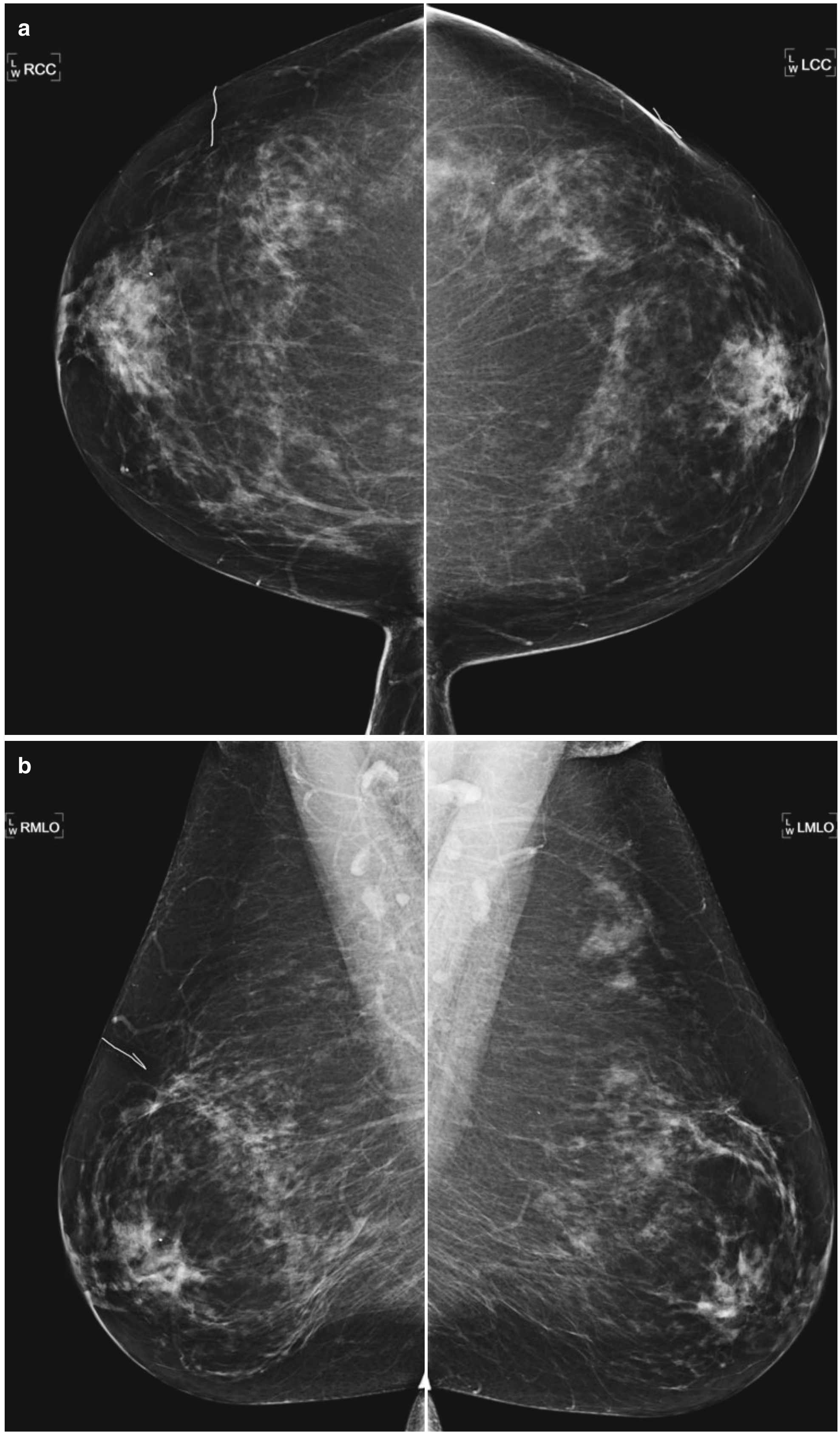


Fig. 16.2 (**a**) Prior bilateral benign excisional biopsies. Skin scar markers overlie the areas of prior biopsy and correlate to underlying subtle architectural distortion. (**b**) Note the apparent asymmetry in the posterior upper left breast due to excision of tissue on the right

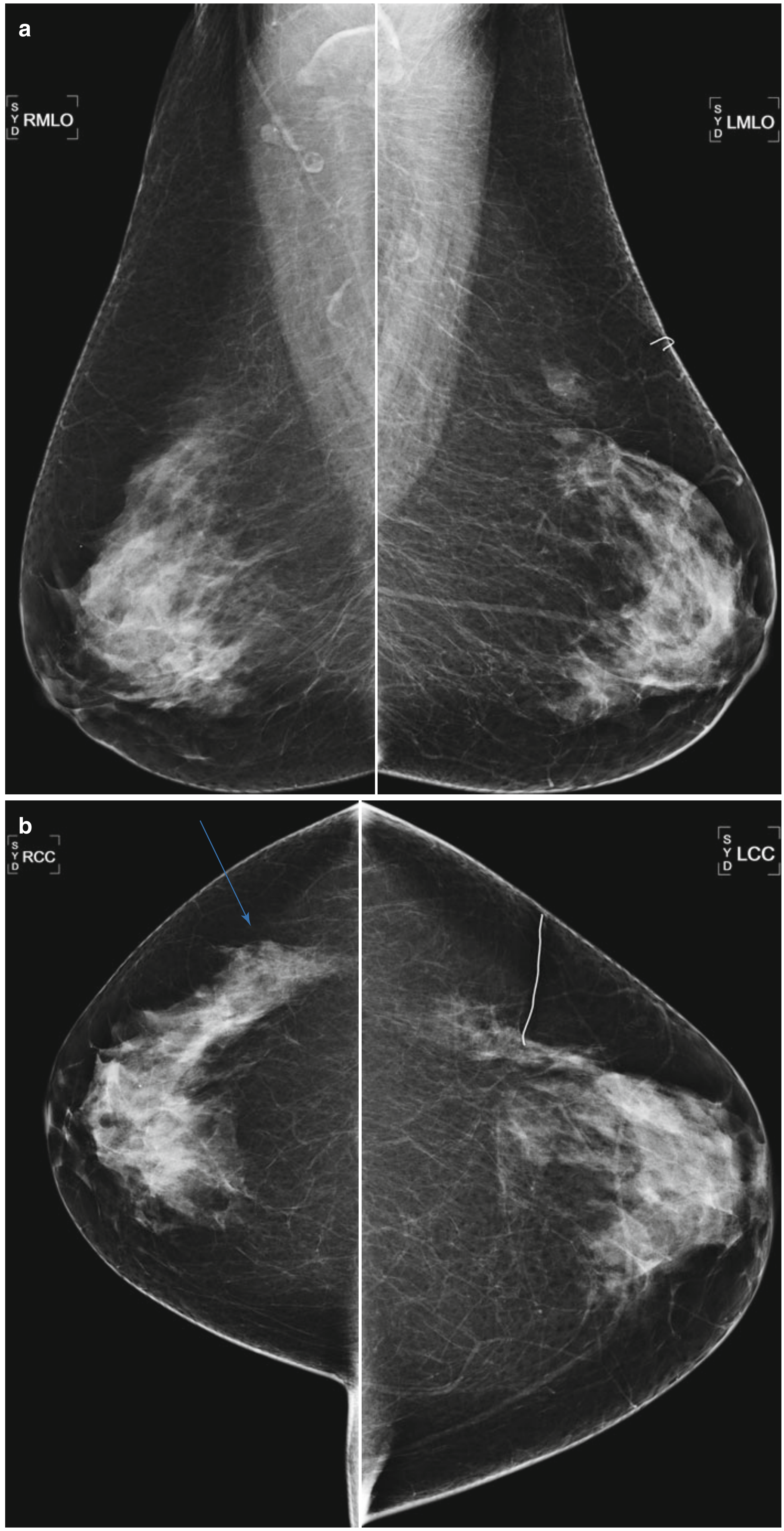


Fig. 16.3 (**a**) A 73-year-old female status post benign excisional biopsy in the upper outer left breast. Architectural distortion is present in the biopsy bed. (**b**) Note the apparent asymmetry in the posterior outer right breast due to asymmetric glandular tissue after tissue was removed from the outer left breast

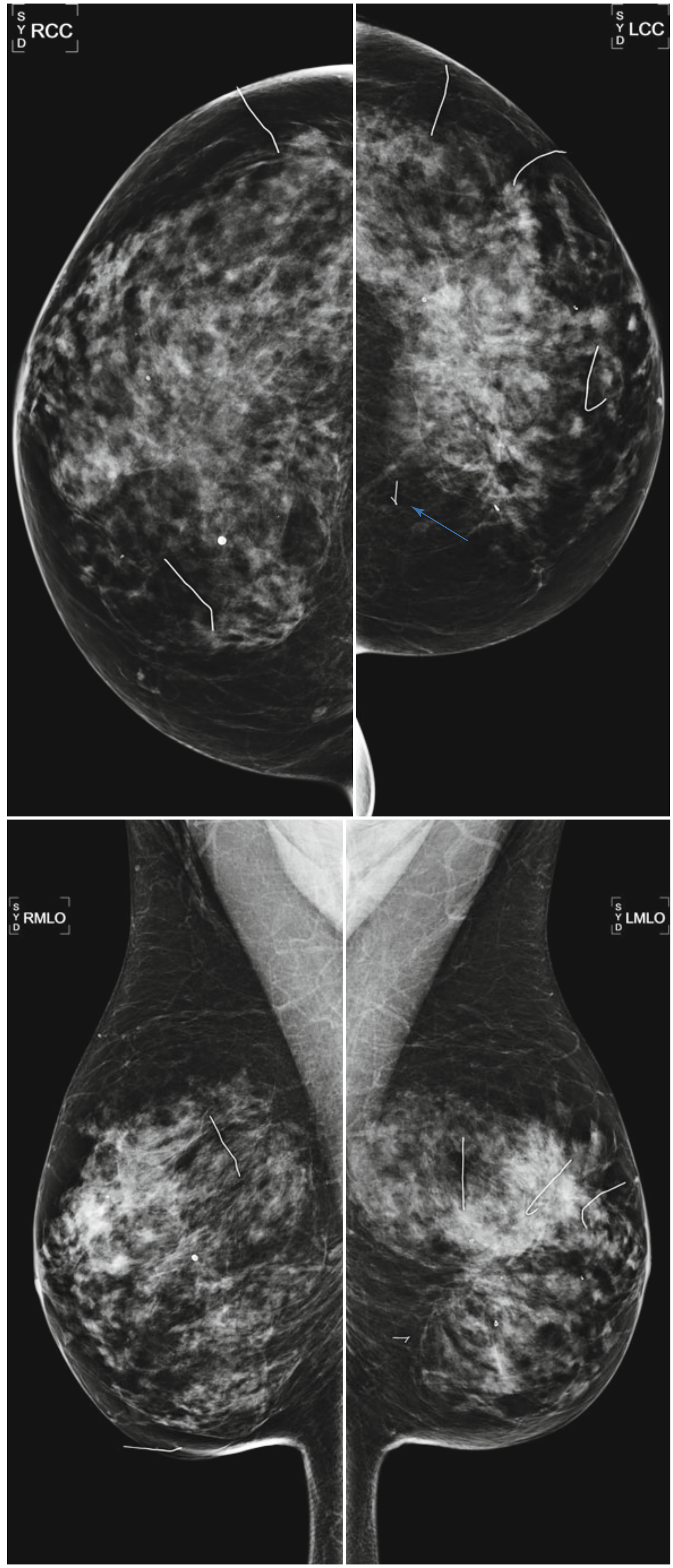
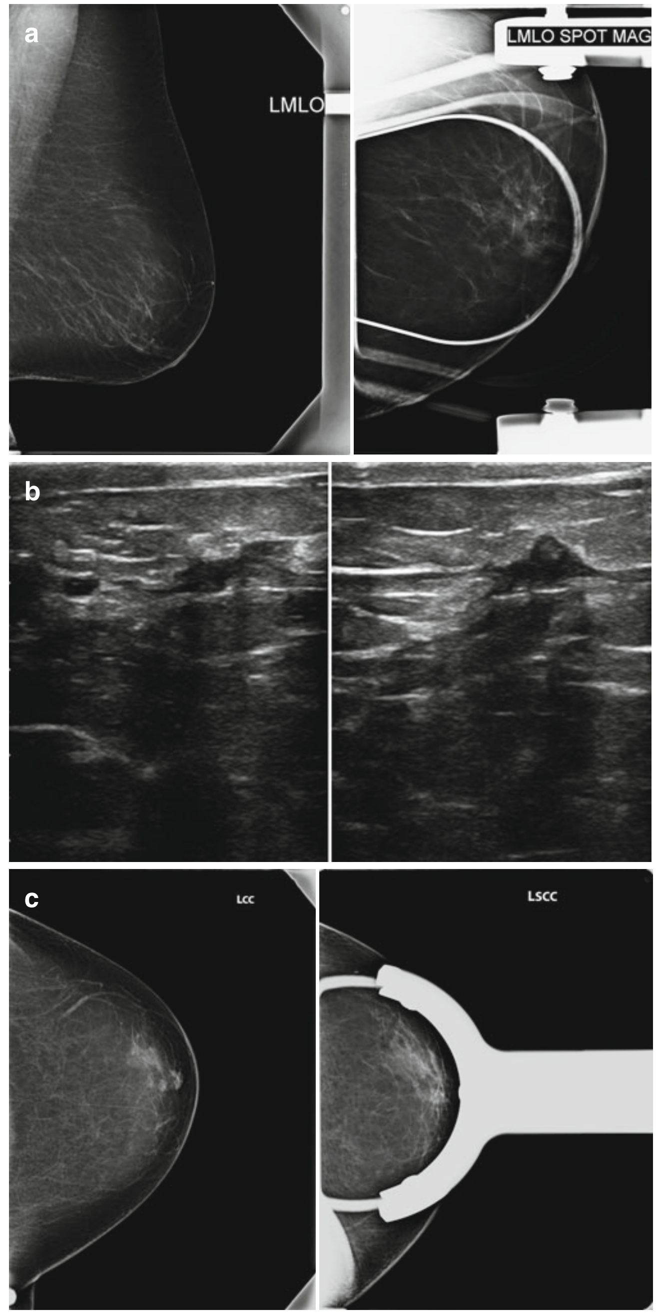
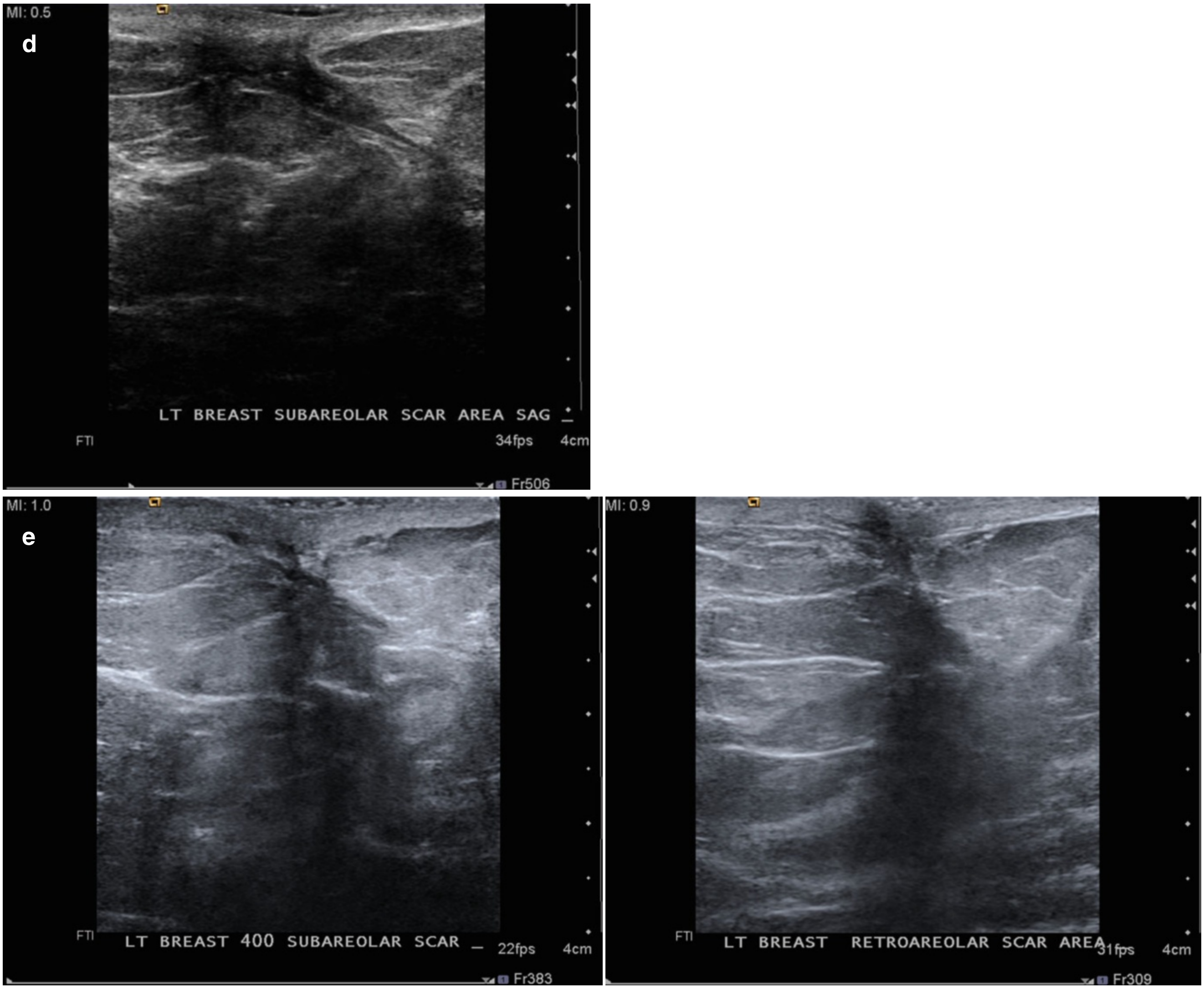


Fig. 16.4 A 59-year-old female status post multiple bilateral benign excisional biopsies. Note mild asymmetry in breast size from more biopsies being performed on the left breast and architectural distortion in the central left breast. A portion of a retained hookwire is present in the posterior medial left breast

Fig. 16.5 (**a**) A 65-year-old female with mass in the retroareolar position. (**b**) Ultrasound demonstrated a corresponding 6 mm intraductal mass. (**c**) 1 year after surgical excision of benign papilloma. Nodularity in the area of surgery is less conspicuous with spot compression. (**d**) Ultrasound demonstrated benign scar tissue. No residual or recurrent mass visualized. (**e**) Follow-up ultrasound performed 6 months (*left*) and 12 months (*right*) later shows resolving postoperative findings. (**f**) Mammogram 2 years (*left*) and 3 years (*right*) after surgery demonstrate progressively resolving postoperative changes





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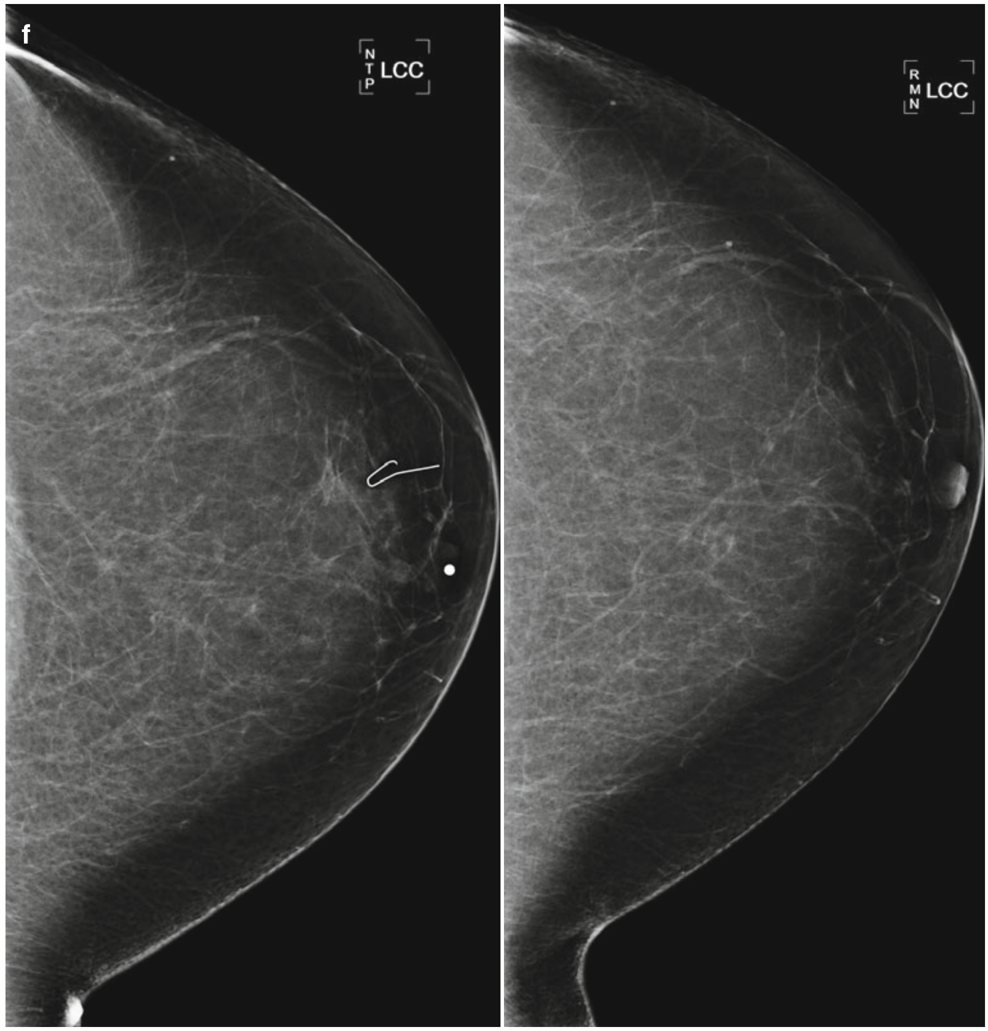

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gins is also helpful to direct the imager to give additional attention to these areas. The pre-lumpectomy mammogram is particularly useful in the cases of ductal carcinoma in situ to evaluate for residual calcifications. It is important to recognize that the absence of mammographic findings does not exclude residual disease and lumpectomy is still required despite a negative mammogram. Preoperative breast MRI is also valuable to evaluate for residual disease and to assess for multicentric or contralateral disease in these patients [3–5].

Post-lumpectomy

As the use of mammography and MRI for screening has become more widespread, the detection of early-stage (I or II) breast cancer has increased. Given equivalent survival rates for breast conservation therapy and mastectomy [6, 7] in prospective, randomized trials, lumpectomy with radiation therapy has become the treatment of choice for early-stage breast cancer. Breast conservation therapy achieves local tumor control by surgical removal of the cancer with a margin of normal breast tissue followed by whole breast radiation to try to eliminate any residual microscopic disease that was not evident by radiology, surgery, or pathology.

Imaging plays an important role in evaluating breast cancer patients in both preoperative and postoperative periods. Before surgery, imaging is used to evaluate extent of disease for treatment planning. Following surgery, imaging is used to detect residual or recurrent disease on the affected side and screen the contralateral breast. The imaging challenge in evaluating these patients postsurgery is distinguishing normal benign postoperative and postradiation alterations from tumor recurrence, the imaging findings of which can overlap. The ability to differentiate between the two is usually accomplished by an understanding of expected postoperative findings in correlation with timing since surgery and with evaluation of studies in a temporal context to detect interval changes, sometimes quite subtle.

Presurgical Evaluation

Once a diagnosis of cancer is established by biopsy, review of the mammogram to reevaluate for any possible multifocal or multicentric disease can be performed prior to surgery. Spot

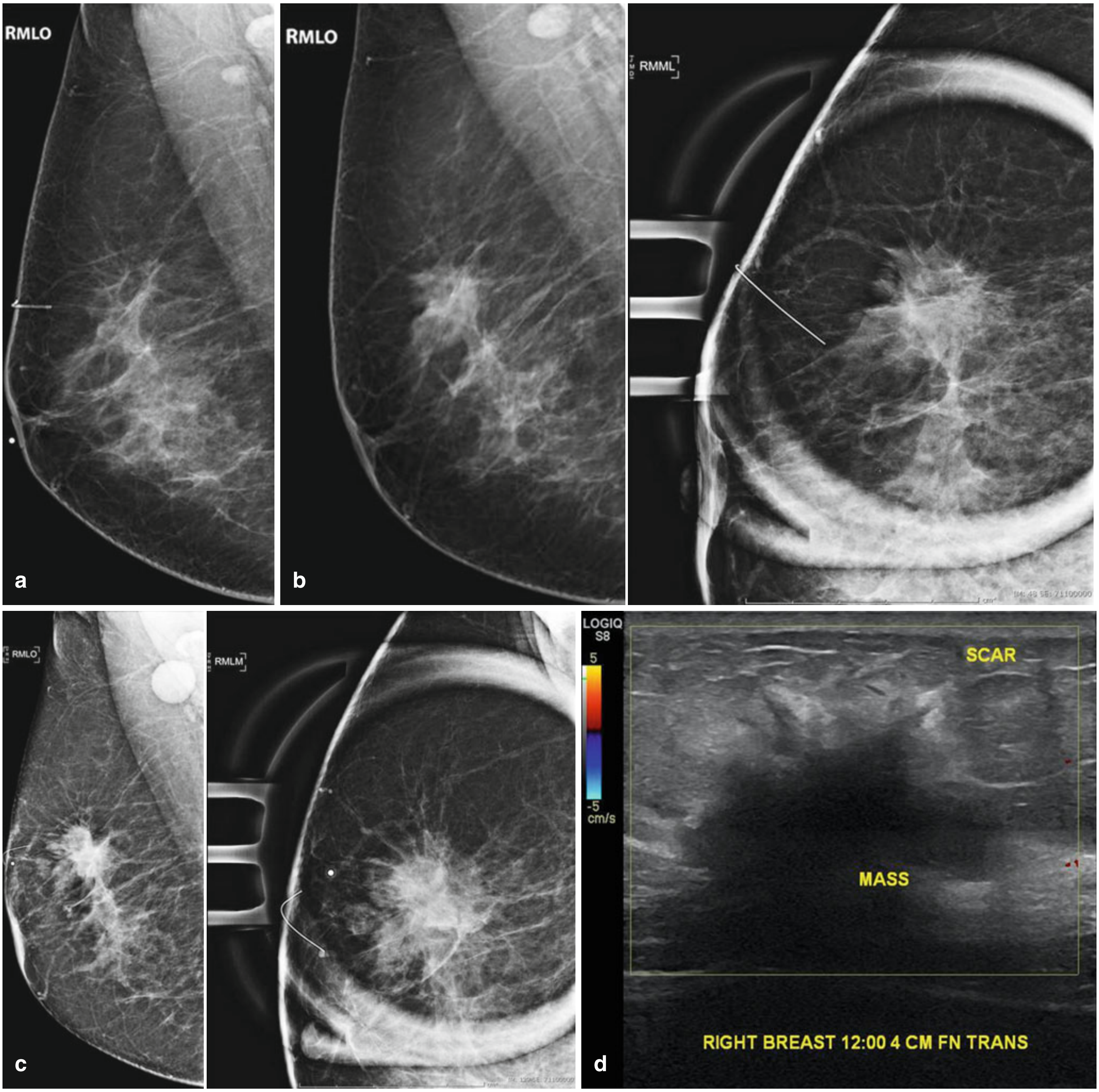


Fig. 16.6 (**a**) Right mammogram 9 months following excisional biopsy of calcifications. Pathology was benign. Mild architectural distortion is present in the mid upper breast. (**b**) The patient returns 2 years later. Increased prominence of the glandular tissue in the region of the scar prompted diagnostic mammogram which was interpreted as benign postsurgical change. (**c**) 7 months later, the patient returned complaining of a palpable abnormality. A high-density mass with irregular margins is visualized. Note enlarged right axillary lymph node. (**d**) US demonstrates a corresponding 4.2 cm hypoechoic mass superimposed on an area of architectural distortion related to a previous surgical excision site. Biopsy yielded invasive carcinoma

magnification view of indeterminate calcifications separate from the cancer and spot compression views of potential satellite nodules adjacent to the cancer or indeterminate masses in distant quadrants can be helpful to exclude additional disease.

As discussed in greater detail elsewhere in this book, breast MRI is also an important tool in the presurgical evaluation of newly diagnosed breast cancer. Multiple studies have demonstrated that MRI detects additional cancer in both the ipsilateral and contralateral breast [8–12]. Use of preoperative breast MRI varies by institution, although by the ACS guidelines breast MRI is recommended in all new diagnoses. A greater extent of the disease is often visualized on these exams.

Post-lumpectomy Evaluation

When postlumpectomy patients return for annual diagnostic imaging, it is helpful to have information on characteristics of the patient's initial cancer in order to have a better understanding of the features that may increase probability for recurrence. Important tumor features to know include tumor size and grade, proximity of tumor to margins, presence of extensive intraductal component, lymphovascular invasion, and biomarkers. It is also helpful to know if the patient was able to complete radiation and chemotherapy or antiestrogen therapy. Obtaining any prior imaging before reading the mammogram is helpful for comparing the current study to the earliest available postoperative study as detection of subtle progressive changes may not be readily apparent when comparing to exams performed 1–2 years prior. Given that 65 % of tumor recurrences are within a few centimeters of the excision site [13], dedicated attention to the lumpectomy cavity is warranted. One way of providing a more thorough examination of the lumpectomy bed is to perform spot magnification views of the surgical site. At our institution, we routinely perform these additional views for the first 5 years following surgery, although there is no published consensus on this practice.

Accurate interpretation of the postlumpectomy mammogram involves detection of potential recurrence as early as possible while limiting misinterpretation of postsurgical change as tumor recurrence. Diagnostic accuracy will be increased by familiarity of timing of tumor recurrence and expected chronological posttreatment changes. These changes include edema and skin thickening, masses and fluid collections, scarring and architectural distortion, and calcifications. These are the post-biopsy changes at the surgical site (previously discussed) with added diffuse skin thickening and breast edema associated with breast radiation. The changes seen after lumpectomy are usually more profound and prolonged than those seen after benign excision (Fig. 16.7). In comparison to the changes seen in the postlumpectomy breast, the changes following excisional biopsy usually resolve more quickly and, on occasion, completely.

Mammography performed 6–12 months after lumpectomy will demonstrate the greatest post-procedural changes [14]. The appearance of expected post-lumpectomy findings is dependent on the size of the lumpectomy and the time that has elapsed since the surgery (Figs. 16.8a–f and 16.9). Mendelson summarizes the expected time course for changes in the conservatively treated breast in the following chart (Fig. 16.10).

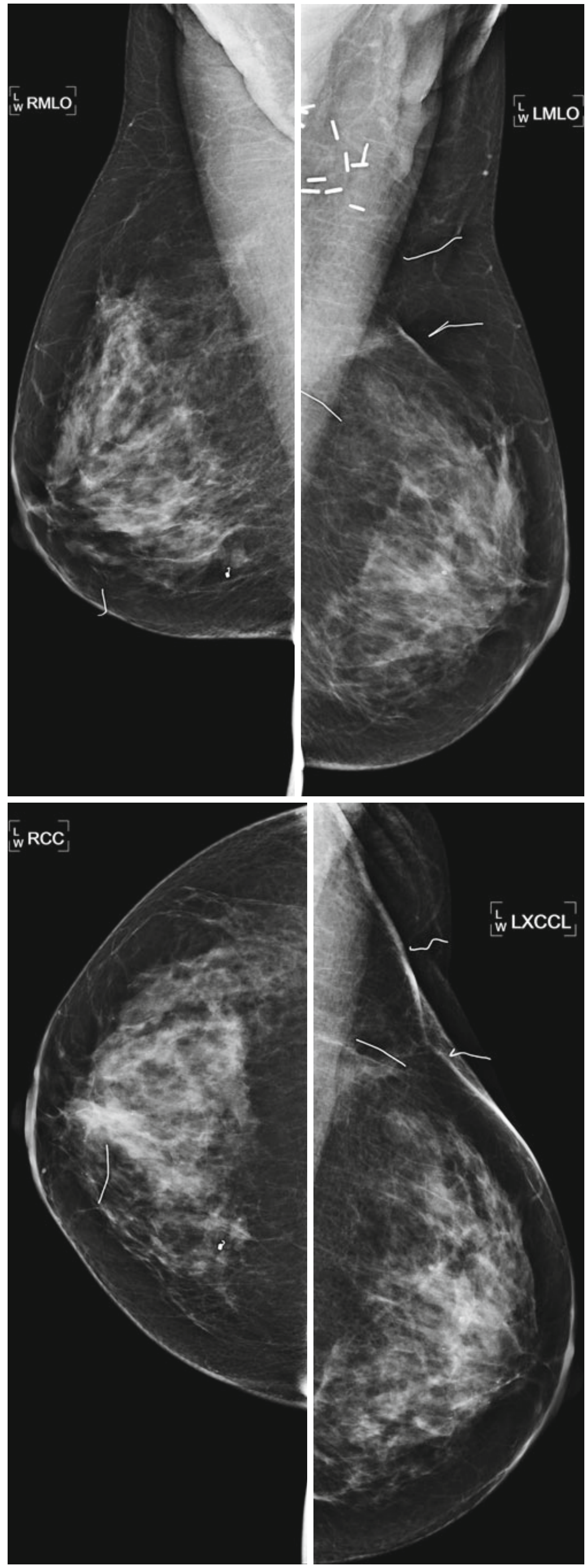


Fig. 16.7 Routine annual exam in a patient who underwent left lumpectomy and right breast excisional biopsy at the same time, 8 years prior to the exam. Note greater volume loss and postsurgical clips at the site of lumpectomy

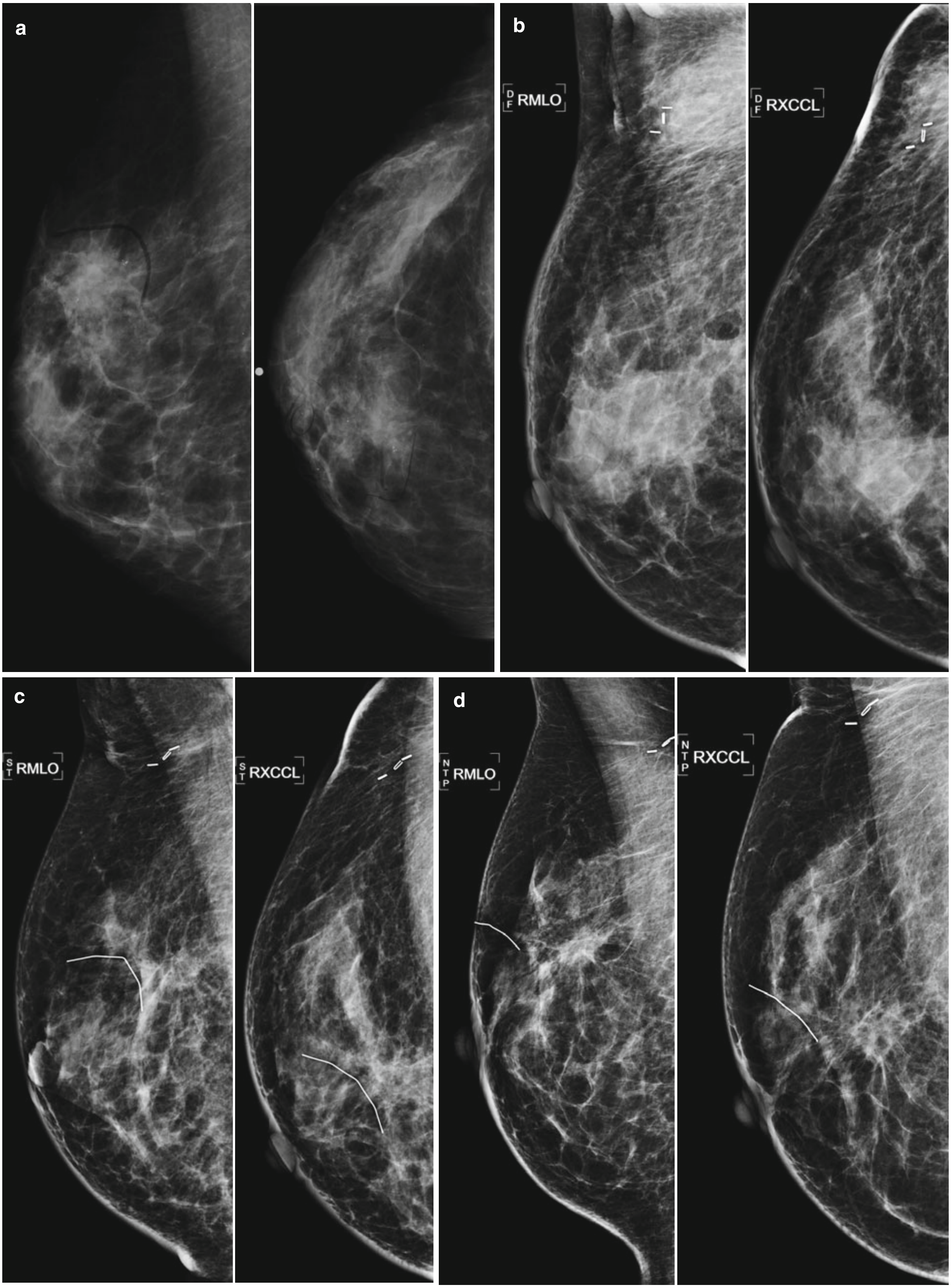


Fig. 16.8 (**a**–**f**) Progressive chronological changes in the lumpectomy cavity. (**a**) A 58-year-old with new spiculated mass in the upper inner right breast. Biopsy yielded invasive carcinoma. (**b**) The patient presented to our clinic 12 months following lumpectomy. (**c**) 18 months following lumpectomy. (**d**) 24 months post lumpectomy. (**e**) 36 months post lumpectomy. (**f**) 5 years post lumpectomy with continued decrease in edema and scarring

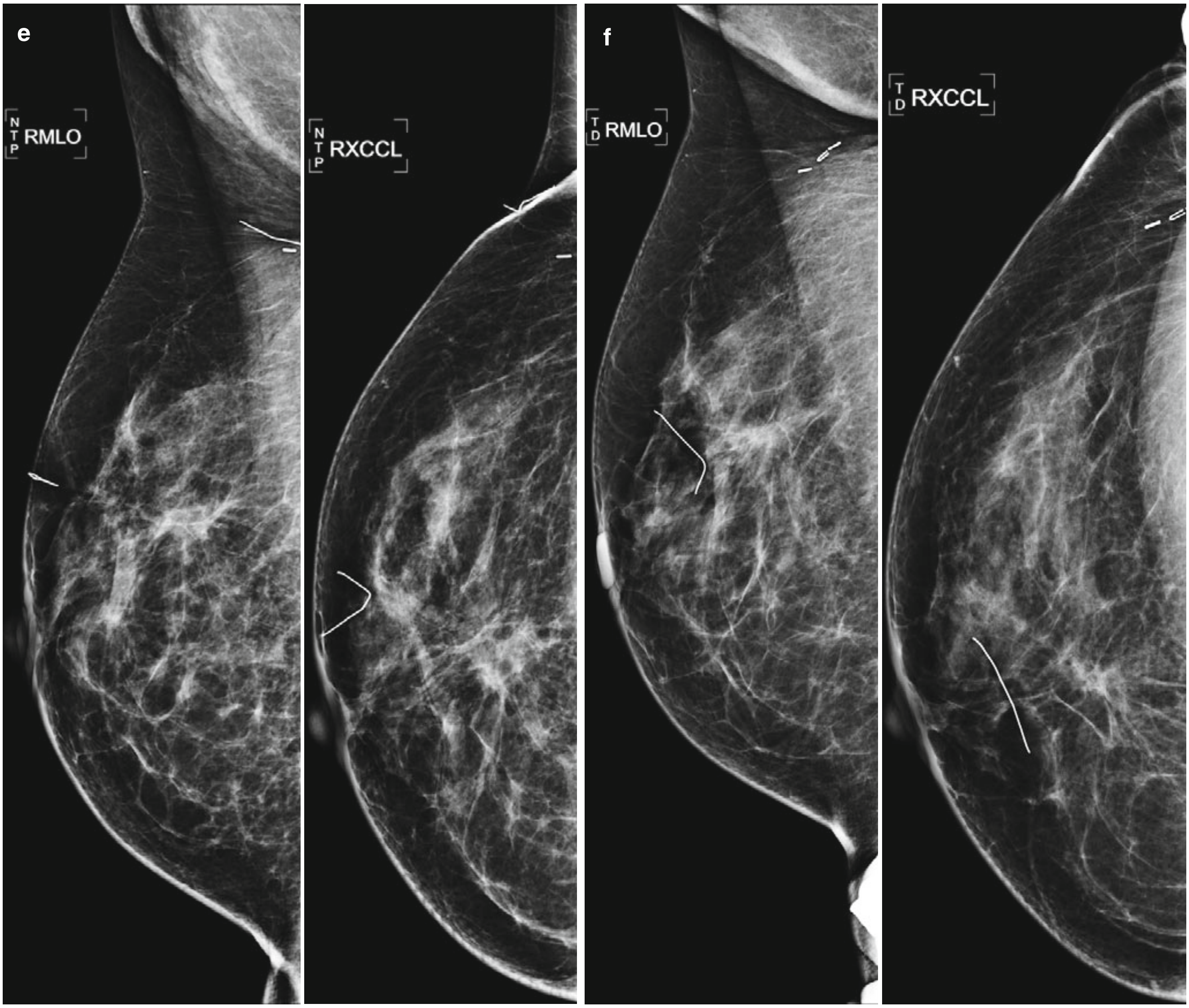


Fig. 16.8 (continued)

As demonstrated in the chart, breast edema and skin thickening are post-treatment changes with similar time courses after surgery. Breast edema manifests as skin and stromal thickening, trabecular thickening (engorgement of intramammary lymphatics) and diffusely increased breast parenchymal density [15]. The increased parenchymal density may be due to attenuation of the x-ray by edematous tissues and fibrosis and perhaps in part due to less compression secondary to patient discomfort. Initially the breast may appear enlarged due to edema. These changes are most prominent in the periareolar and dependent areas of the breast and will make the breast less compressible. Breast edema and skin thickening are particularly apparent when comparison is made with pretreatment mammograms by doing direct comparison with the contralateral breast. As the edema resolves, usually within the first 2 years after treatment, the breast will progressively decrease in size and the breast parenchyma will retain an increased density due to loss of volume and radiation fibrosis. If breast edema recurs or increases after stabilization, differential considerations include lymphatic spread of cancer, obstructed venous drainage, congestive heart failure, and infection [14].

Architectural distortion in the lumpectomy bed may be due to parenchymal scarring, fat necrosis, or recurrent cancer (Fig. 16.11a, b). The best way to discriminate scarring and recurrence on mammography is careful temporal evaluation. Scars contract and decrease in size as they mature and stabilize [14]. Radiolucent fat can be seen interspersed within the spiculated soft tissue of the scar. Mammographic findings suggestive of recurrence include lack of central radiolucent areas, new skin retraction, and increase in size, density, or nodularity of the scar [16].

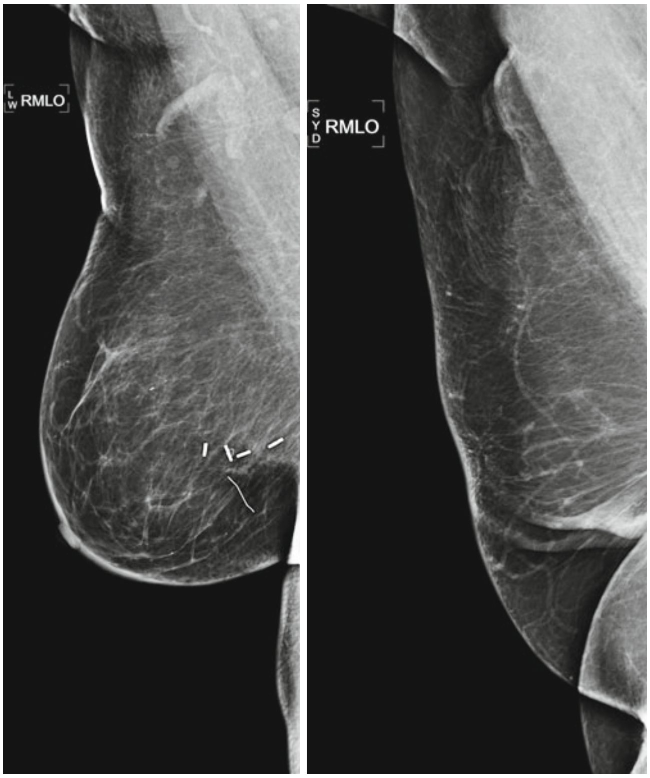


Fig. 16.9 Minimal postsurgical change (*left*) 3 years after lumpectomy for a small area of DCIS. Note the absence of findings in the axilla as no axillary dissection was performed. Compare with more significant distortion (*right*) in another patient 3 years following a more extensive lumpectomy

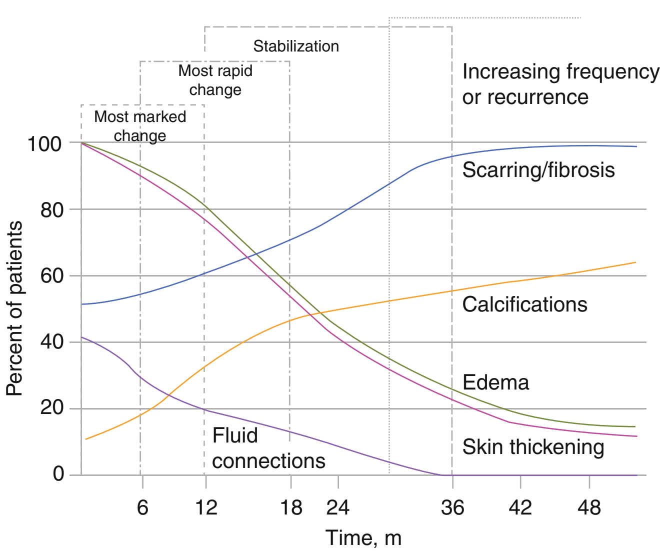


Fig. 16.10 Chronological change in appearance of the breast following lumpectomy (Used with permission from Mendelson [18])

Various fluid collections can develop following surgery including hematomas, seromas, and less commonly abscesses (Fig. 16.12a–c). These fluid collections may present as palpable or mammographically detected radiodense masses in the first year after breast conservation therapy [17]. Mammography will demonstrate postoperative fluid collections in 50 % of patients at 4 weeks and in 25 % of patients at 6 months after surgery [18]. Fluid collections are better evaluated with ultrasound and will be discussed in greater detail in the section on sonographic evaluation post lumpectomy. Most postoperative fluid collections resolve by 12 months.

Evaluation of newly developing calcifications in the postlumpectomy mammogram is of particular importance because often recurrences that present this way are not clinically detectable and provide an opportunity for early detection [13]. From a temporal standpoint, it is common for new calcifications to form in the lumpectomy bed within the first year after surgery in up to 28 % of cases [18]. Given that the risk of recurrence is greatest starting 2–3 years after surgery, most studies assign a low probability of malignancy in calcifications that occur within the first 18 months after surgery and radiation. Although most newly occurring calcifications in the postsurgical breast are benign, calcifications in post-treatment mammograms in patients with history of invasive carcinoma with extensive intraductal component or large areas of comedonecrosis should be approached with a higher level of suspicion as these tumors have higher risk of recurrence [18].

Calcifications at the lumpectomy site should be assessed in the same manner calcifications on routine screening mammograms are evaluated: calcifications with suspicious morphology or distribution increase the probability of malignancy and should prompt biopsy. The majority of calcifications that develop after surgery will be benign fat necrosis, dystrophic calcifications, or calcifying suture material (Figs. 16.13, 16.14, and 16.15). Magnification views are required to distinguish these benign calcifications from suspicious pleomorphic calcifications of cancer recurrence. Benign oil cysts present as thin rims of calcifications around a radiolucent center.

Fat necrosis calcifications typically demonstrate coarse curvilinear morphology and usually form around the periphery of a radiolucent center of fat (Figs. 16.16a, b, 16.17a, b, 16.18, 16.19a–c, and 16.20a–c). The time of development of fat necrosis is variable ranging from months to years. Although there is a classic appearance of benign calcifications, these calcifications do not always present in their classic form, making assigning benign etiology difficult, particularly when they are more faint in their early stages. When calcifications are indeterminate, careful inspection of prior mammograms may show regression of the calcifications over time or formation of the calcifications around a radiolucent center of fat, suggesting benign etiology [19]. If there is low suspicion based on morphology, monitoring with 6-month follow-up is a reasonable approach. Otherwise,

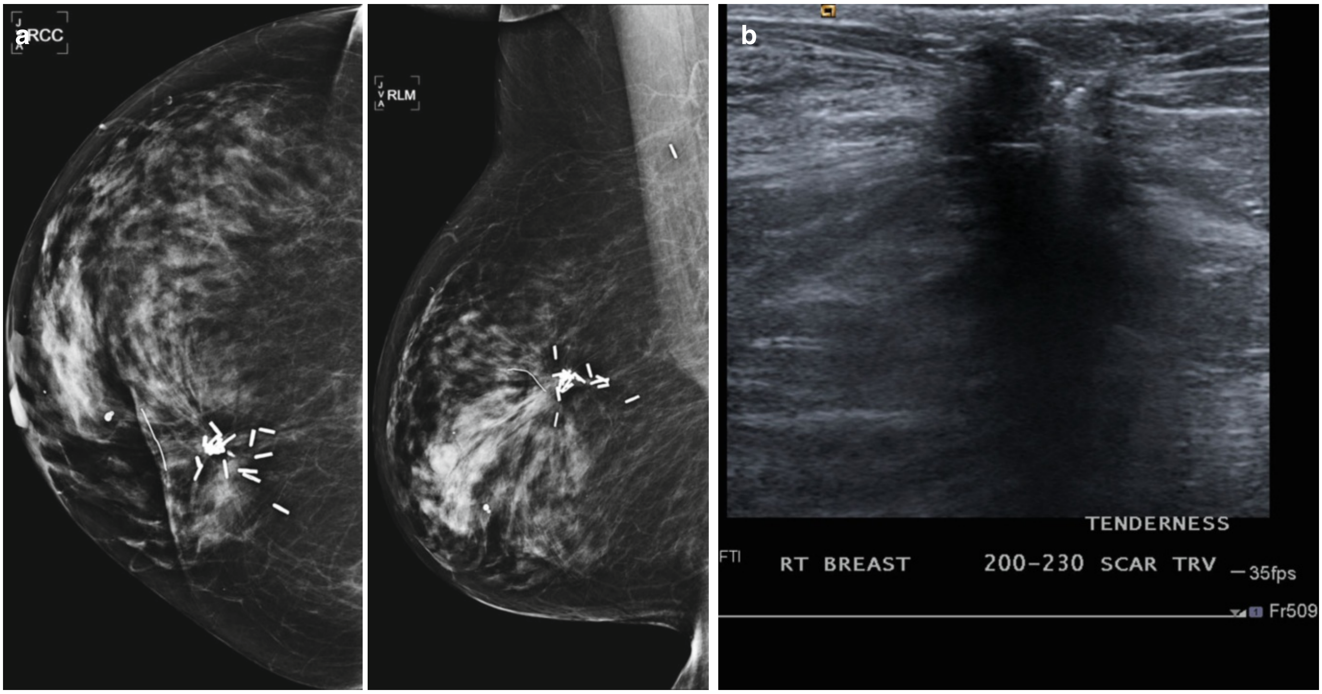


Fig. 16.11 (**a**) A 69-year-old female status post lumpectomy 12 years prior to exam. Post-lumpectomy changes are present in the upper inner right breast including surgical clips deployed at the margins of the lumpectomy site to focus follow-up mammography and to guide radiation planning. (**b**) Ultrasound of the area of prior lumpectomy shows expected sonographic findings of scar tissue

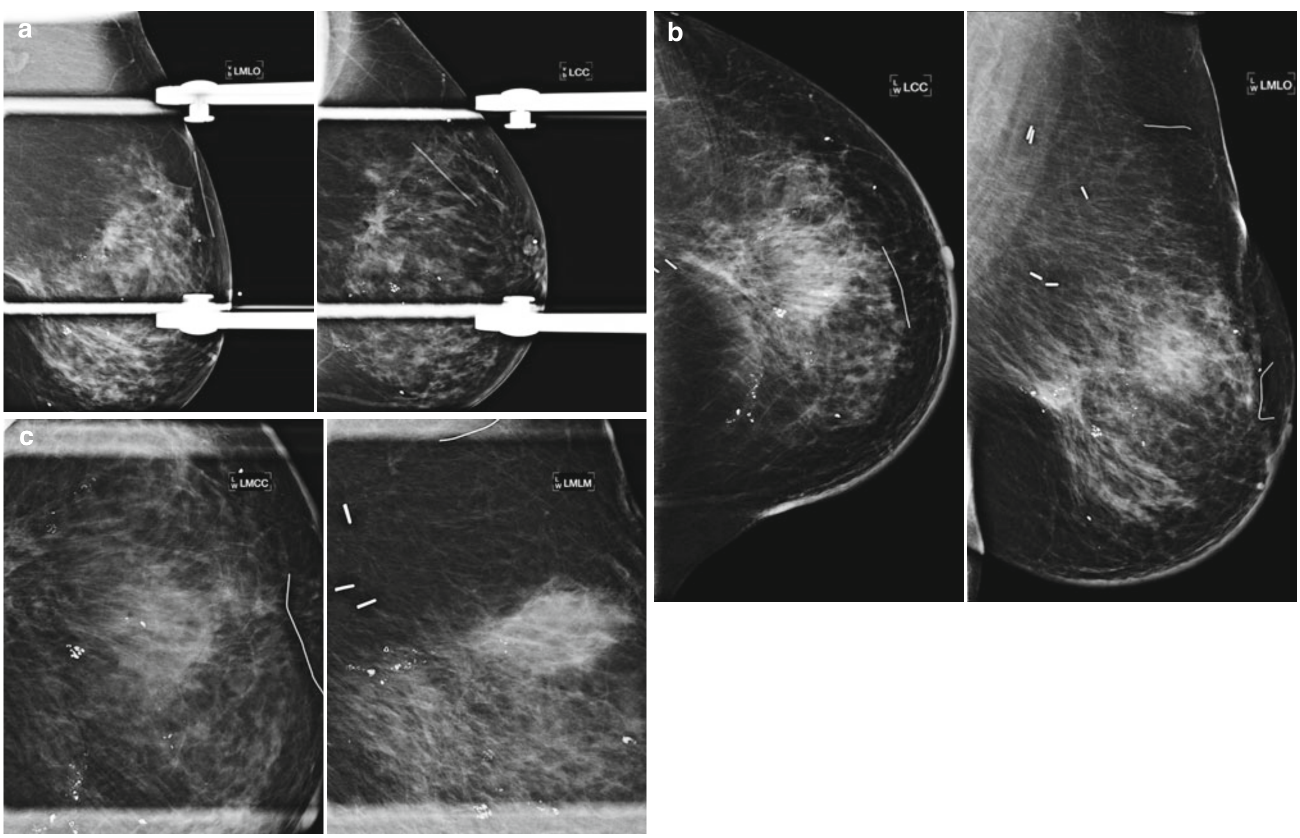


Fig. 16.12 (**a**) An 80-year-old female with new 7 mm irregular mass in the posterior upper central left breast. Biopsy yielded invasive carcinoma. (**b**) 6-month follow-up after lumpectomy. (**c**) Spot magnification views of the lumpectomy bed. Focal increased density likely represents a resolving postoperative fluid collection. Scattered benign-appearing coarse calcifications are present

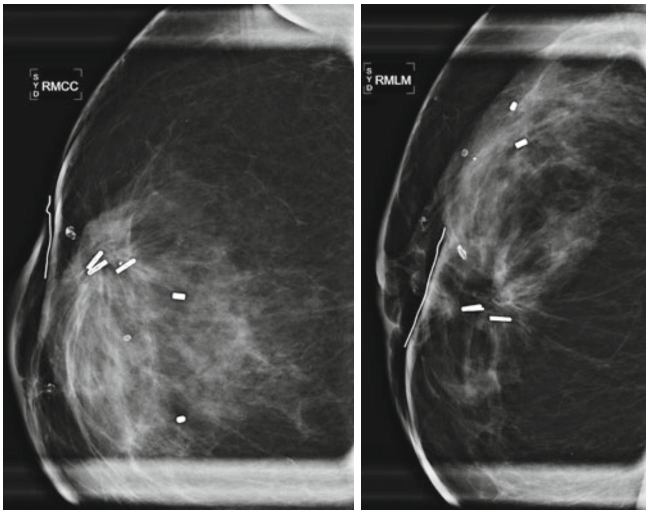


Fig. 16.13 Stable architectural distortion and benign calcifications 5 years post lumpectomy

biopsy should be performed for definitive diagnosis of benignity.

Most changes after lumpectomy diminish and regress over time and then remain stable. Stability is defined as the lack of interval change on two successive studies and occurs on average 2–3 years after breast conservation therapy is completed [18]. Fortunately for the breast imager, stability occurs around the time that tumor recurrences begin to appear [14]. Once stability is established, any increase in changes or new findings should be evaluated for tumor recurrence (Fig. 16.21a, b).

Imaging Schedule Post-lumpectomy

Currently there is no widely accepted protocol for appropriate post-lumpectomy surveillance. Although there is consensus on annual mammography of the contralateral breast, recommendations for follow-up mammography on the side of lumpectomy vary by institution and demonstrate considerable geographic variation. At some facilities, a unilateral postsurgical mammogram is performed immediately after lumpectomy but prior to initiation of radiation therapy to evaluate for residual disease at the tumor site. This is particularly recommended in patients who initially presented with extensive area of calcifications on their mammogram or may be helpful for surgical planning if positive margins were present on pathology at the time of lumpectomy. Other institutions obtain a baseline unilateral mammogram immediately following completion of radiation therapy. Some facilities will wait to perform a unilateral mammogram on the side of lumpectomy until 6 months after surgery. Thorough preoperative evaluation of the mammogram and preoperative breast MRI limit the risk for finding unexpected

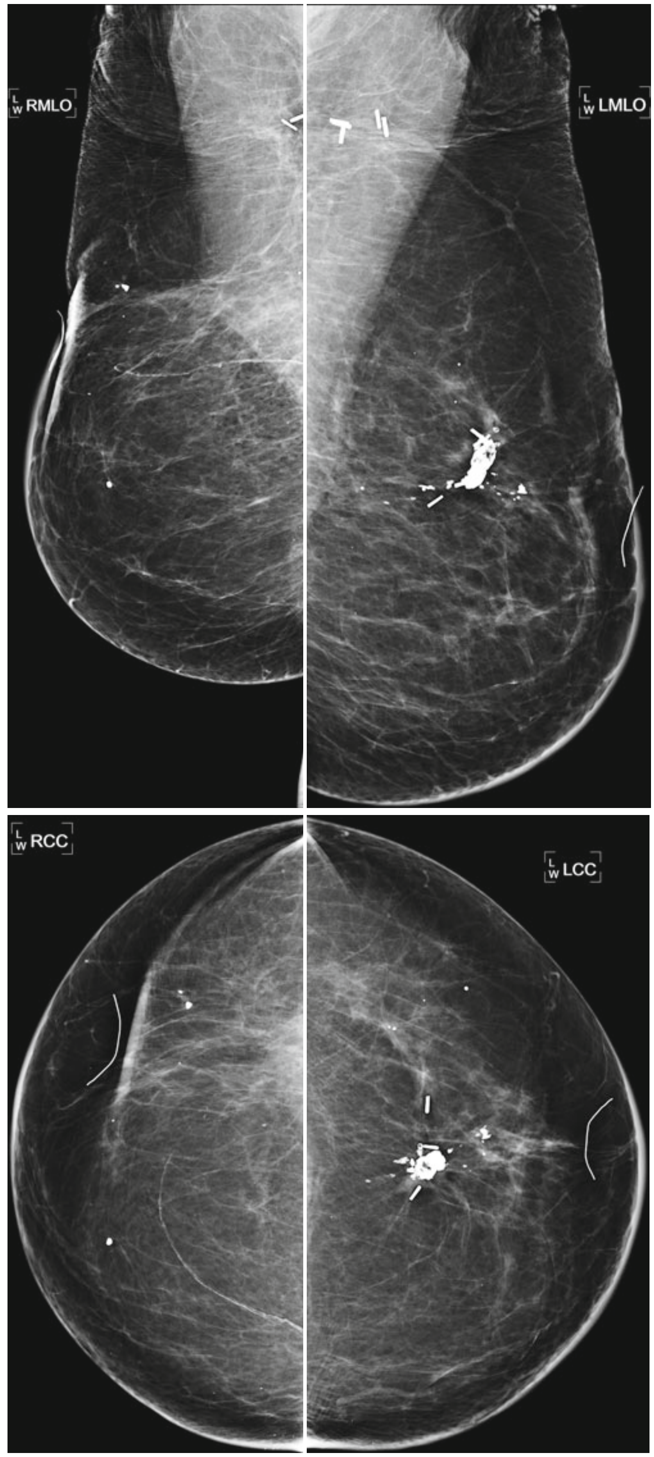


Fig. 16.14 Bilateral lumpectomies 9 years prior. The left breast shows benign fat necrosis, while the right breast has greater volume loss and architectural distortion

additional disease at the time of surgery and decrease the utility of a mammogram immediately after lumpectomy when it is often painful for the patient. In addition, an irradiated breast can be difficult to position for imaging and may

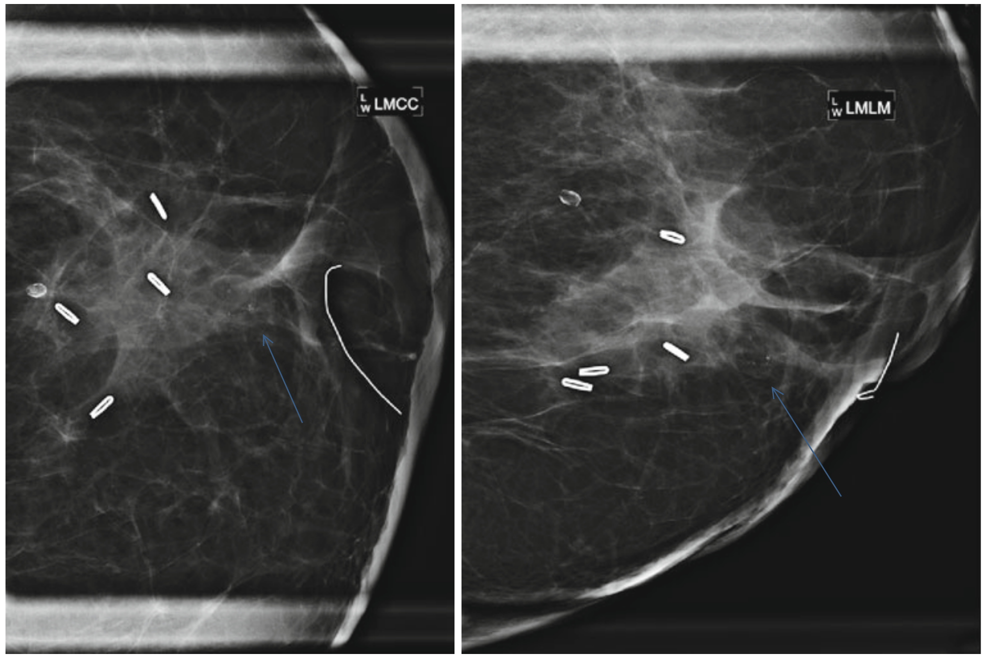


Fig. 16.15 Patient had left lumpectomy 3 years prior to exam. A new 5 mm cluster of heterogenous calcifications is visualized in the lumpectomy bed. Stereotactic biopsy was performed with pathology of dense fibrous connective tissue consistent with lumpectomy bed, histiocytic inflammatory response associated with microcalcifications and fat necrosis

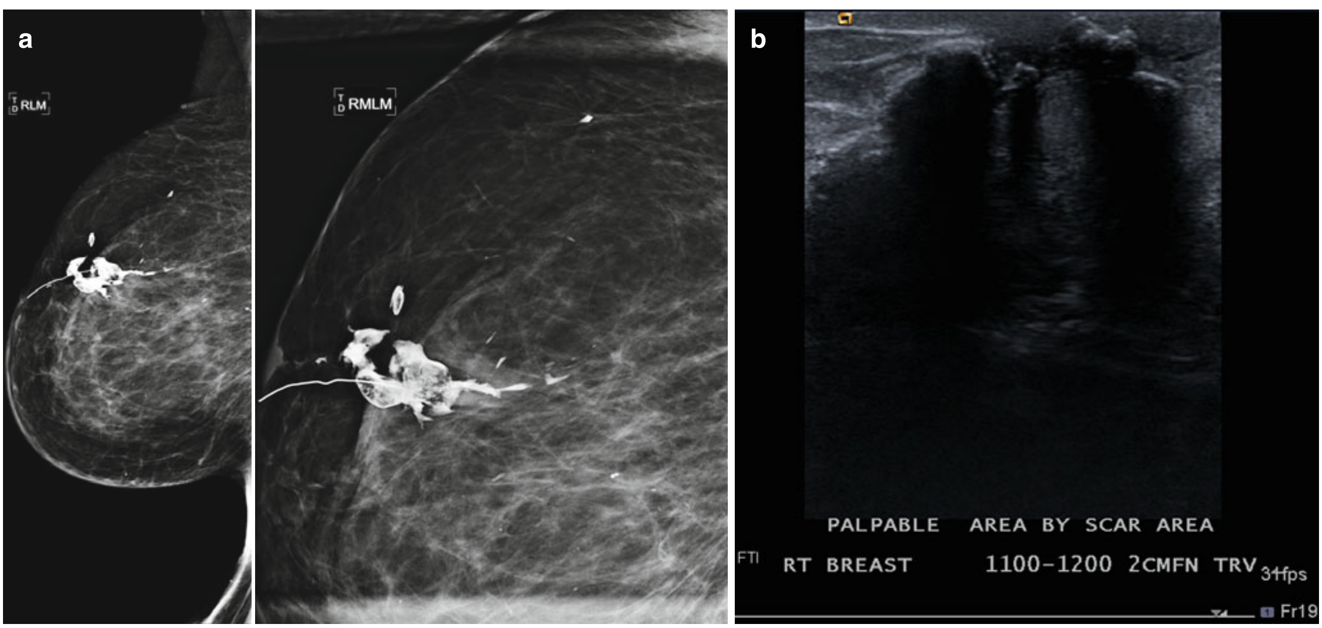


Fig. 16.16 (**a**) An 80-year-old female with history of right breast CA post lumpectomy 20 years prior to the exam. Recent 100 lb weight loss and new palpable abnormality in the right breast. The coarse fat necrosis calcifications were not significantly changed from a prior mammogram 2 years prior but was now better felt by the patient due to her weight loss. (**b**) Ultrasound of the area of palpable complaint demonstrates expected coarse calcifications and associated posterior acoustic shadowing consistent with fat necrosis

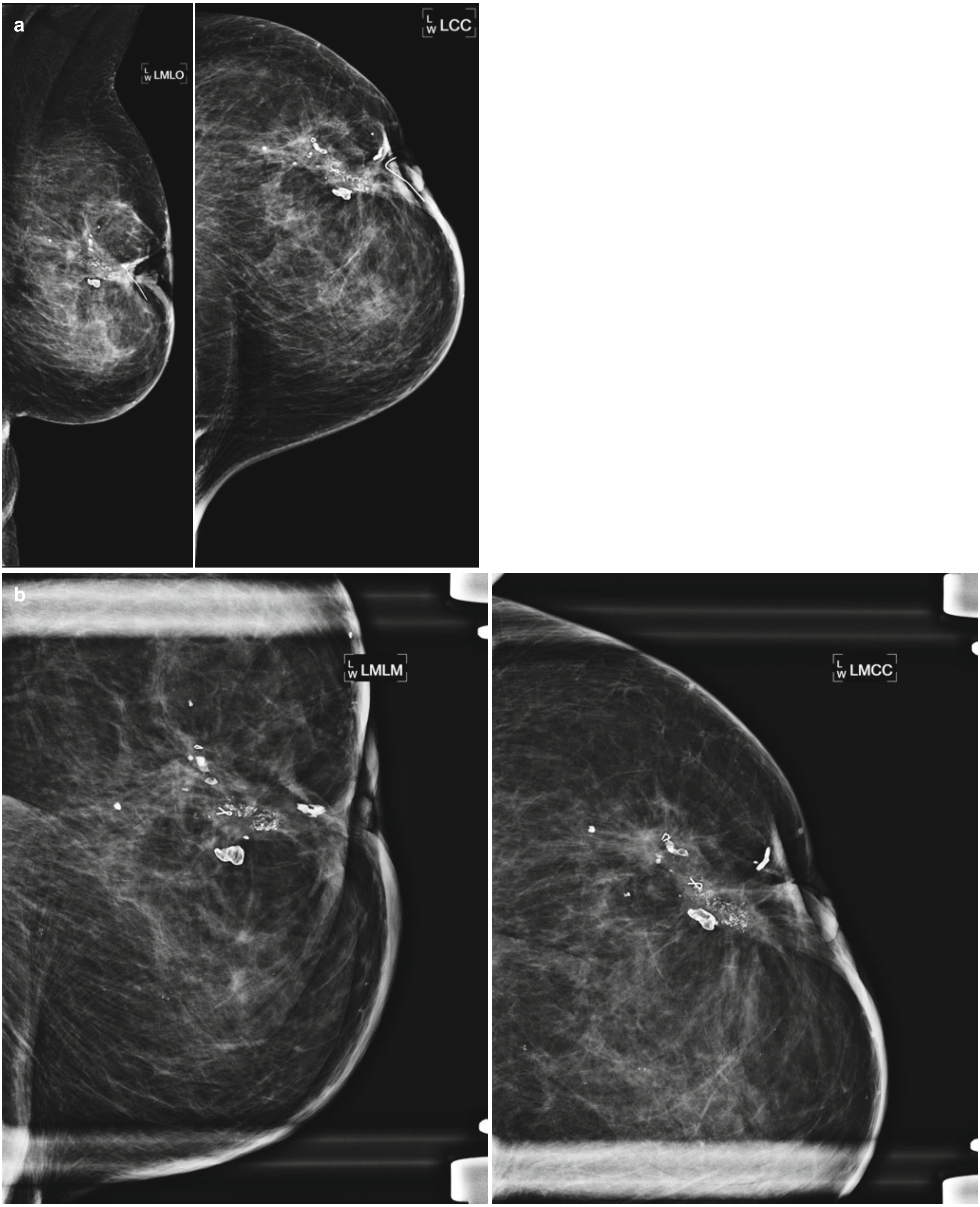


Fig. 16.17 (**a**) A 72-year-old female with history of lumpectomy 12 years prior. The patient lost 50 lb in the time since her prior mammogram and the patient and physician perceive “hardening” in the lumpectomy bed. (**b**) Spot magnification views demonstrate coarse, heterogenous fat necrosis calcifications that had been stable over several years. Note multiple biopsy clips localizing prior benign biopsies yielding fat necrosis

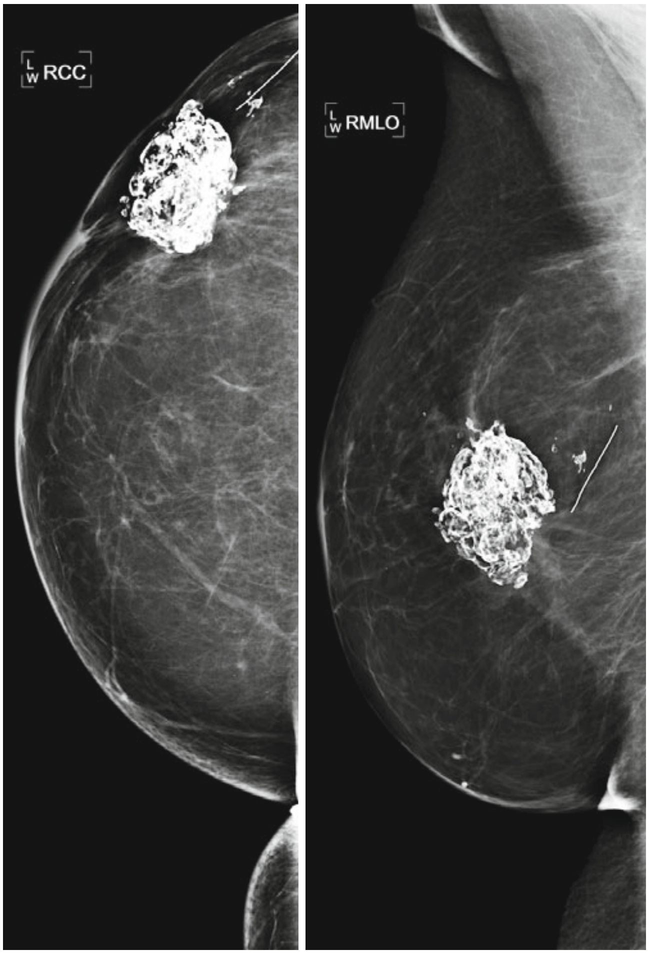


Fig. 16.18 Status post right lumpectomy with benign fat necrosis calcifications in the lumpectomy bed. Note the proximity of the calcified mass to the lateral skin making the mass palpable and leading the patient to call it "the rock" in her breast

be difficult to compress sufficiently due to patient discomfort.

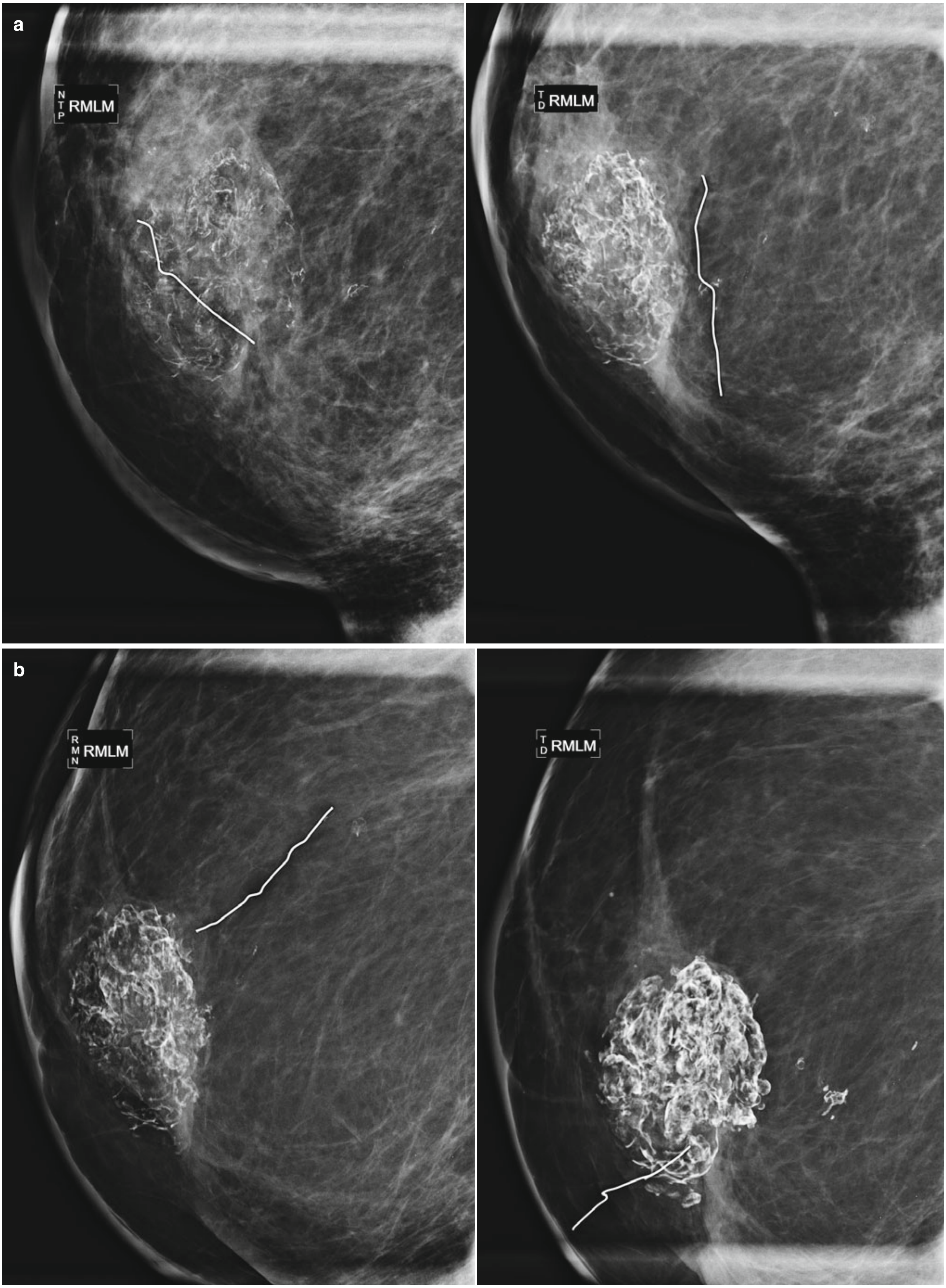
After the initial unilateral mammogram 6 months post lumpectomy, bilateral mammography is performed at our facility 1 year following lumpectomy and on an annual basis thereafter, unless new imaging findings arise that require closer surveillance. However, various schedules have been proposed for follow-up mammograms after the 12-month study. Some facilities prefer to follow the post-lumpectomy breast at 6 month intervals for up to 3 years. Proponents of this schedule argue that this approach provides the optimum coverage through the "stabilization" period described in the chart. Proponents of extending 6-month follow-up out to 5 years believe that it provides better coverage when the breast transitions from the stabilization phase into the time when there is increasing frequency for recurrence. Some places will modify their schedule to perform more frequent follow-up in the patients that are at higher risk for recurrence based on the characteristics of that individual patient's cancer. We perform routine magnification views of the lumpectomy for 5 years following lumpectomy, another practice that varies by institution.

Ultrasound

There are also typical post-lumpectomy changes on sonography. Similar to mammography, familiarity with the expected sonographic appearance after surgery and radiation therapy is useful to avoid misinterpretation. Ultrasound of the lumpectomy bed within the first year after surgery usually demonstrates skin thickening and a fluid collection at the site of surgery, the size of which is variable by patient. Skin thickening after radiation therapy may reach 1 cm or greater [20]. Sonography is helpful in establishing fluid content with a mass seen in the lumpectomy cavity on mammography. The margin of the mass may be well circumscribed, ill defined, or spiculated due to the fibrotic reaction associated with healing (Fig. 16.22a, b). The fluid collection may be round or oval with varying margins (circumscribed, ill defined, or spiculated) and may appear simple or look like a complex cystic mass with septations or echogenic nodules [21] (Fig. 16.23). Aspiration of the postoperative seroma is not recommended and usually reserved for patients that have severe pain at the site or if there is suspected infection due to a tender, tense mass in a patient with fever. Ultrasound can be used for guidance if drainage is indicated. Reaccumulation of fluid following aspiration is common and there is a risk for the development of chronic draining sinuses.

Postoperative masses should remain stable, improve, or resolve. As the fluid is gradually reabsorbed, the residual fibrosis and scarring will be a hypoechoic mass with irregular margins and posterior acoustic shadowing. Identifying this finding beneath the skin scar or identifying a tract between the surgical bed and the skin is helpful in confidently identifying the mass as scar tissue. Sonography is useful in further evaluating mammographic masses as cystic or solid and can also help in further evaluating palpable masses

Fig. 16.19 (**a**–**c**) Evolution of fat necrosis. (**a**) The patient presented to our clinic 1 year following lumpectomy with faint, curvilinear calcifications visualized in the lumpectomy bed. Six months later, the calcifications are coarsening. (**b**) 24 and 36 months post lumpectomy. Stabilization of calcifications 3 years following surgery. (**c**) 48 months post lumpectomy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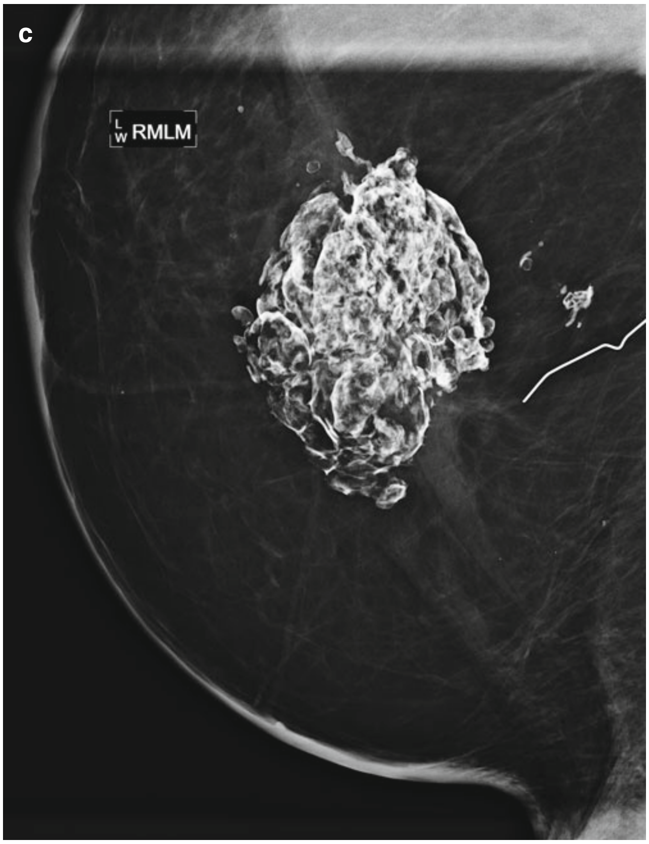


Fig. 16.19 (continued)

that are obscured by postsurgical changes or dense breast tissue. If a suspicious solid mass is identified, ultrasound can then be used to guide for biopsy. Residual skin thickening is seen in about 20 % of women 2 years after radiation therapy. Most fluid collections resolve within 2 years from the time of surgery. If a mass increases in size, further evaluation with ultrasound and possible biopsy is indicated.

MRI

Screening with breast MRI has high sensitivity, moderate specificity, and high cost when compared with mammography. In published recommendations from the Society of Breast Imaging and American College of Radiology, breast MRI may be considered in women with between 15 and 20 % lifetime risk for breast cancer on the basis of personal history of breast or ovarian cancer or biopsy-proven lobular neoplasia or ADH [4]. The American Cancer Society guidelines for breast screening with breast MRI published in 2007 stated there was insufficient evidence to recommend for or against screening women with a personal history of breast cancer [22]. A study by Morris et al. evaluated breast MRI screening in women with elevated risk of developing breast cancer and negative mammograms. The study included 245 women with personal history of breast cancer. In this group, breast MRI detected mammographically occult cancer in 4 % of the patients [23]. Consultation with referring clinicians can be helpful in selecting a subset of patients with history of breast cancer that is at

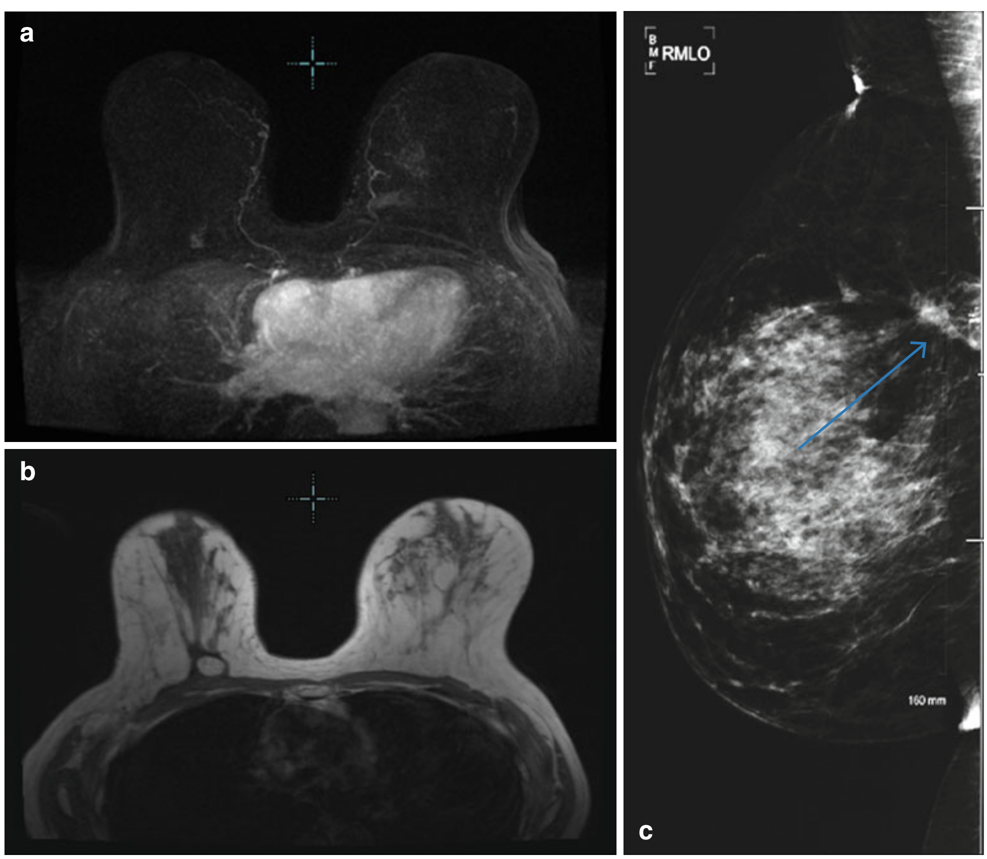


Fig. 16.20 (**a**) A 73-year-old female with history of right breast cancer status post lumpectomy 2 years prior. Patient is reporting new palpable complaint in the left breast with no mammographic or sonographic correlate. MIP image demonstrates non-mass-like enhancement in the area of palpable complaint. Biopsy was performed and yielded fat necrosis. Nodular enhancement is present in the right lumpectomy cavity. (**b**) T1 axial non-contrast image demonstrates central fat within the area of enhancement consistent with benign fat necrosis. (**c**) Right breast mammogram confirms the presence of fat necrosis

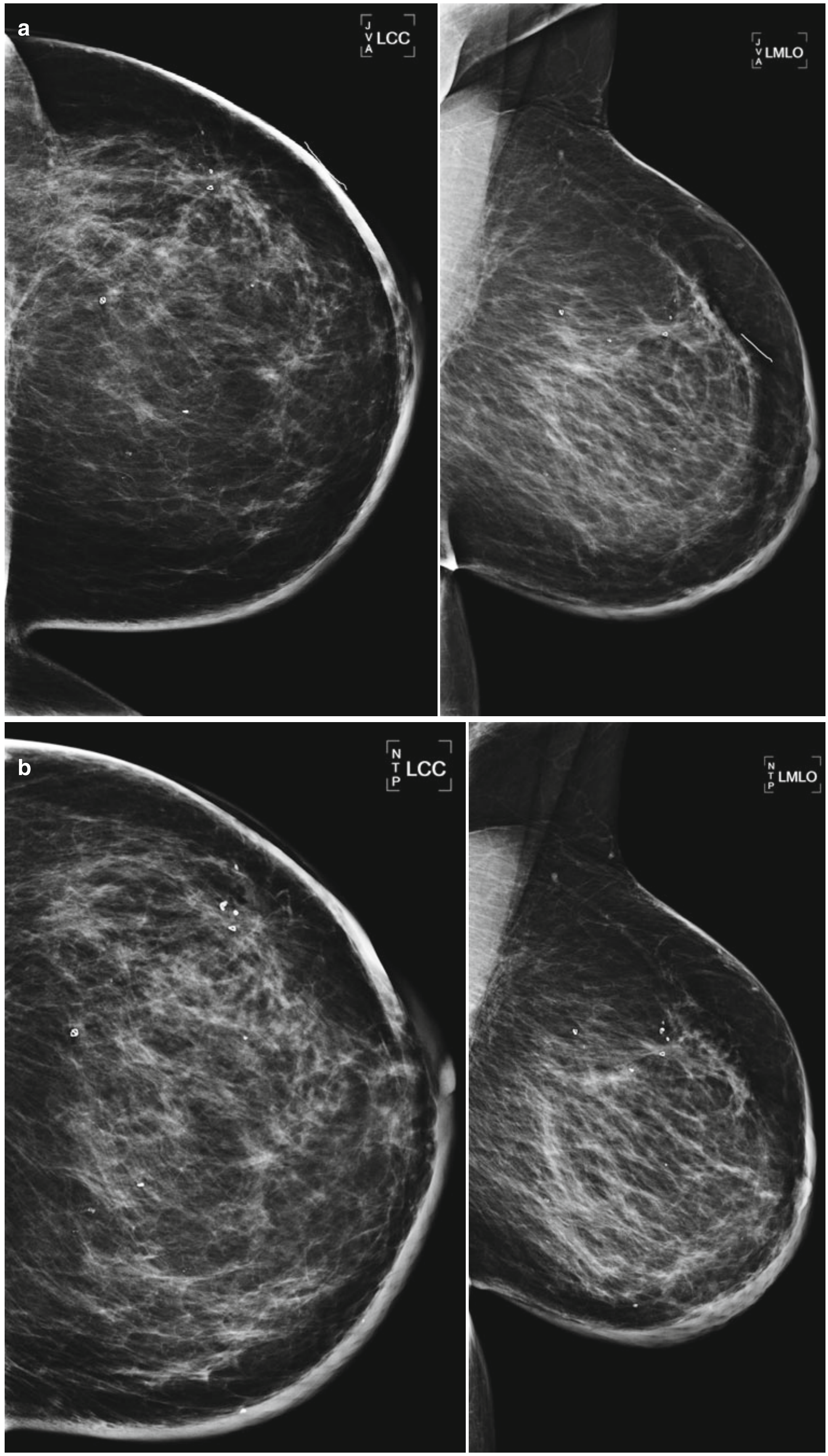


Fig. 16.21 (**a**) 10 years post lumpectomy and radiation therapy with residual skin thickening. (**b**) Over the following 3 years, the patient developed progressive increase in skin thickening. The patient reported increased breast heaviness. The interval change prompted skin biopsy which revealed dermal fibrosis consistent with scar. Following the biopsy, the patient's symptoms improved and on the subsequent mammogram the skin thickening returned to postsurgery baseline

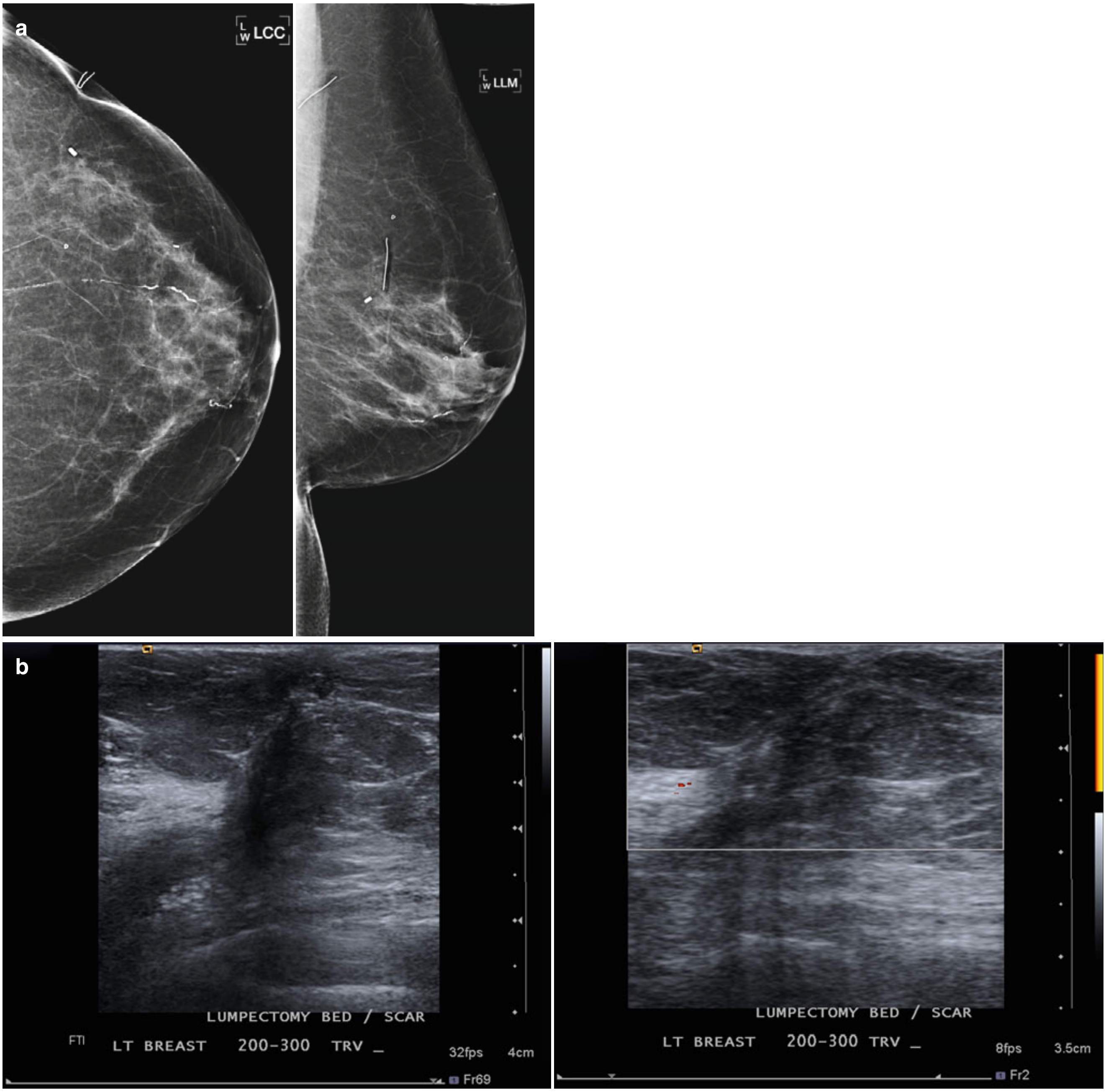


Fig. 16.22 (**a**) Left lumpectomy 8 years prior. Post-lumpectomy changes in the upper outer breast. (**b**) Ultrasound appearance of the post-lumpectomy scar area. An irregular hypoechoic area is present with changes extending to the skin. Doppler US does not demonstrate vascularity in the fibrotic scar tissue

particularly high risk for recurrence for supplemental screening with breast MRI. Importantly, the impact of breast MRI screening on breast cancer mortality has not been established by randomized clinical trials. As with its use in screening of the high risk for breast cancer population, breast MRI used in screening patients with a personal history of breast cancer should always be performed as an adjunct to mammography as some recurrences, particularly of DCIS, are detected by mammography only.

Recurrence

As therapy for breast cancer continues to improve, the number of long-term survivors is increasing and the population of patients being screened for recurrent disease is increasing. Although there are no randomized trials establishing mortality benefit of screening mammography after breast conservation therapy, the use of screening mammography has been demonstrated to decrease breast cancer mortality and

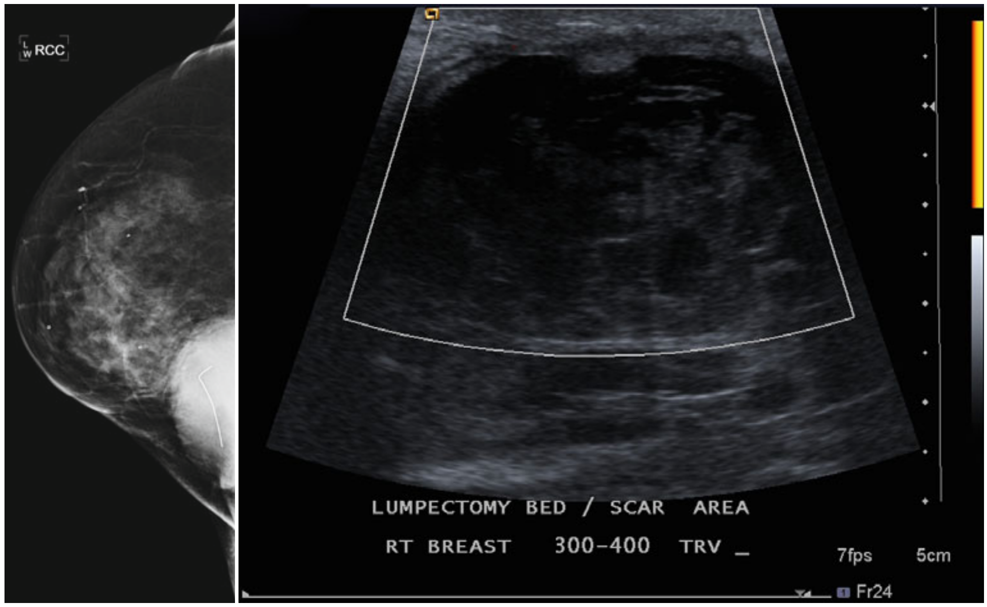


Fig. 16.23 Persistent complex postoperative seroma 2 years after lumpectomy. Hyperdense mass in the posterior inner right breast corresponds to a complex fluid collection visualized in the area of the lumpectomy scar on ultrasound. The fluid collection is decreased in size from prior exams but will likely persist on future mammograms

therefore is likely to decrease breast cancer mortality from a second primary tumor. Imaging plays a fundamental role in monitoring breast conservation patients for recurrence and, in combination with clinical history and physical exam, is an important part in optimal surveillance for breast cancer recurrence. It is estimated that 35–50 % of local recurrences will be detected with mammography in the absence of physical findings [24]. Evaluating mammograms in sequence and comparing the current mammogram to not only the prior year but also to mammograms going back several years is critical for detecting subtle findings of recurrence. The goal of surveillance is to detect recurrences at an early time point in order to initiate therapy to improve survival and to maintain a high quality of life.

Tumor recurrence can occur locally (ipsilateral treated breast), regionally (ipsilateral lymph nodes), or as a distant metastatic disease. Local tumor recurrence in the ipsilateral breast 5 years after breast-conserving therapy occurs in approximately 7 % of patients with whole breast irradiation and 26 % of patients without whole breast irradiation [25]. Most recurrences occur in the lumpectomy bed, and positive pathologic margins, younger age, higher grade tumor, larger tumor size, negative estrogen receptor status, and involvement of axillary lymph nodes have all been reported to increase the risk of ipsilateral breast tumor recurrence [25–28]. The development of pleomorphic, heterogenous, or linear calcifications, new masses, or skin thickening or increases in size or density of architectural distortion on mammography may indicate breast cancer recurrence and should prompt biopsy (Figs. 16.24a–c, 16.25a, b, 16.26a, b, 16.27a–c, 16.28a, b, 16.29a, b, 16.30a–c, 16.31a, b, and 16.32a, b).

Tumor recurrence rarely occurs in the first 2 years following treatment [18]. Changes in the mammogram in that time are more likely alterations from benign processes. Tumor recurrence in the postoperative site or quadrant peaks at a rate of 2.5 % between 2 and 6 years after breast conservation therapy. Recurrent cancers at the original tumor site usually result from failure to eradicate the original cancer and usually occur sooner than tumor developing elsewhere in the breast. Recurrence more than 10 years after therapy will more likely occur outside the treated area and likely represent new malignancies. Recurrent tumor is usually treated with salvage mastectomy. However, if the patient did not undergo radiation therapy in their initial therapy, surgical re-excision with subsequent radiation is a possible alternative.

Breast cancer in the contralateral breast of women with known history of breast cancer may represent a new primary or a metastasis from the original breast cancer (Figs. 16.33a–d, 16.34a–d, and 16.35a–c). Cancer with different pathology from the original cancer or a cancer with an associated in situ component is classified as new primaries. The risk for a metachronous, contralateral second primary breast cancer is estimated at 0.5–1.0 % per year [29]. Factors that increase the risk include a known BRCA1 or BRCA2 mutation, young age at first primary, family history of breast cancer, lobular histology for first primary breast cancer, and prior radiation exposure [30–32]. Treatment of estrogen-positive primary cancers with tamoxifen can decrease risk for contralateral breast cancer by 50 % [25]. Adjuvant endocrine therapy trials incorporating an aromatase inhibitor document an even greater reduction in the occurrence of contralateral breast cancer [33]. Knowledge of the receptor status of the patient's original tumor and possible subsequent endocrine therapy can be helpful to breast imagers in the pretest probability assessment for risk for recurrent disease.

Calcifications are an important marker for new or recurrent cancer following lumpectomy. Up to 43 % of mammographically detected cases of recurrent cancer manifest as microcalcifications [34]. The presence of pleomorphic calcifications is concerning for recurrent or residual malignancy and biopsy should be performed. In general, increasing microcalcifications in the lumpectomy bed are worrisome for breast cancer recurrence, unless the calcifications are increasing in coarseness as would be seen in fat necrosis or dystrophic calcifications. Ultrasound is limited in the evaluation of calcifications and therefore is not recommended as the primary imaging method to evaluate for recurrence. Although sonography alone is not recommended as the primary means of evaluation for recurrence, sonography can be a useful adjunctive study for supplemental screening [35].

Some patient present with perceived changes in their lumpectomy bed. The patient may describe the scar becoming more firm or larger. Usually these subjective changes are due to scar tissue or fat necrosis. If evaluation with mammography and ultrasound fails to demonstrate interval change, evaluation with breast MRI may be helpful in discriminating postsurgical scarring from recurrent tumor at the lumpectomy site [36].

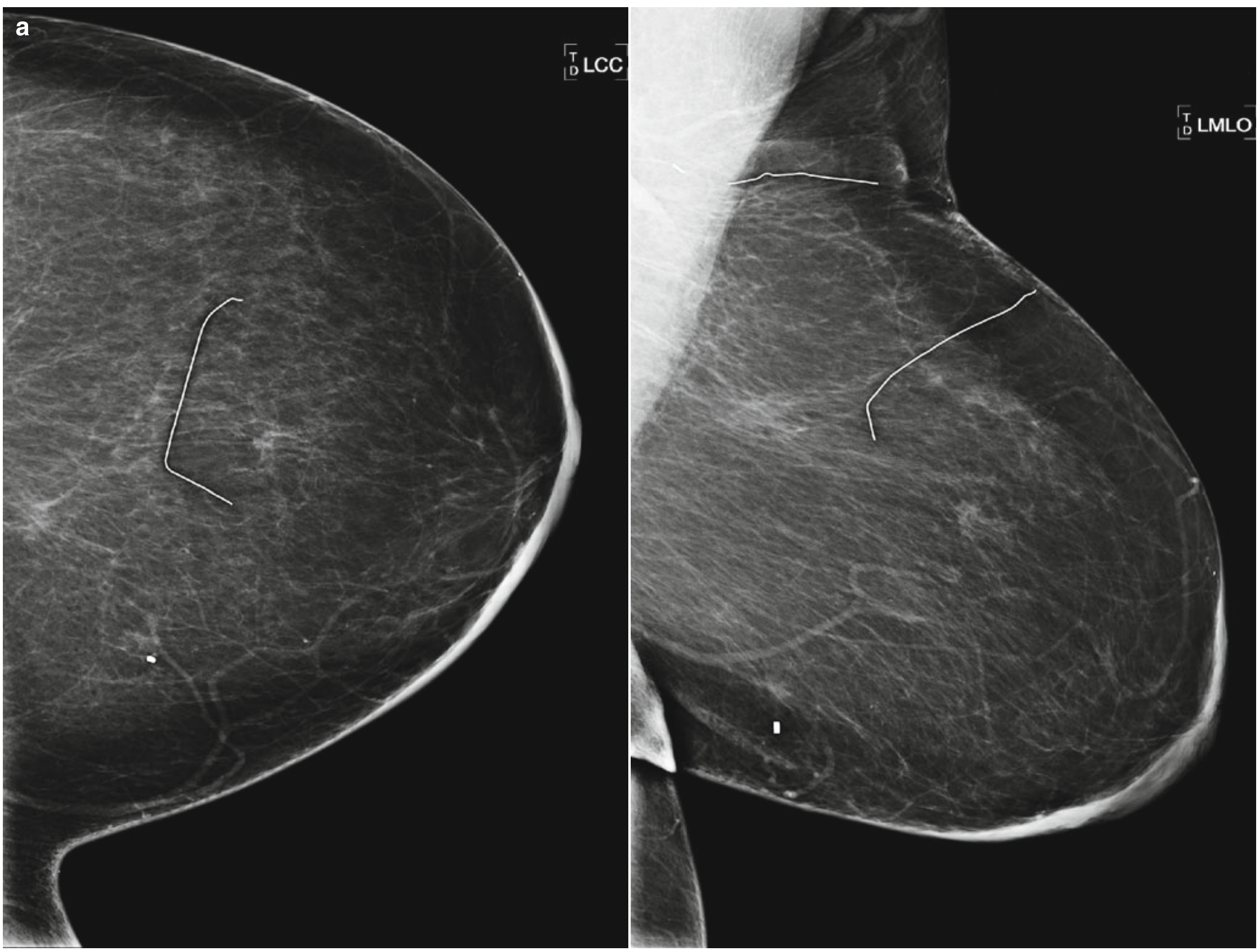
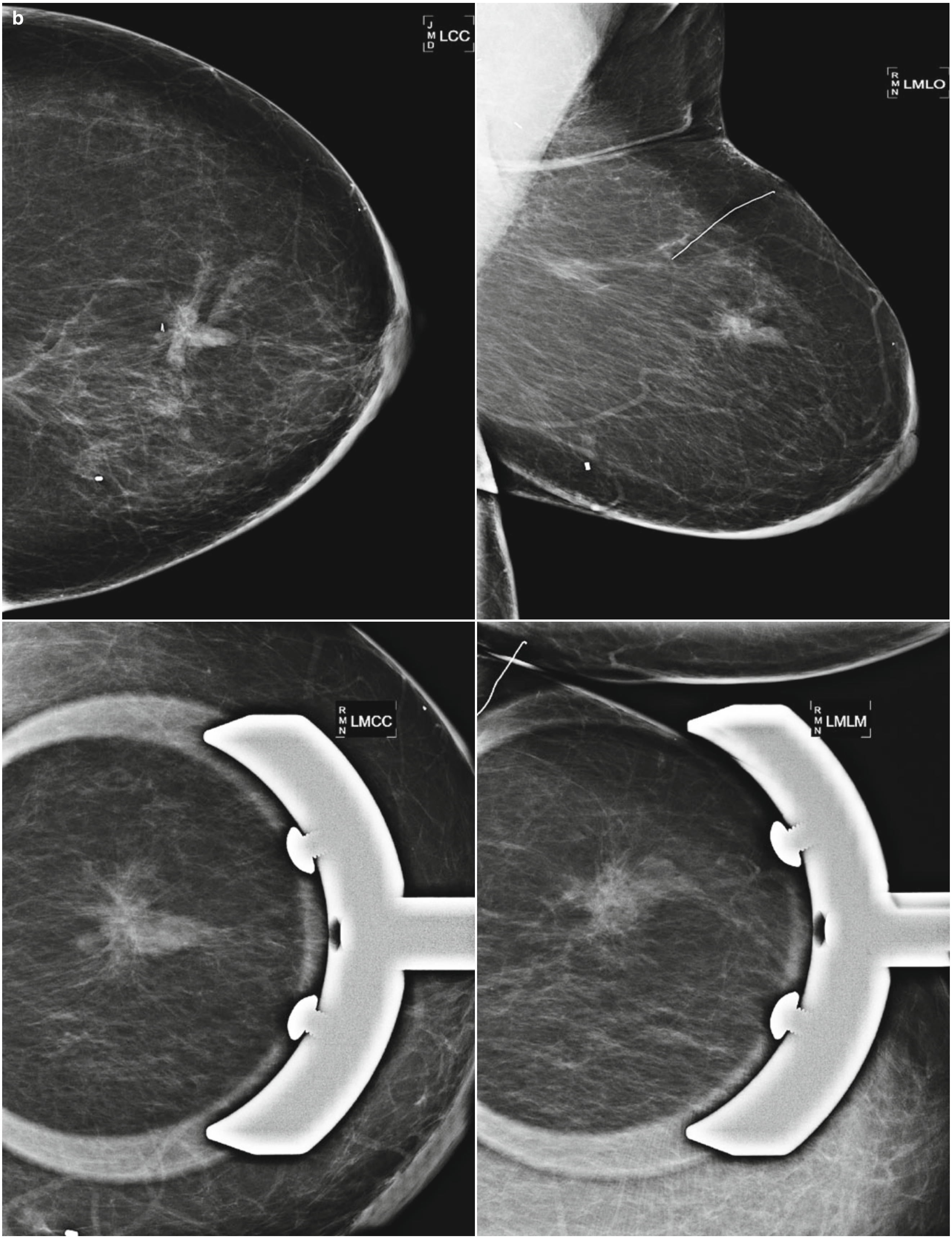


Fig. 16.24 (**a**) 8 years post left lumpectomy for a 5 mm invasive lobular carcinoma and no positive axillary lymph nodes. Following surgery and XRT, the patient took 5 years of tamoxifen. Stable postsurgical changes in the upper central breast. A small asymmetry in the mid upper central breast was unchanged from multiple prior exams. (**b**) Nine years post lumpectomy. Interval development of a high-density spiculated mass in the upper central breast. (**c**) 3 cm anterior to the lumpectomy scar, a 1.1 cm irregular hypoechoic mass with spiculated margins corresponds to the mass seen on mammography. US-guided biopsy yielded infiltrating lobular carcinoma with focal pleomorphic features. The patient underwent left mastectomy



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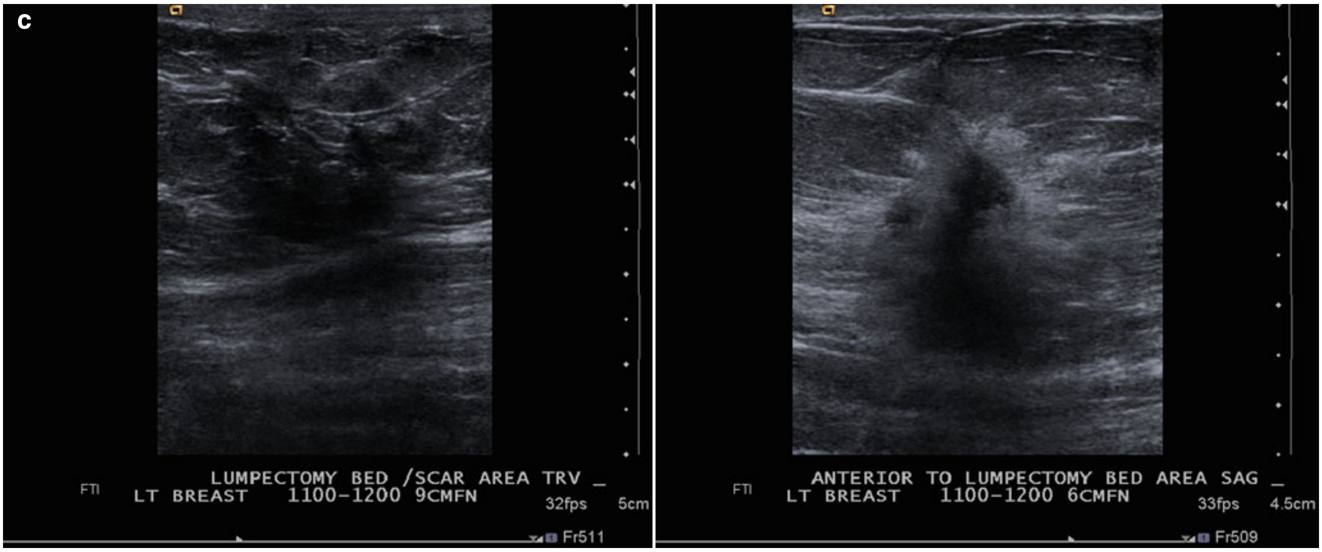

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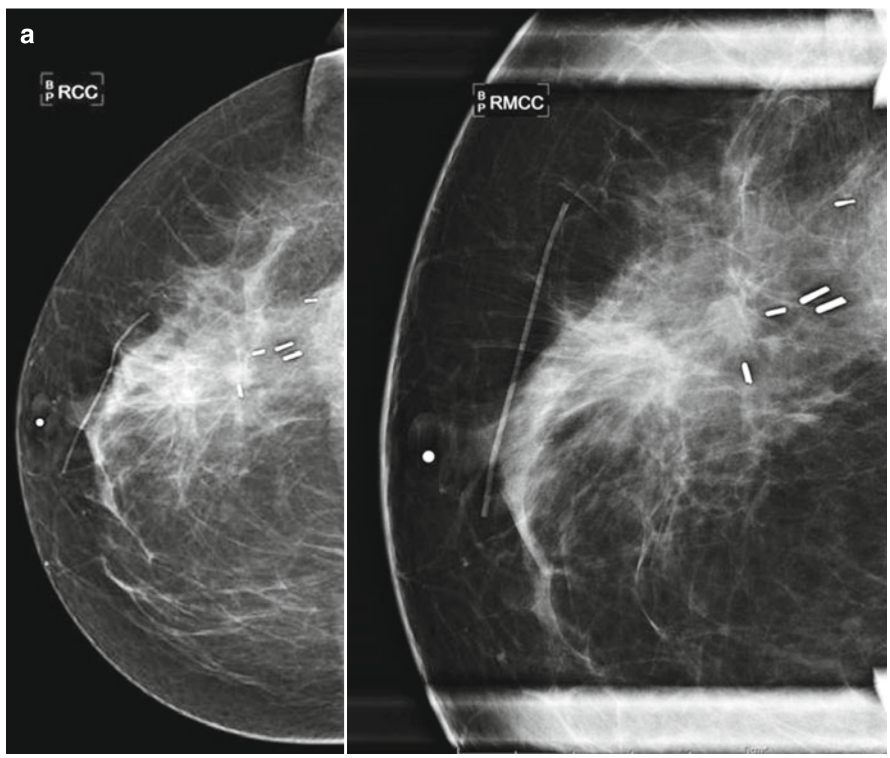


Fig. 16.25 (**a**) 6 months post lumpectomy. An 8 mm mass is visualized in the lumpectomy bed. (**b**) US demonstrates a corresponding irregular solid mass. Biopsy yielded invasive carcinoma. Biopsy yielded invasive carcinoma

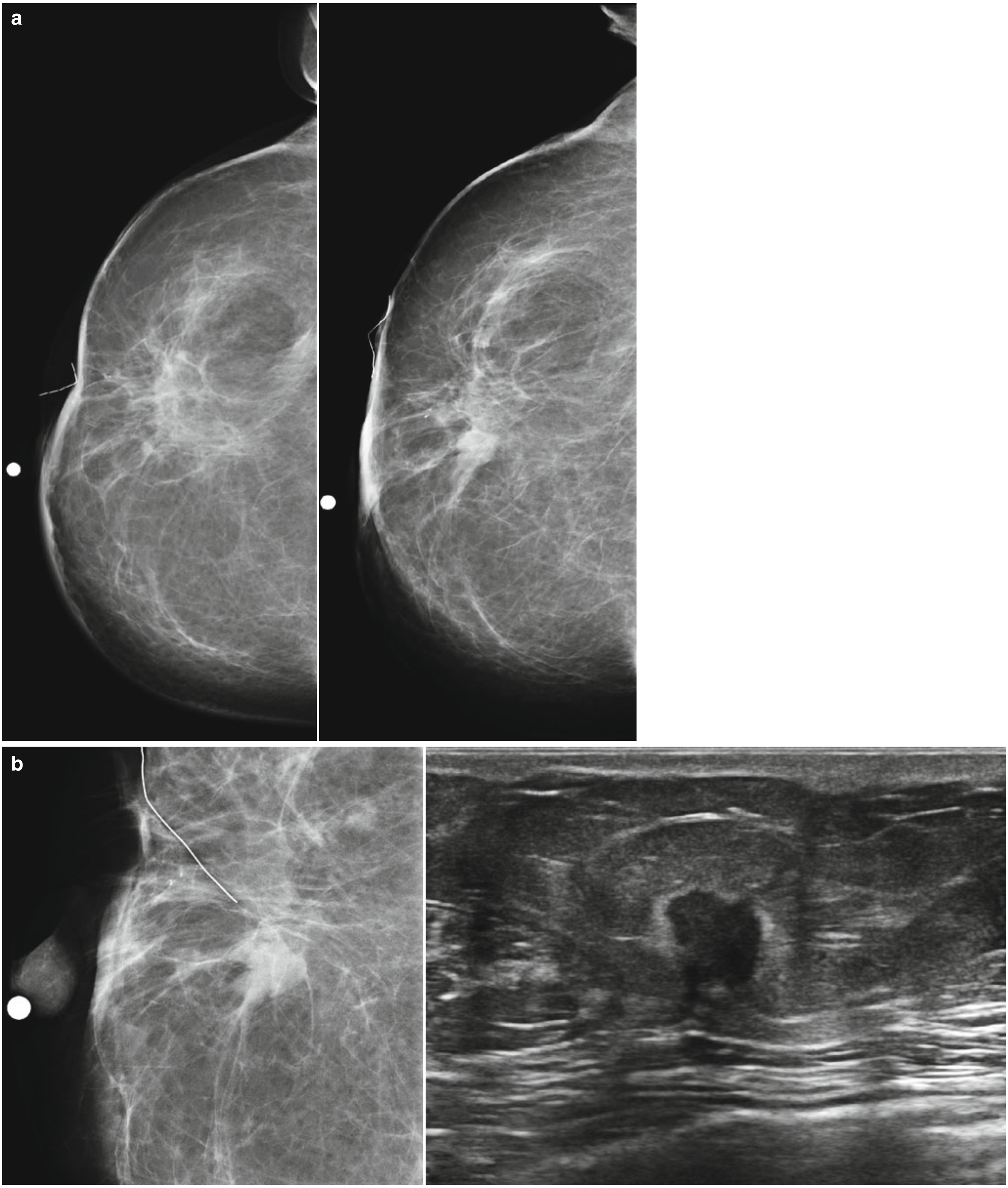


Fig. 16.26 (**a**) Right breast recurrence: Mammogram on the left was performed 3 years after lumpectomy. Mammogram on the right was performed 5 years after lumpectomy and demonstrates a new 1 cm spiculated mass in the central breast. (**b**) Spot magnification views and ultrasound demonstrate suspicious spiculated margins to the mass. US-guided core needle biopsy was performed with pathology of invasive carcinoma. The patient declined radiation therapy at the time of her lumpectomy and thus was a candidate for lumpectomy and radiation therapy for the recurrence

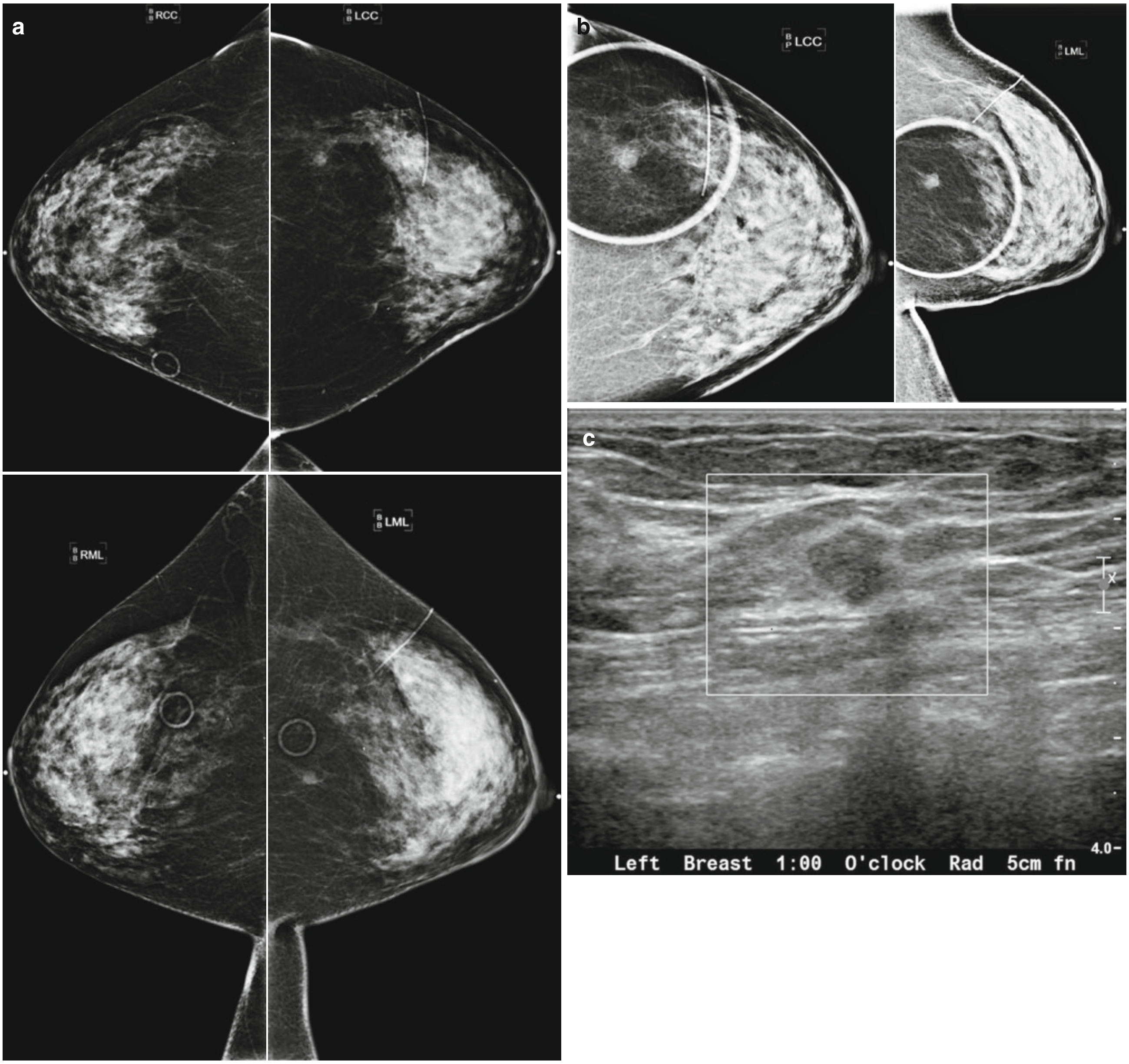


Fig. 16.27 (**a**) A 72-year-old female status post left lumpectomy for DCIS 1 year prior. (**b**) Spot magnification views confirm a new mass in the posterior upper outer left breast. (**c**) A corresponding 8 mm solid mass is seen on ultrasound. Biopsy yielded invasive carcinoma

Postmastectomy

Mastectomy is the surgical removal of the entire breast tissue. This is performed in women with breast cancer who cannot be adequately treated with breast conservation therapy or in women who prefer this method for treatment of their cancer. Also, women who have a high risk for developing breast cancer such as BRCA 1 and BRCA 2 carriers can opt to have prophylactic mastectomies. The risk of developing a breast malignancy is significantly reduced but not entirely eliminated in patients who undergo prophylactic mastectomy or any mastectomy for that matter, because a small amount of residual breast tissue remains. The lack of a distinct boundary between the breast and adjacent adipose tissue makes the removal of all breast tissue difficult [37].

Mastectomy Without Reconstruction

The type of mastectomy performed depends on the clinical scenario. A simple or total mastectomy involves the removal of only breast tissue including the nipple–areolar complex.

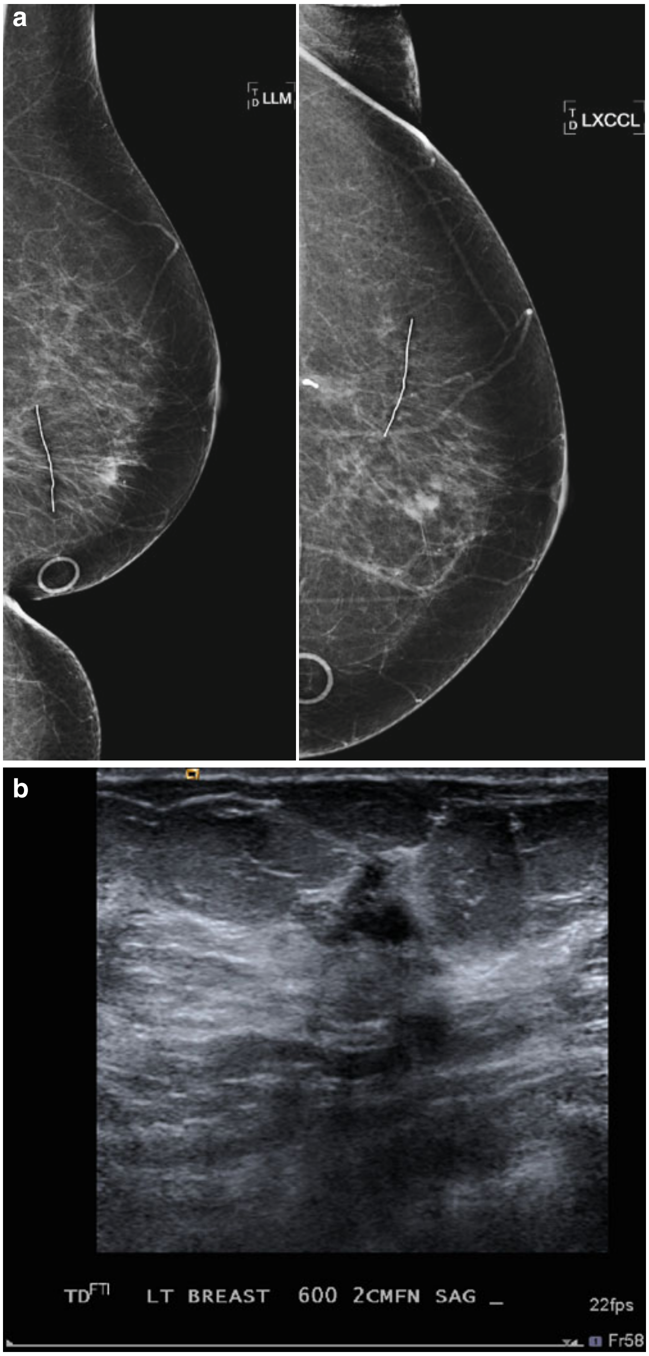


Fig. 16.28 (**a**) 10 years post lumpectomy. New 1 cm mass in the mid lower central left breast. (**b**) 1.1 cm corresponding hypoechoic mass on US. Biopsy yielded infiltrating mammary carcinoma

No removal of lymph nodes or pectoralis muscle occurs (Fig. 16.36a–d). A modified radical mastectomy involves the removal of breast tissue and nipple–areolar complex and an axillary dissection involving the removal of level I and II axillary lymph nodes (Fig. 16.37). A similar but more extensive rarely performed procedure due to its deforming nature and lack of impact on survival is the radical or extended mastectomy. Here, level I, II, and III lymph nodes and the pectoralis muscle are removed. A portion of the pectoralis muscle may be resected in a simple or modified mastectomy, if there is evidence of tumor invasion [38].

Mastectomy with Reconstruction

A woman who undergoes a mastectomy not only has to deal with the emotional and physical consequences of treatment but also the psychological impact of losing her breast. Patients who have had a mastectomy can choose to use an external prosthesis or have a reconstruction [39]. Continued improvement and advancement in the field of microsurgery provides women with choices when it comes to having a mastectomy with reconstruction. A woman can now have a mastectomy with reconstruction using her own tissue (autologous) to create a neobreast similar in appearance and even touch to her native breast. A woman can also choose to have a reconstruction with a breast prosthesis such as with a silicone or saline implant or with both autologous tissue and implants [38]. Studies have shown that having a mastectomy with breast reconstruction does not change survival compared with a simple mastectomy [40, 41].

Types of Autologous Reconstruction

For women who prefer to use their own tissue, the most standard method is through the transplantation of a transverse rectus abdominis myocutaneous (TRAM) flap into the mastectomy bed. This method provides a neobreast which is similar to the native breast in texture and appearance and is often referred to as the "tummy tuck" reconstruction. In this procedure, an autologous myocutaneous flap consisting of abdominal skin, subcutaneous fat, the rectus abdominis muscle (dual blood supply via the superior and inferior epigastric arteries), and adjoining vasculature is used for reconstruction following mastectomy. Since its introduction by Hartrampf et al. in 1982, refinements have been made to the basic technique including the pedicled, free, and delayed flap reconstruction [42, 43]. The two major technical variants of the TRAM flap include the pedicled flap which uses the superior epigastric vessels and the microsurgical free flap which uses the more robust inferior epigastric vessels. The pedicle TRAM flap requires the full length of the rectus abdominis muscle. The muscle along with its overlying lower abdominal skin and subcutaneous tissue are elevated and tunneled subcutaneously into the mastectomy defect. A portion of the skin overlying the mastectomy defect will then become the surface of the newly created neobreast. In a unilateral breast reconstruction, the contralateral muscle is used, and in cases of bilateral reconstructions, the ipsilateral rectus abdominis muscle is used to prevent vascular compromise due to crossing of the pedicles [43].

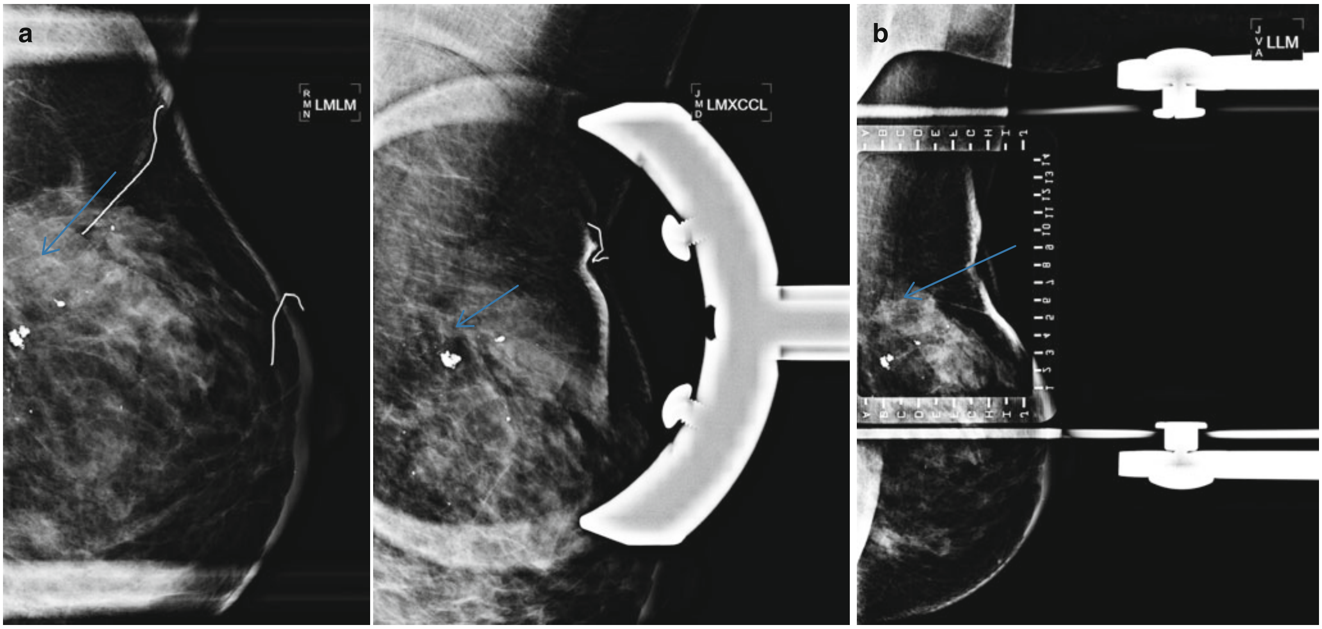


Fig. 16.29 (**a**) Left lumpectomy 3 years prior. New heterogenous calcifications are seen in the posterior aspect of the lumpectomy bed on the spot magnification views. (**b**) Localization picture for stereotactic biopsy. Pathology demonstrated ductal carcinoma in situ, atypical ductal hyperplasia

Continued improvement in microsurgical techniques led to the development of the free TRAM flap technique. This procedure utilizes the more robust inferior epigastric vasculature which is reanastomosed to the internal mammary, thoracodorsal, or subscapular vasculature. The establishment of a direct anastomosis offers a better and more predictable perfusion. Also, since only a small portion of the rectus abdominis muscle is utilized, the risk of abdominal wall hernias is decreased [43–45].

Expansion of the free tissue concept led to the development of additional flap options for autologous breast reconstruction, namely, the latissimus dorsi myocutaneous flap, based on the thoracodorsal vasculature. This reconstruction is often performed with an implant. Other flaps include the gluteal free flap, based on the inferior gluteal or superior gluteal vessels, and the lateral thigh flap which overlies the tensor fascia lata muscle with blood supply from the lateral femoral circumflex, which is long enough to be anastomosed with the axillary vessels. This flap has a low incidence of fat necrosis. The Rubens flap overlies the peri-iliac region and is supplied by the deep circumflex vessels [45, 46].

The development of perforator flap techniques added even more to the armamentarium of options for autologous breast reconstruction. The main idea here is to eliminate the harvesting of muscle entirely by establishing perfusion to a skin paddle from a single dominant perforating vessel. Although, donor site morbidity is minimized, procedure time is prolonged; therefore, appropriate patient selection matters. The deep inferior epigastric (DIEP) technique is a perforator flap technique applied to a TRAM flap. This procedure uses the lower abdominal skin and subcutaneous tissues with complete sparing of the rectus abdominis muscle. The internal mammary vessels are the preferred site of anastomosis. The DIEP flap is of tremendous benefit when a bilateral reconstruction is performed due to minimal disruption of the abdominal wall which precludes the use of an abdominal mesh and a lower incidence of abdominal wall bulges and hernias [45, 47]. The superior gluteal artery perforator (SGAP) is an additional surgical application or the perforator flap principle. The long length of the vascular pedicle and low incidence of donor site morbidity make this a good choice for autologous breast reconstruction. The superficial inferior epigastric artery (SIEP) flap is another perforator flap technique which is supplied by the superficial system. The idea behind this technique is to eliminate the need to harvest not only muscle but also the deeper vasculature. However, the unpredictable perfusion secondary to size and length of the pedicle makes this "idyllic" technique not a commonly utilized one [45].

Reconstruction with Prosthesis

If a woman does not wish to undergo autologous reconstruction, the use of breast prosthesis with a silicone or saline breast implant is an option. The benefits of this option are no additional sites of scars elsewhere in the body and no flap or donor-site complications. There is greater flexibility in determining breast size and postoperative recovery is often shorter. Reconstruction with prosthesis is often a better choice for a patient requesting reconstruction, but not having sufficient

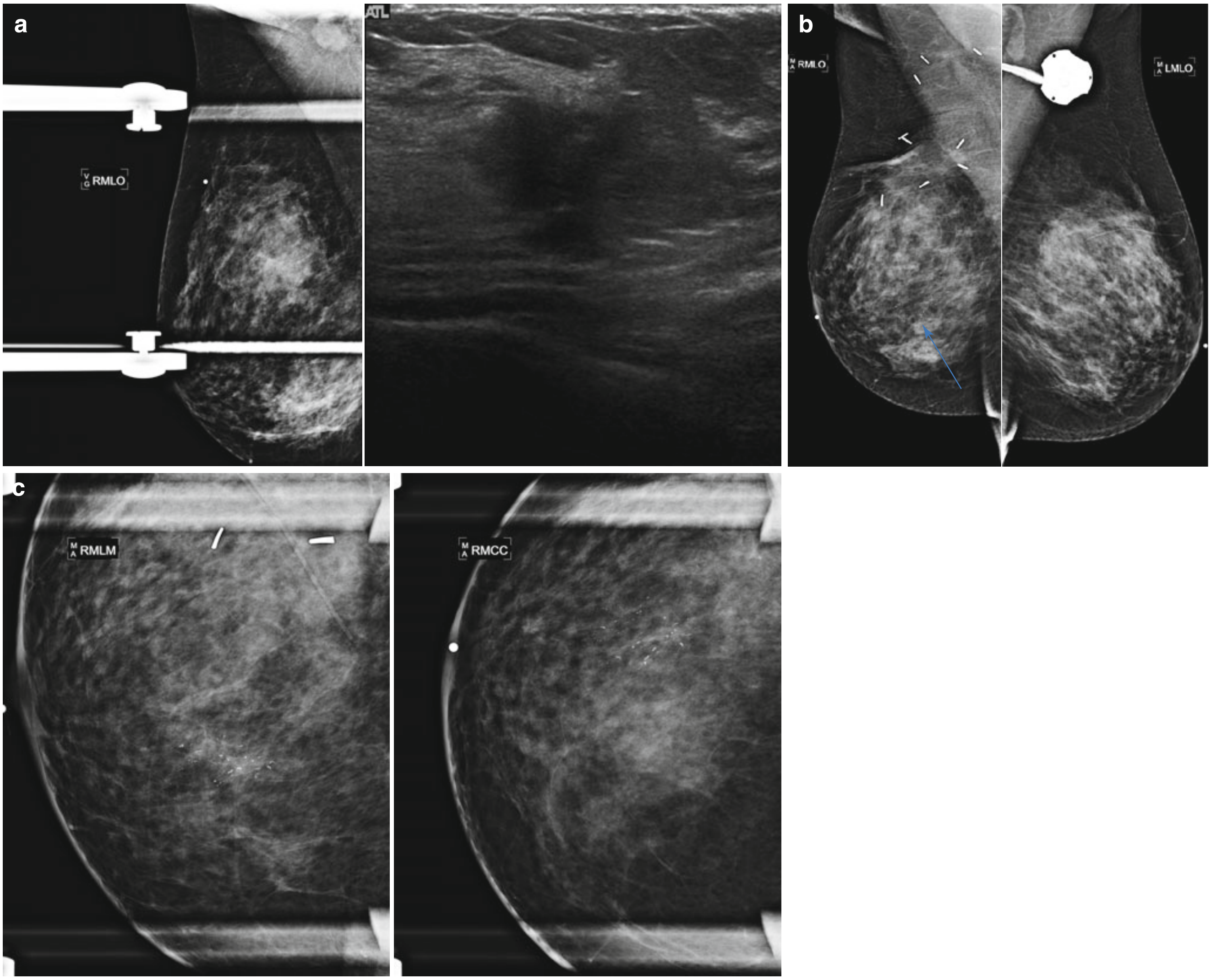


Fig. 16.30 (**a**) A 42-year-old female present with palpable abnormality in the right breast. Note prominent right axillary lymph node. US demonstrates a corresponding suspicious 1.5 cm mass. Biopsy demonstrated IDC. The patient underwent right lumpectomy and XRT. (**b**) 6 months following lumpectomy: post-lumpectomy changes are seen in the mid-posterior upper outer right breast. In the central right breast, pleomorphic calcifications span 6 cm. A scar marker overlies the upper outer left breast at the site of prior excision of a fibroadenoma. A left-sided Port-A-Cath is present. (**c**) Spot magnification views: linear branching calcifications are now seen in the mid central breast. DCIS was found at biopsy

autologous tissue for reconstruction or with comorbid medical conditions (Figs. 16.38 and 16.39). The surgery can be performed in one stage or as a two-stage operation. A two-stage surgery is often performed if there is a concern of skin viability or if the patient is requesting an increase in breast size. If performed in two stages, a tissue expander is first placed into a musculofascial pocket which consists of the pectoralis major and serratus anterior muscles. Expansion with saline is then performed periodically in an outpatient setting as the patient tolerates until the desired breast size is achieved. The tissue expander is then exchanged and replaced with an implant. With the increase use of nipple-sparing mastectomies, the one-stage approach is becoming more common [38, 44].

During breast reconstruction, the nipple–areolar complex (NAC) is sacrificed, and reconstruction of the NAC is the last stage of reconstruction. This can be performed with local flaps (contralateral nipple, inner thigh) or a tattoo [38]. With any reconstruction, the contralateral breast may require a reduction mammoplasty, a mastopexy, or an augmentation mammoplasty to achieve symmetry.

Multidisciplinary input is necessary when considering breast reconstruction regarding appropriate timing and sequencing of intervention. Factors such as delays in therapy in the setting of locally advanced breast cancer and effects of radiation on the reconstructed breast must be considered.

Nipple- and Skin-Sparing Mastectomy

A new technique which precludes the native nipple–areolar complex (NAC) reduces the prominent scars and the unnatural skin paddle on the breast mound is the skin-sparing mastectomy. A smaller periareolar incision is made, thereby requiring a smaller skin paddle to replace the areolar defect. The natural contour of the breast is preserved once the transfer of the flap takes place. The results are a more aesthetically pleasing appearance which often reduces the need for contralateral asymmetry procedures such as a reduction or a mastopexy. The skin-sparing method has garnered increased popularity due to several studies reporting local recurrence rates equivalent to traditional methods (simple mastectomy without reconstruction). Nipple-sparing mastectomy can be considered in patients with high risk factors undergoing a prophylactic mastectomy or in breast cancer patients with a low risk of nipple involvement and smaller tumor burden away from the nipple. Preoperative imaging is helpful in excluding nipple involvement [45, 48–54].

Complications associated with breast reconstruction include total or partial flap necrosis secondary to vascular compromise, fat necrosis, and donor site complications (abdominal wall hernias and umbilical necrosis). Similar to other patients with implants, there is a risk of implant rupture in patients who undergo reconstruction with implant prosthesis (Fig. 16.40). As with all surgical procedures, bleeding, infection, hematoma, seroma formation, and wound dehiscence can also occur. These risks are increased in patients who smoke, are obese, or have had previous radiation therapy [44]. Therefore, appropriate patient selection is crucial when performing breast reconstructive surgery to improve outcome.

Follow-Up Imaging

A simple mastectomy can be performed without reconstruction and surveillance is not routinely performed. Controversy exists regarding surveillance of a reconstructed breast with some advocating routine screening for early detection of non-palpable recurrent cancer in the reconstructed breast and others patients with TRAM flaps, so as to detect non-palpable lesions early [40]. While others believe that routine screening

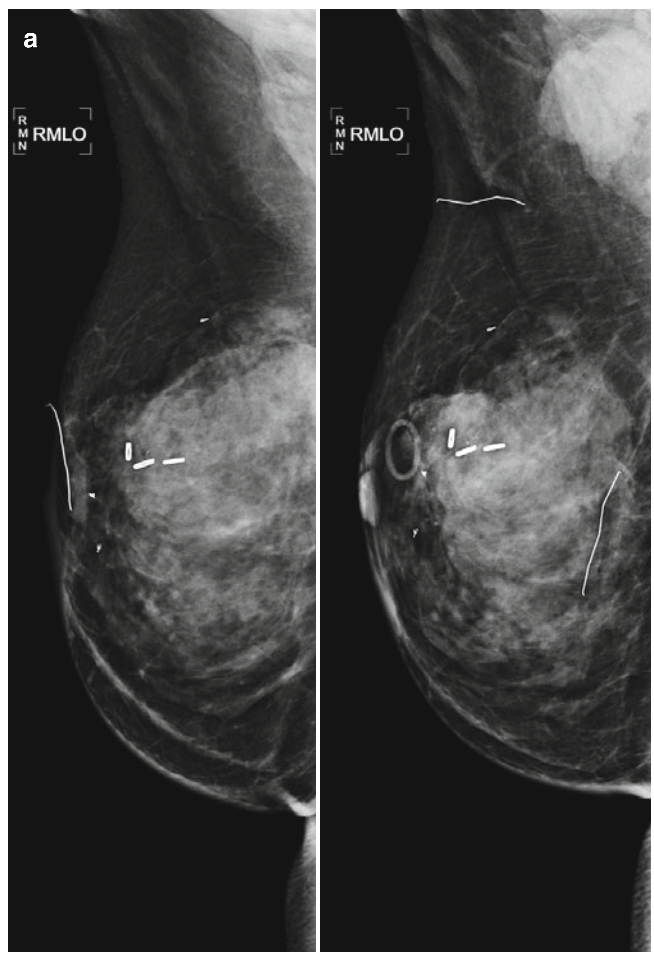


Fig. 16.31 (**a**) 2 years post right lumpectomy (*left*), there was no evidence for recurrent disease. 6 months later, the patient felt a new lump in her right axilla (*right*). (**b**) Spot magnification views of the lumpectomy bed demonstrate pleomorphic calcifications. An ill-defined hypoechoic mass with echogenic foci (calcifications) in the right 12:00 position measures approximately 3.4 cm. In the right axilla, an abnormal lymph node measures 4.4 cm. Biopsy was performed on both masses with pathology of IDC in the breast and metastatic carcinoma in the axilla

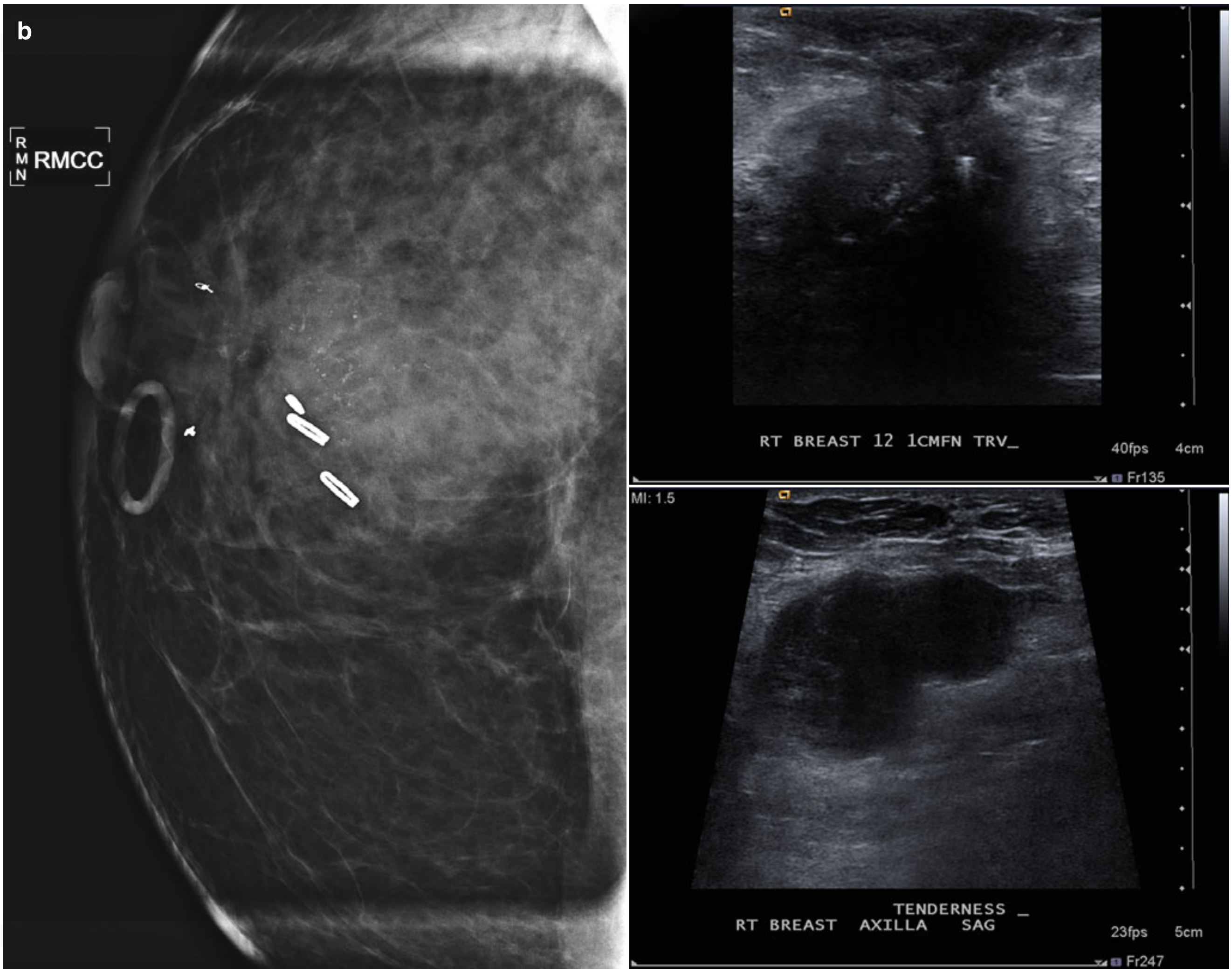


Fig. 16.31 (continued)

is not warranted due to the low incidence of recurrence in the reconstructed breast and low detection rates on mammography and MRI [55, 56]. However, given the increase in the screening of the contralateral breast with MRI in patients with a personal history of breast cancer, an opportunity exists to evaluate the reconstructed breast, chest wall, subcutaneous tissues, and overlying skin regardless of the type of mastectomy since these areas will be in the field of view if a bilateral MRI is performed.

Autologous myocutaneous flaps have a predominantly radiolucent fatty appearance on mammography and the normal fibroglandular tissue and architecture is absent. The nipple–areolar complex is also absent. The muscle pedicle has a varying appearance and can be visible posteriorly on mammography. The transplanted muscle is best seen on the mediolateral oblique view, anterior to the pectoralis muscle (Fig. 16.41). The muscle flap will be absent if a DIEP flap was used. If an LDM flap with partial mastectomy was performed, there might be residual glandular tissue. Common postoperative findings that can be noted on mammography include fat necrosis which may be seen as a lucent mass with surrounding density or curvilinear and dystrophic calcifications typically in the upper outer quadrant of the flap away from the vascular pedicle. Skin thickening, scarring, and surgical clips may also be noted. Recurrent disease will typically be noted on the chest wall and will have suspicious findings similar to the primary malignancy or masses and calcifications with suspicious features requiring further investigation, typically with ultrasound [46, 57].

Ultrasound is a useful modality in the investigation of a palpable area of concern. In a patient with an autologous reconstructed breast, diffuse fatty tissue is noted with absence of fibroglandular tissue. The vascular pedicle may be demonstrated on color Doppler. If close to the postoperative period, fluid collections representing hematomas or seromas may be demonstrated.

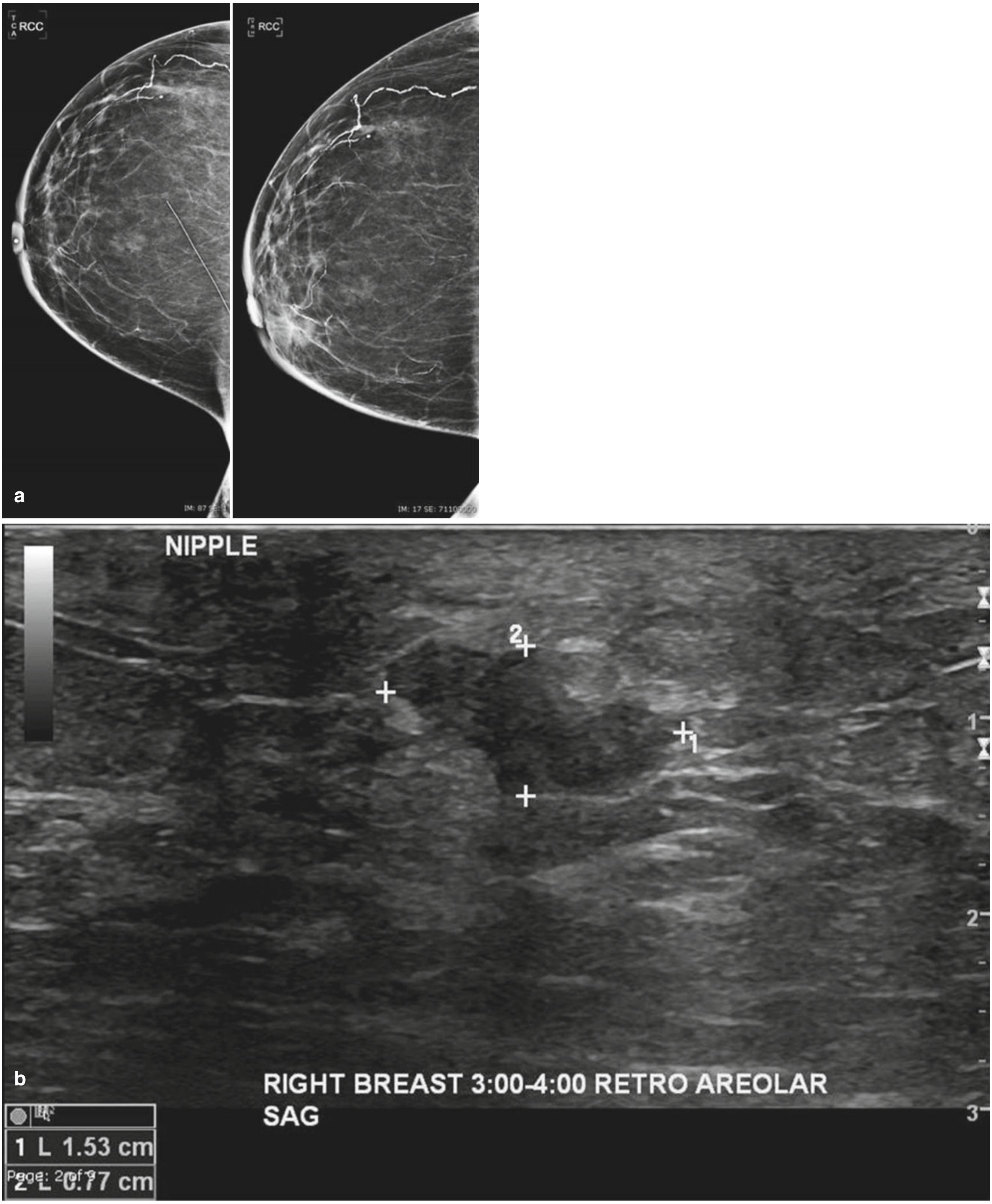


Fig. 16.32 (**a**) Patient is 17 years post lumpectomy. In a 1-year interval, the patient developed increased density and skin thickening in the retroareolar position. (**b**) US demonstrates a 1.5 cm mass with angular margins and skin thickening. Biopsy yielded invasive carcinoma

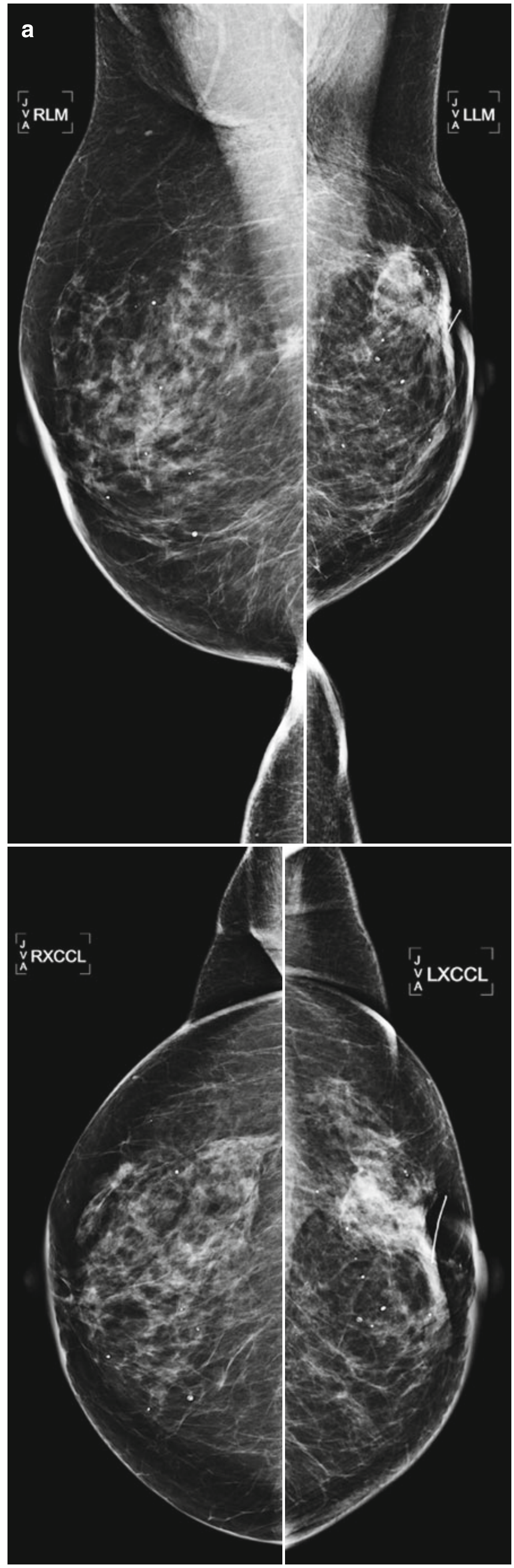
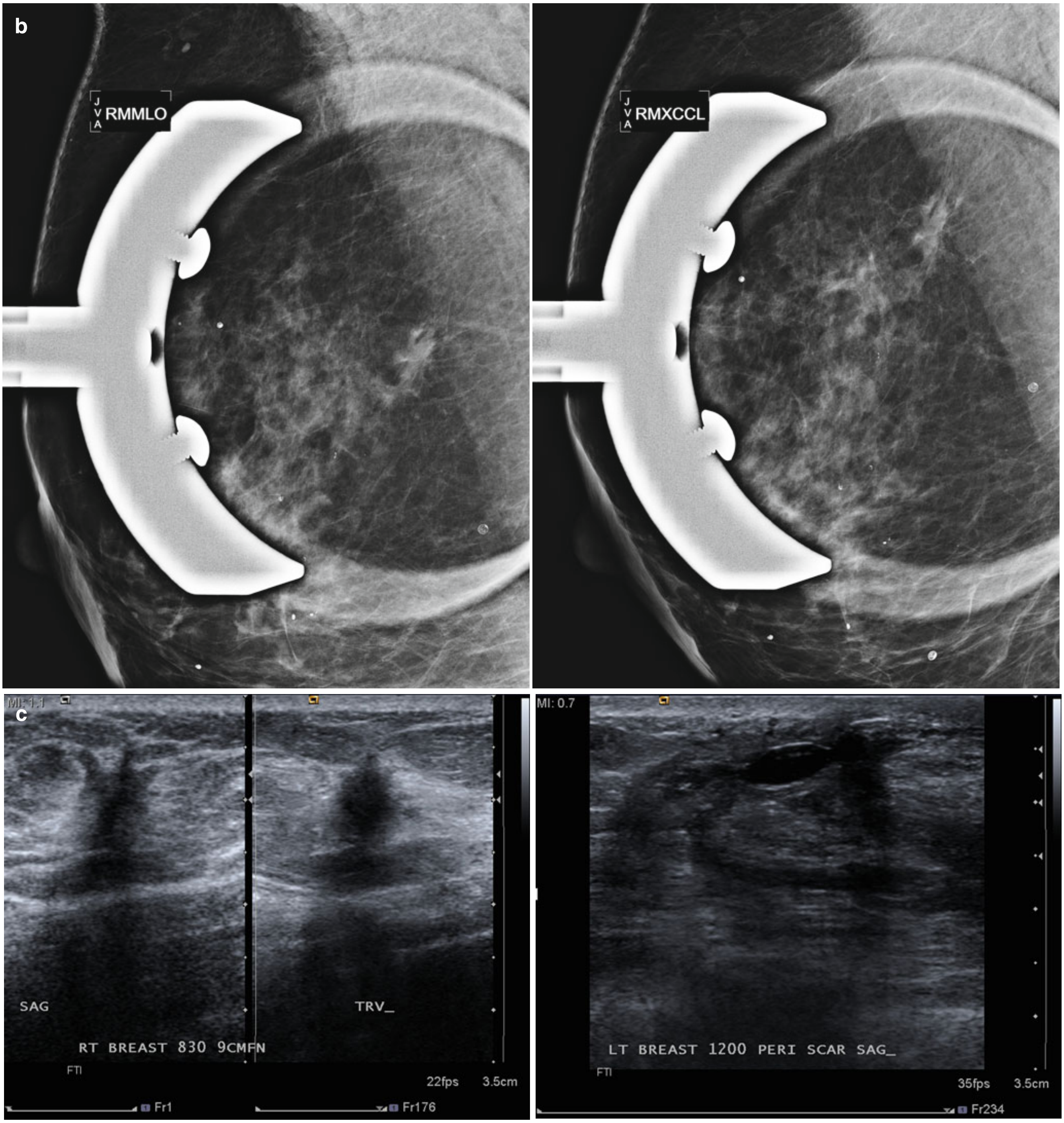


Fig. 16.33 (**a**) Left lumpectomy 11 years prior. Post-lumpectomy changes in the upper outer left breast. A new 1 cm asymmetry is visualized in the posterior upper outer right breast. (**b**) Spot magnification views of the asymmetry in the far posterior breast. (**c**) A corresponding 1.1 cm hypoechoic mass is identified in the right posterior breast on US. Note is also made of residual fluid in the left lumpectomy bed. Biopsy of the right breast mass had pathology of invasive ductal carcinoma. The patient opted for bilateral mastectomies. (**d**) 1 year following surgery, the patient presented with a new palpable abnormality in the far lateral right chest wall. A corresponding 1.4 cm hypoechoic mass was visualized with similar pathology and biomarkers as the prior right breast cancer



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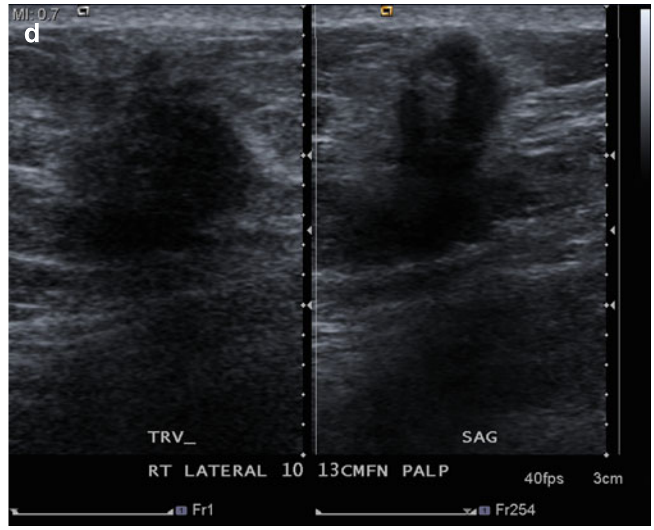
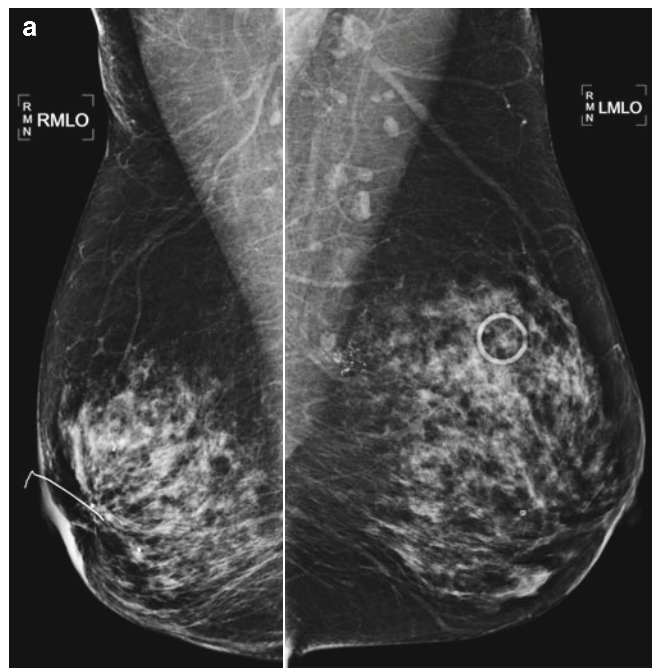
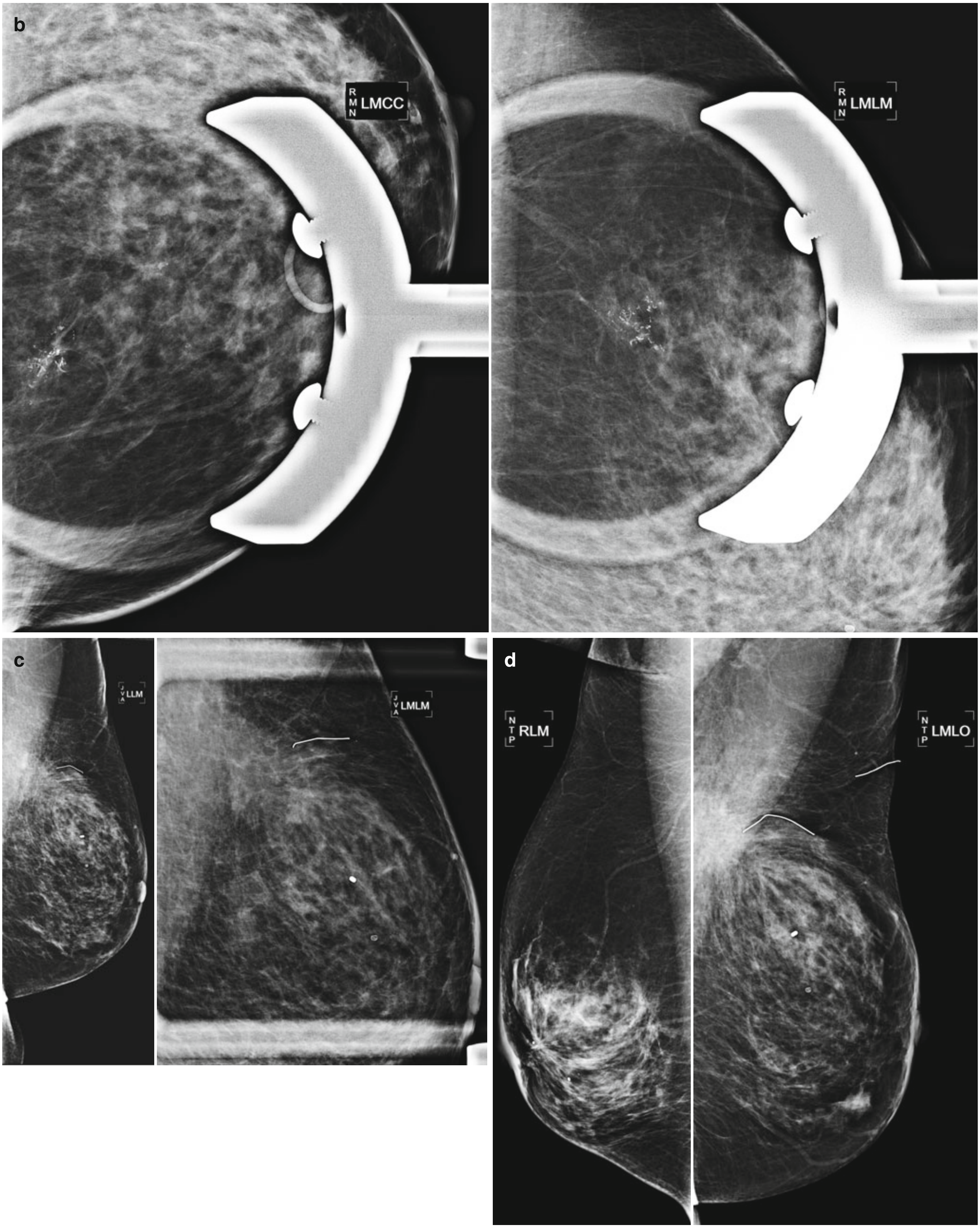


Fig. 16.34 (**a**) 7 years post right lumpectomy. New heterogenous calcifications are visualized in the posterior upper left breast. (**b**) Spot magnification views. Stereotactic biopsy demonstrated in situ carcinoma. (**c**) 6-month follow-up after lumpectomy demonstrates no residual suspicious calcifications in the lumpectomy bed. (**d**) 1 year post left lumpectectomy. Expected post surgical changes are present in the posterior upper outer left breast and right retroareolar position (8 years following surgery). *Note*: Asymmetric glandular tissue in the anterior inferior left breast is stable from prior mammogram





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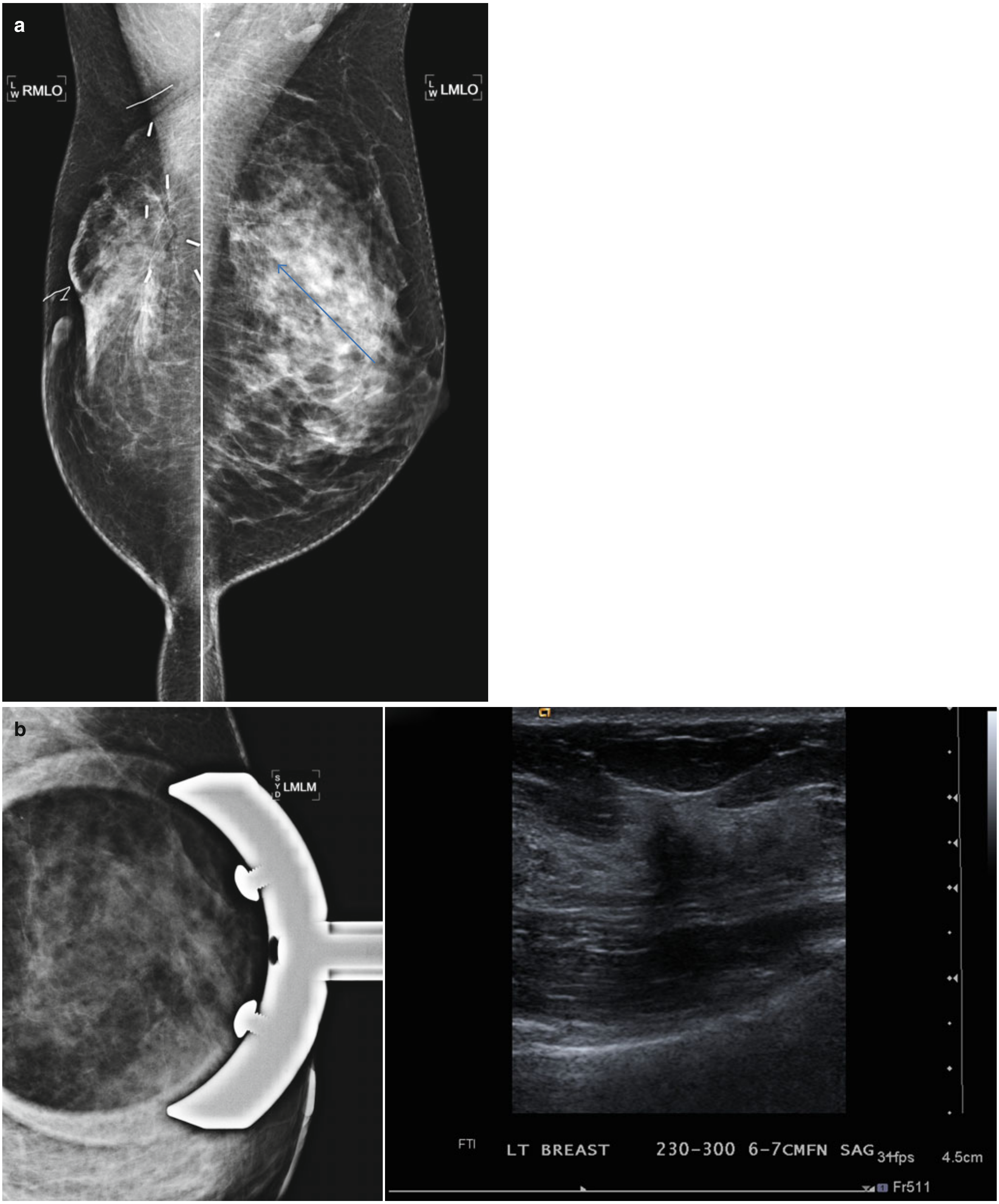

Fig. 16.35 (**a**) 6 years post right lumpectomy for 1.5 cm tubular carcinoma. Stable post-lumpectomy changes on the right. New subtle architectural distortion is seen in the posterior upper left breast. (**b**) The area is less prominent on spot compression views. However, a 1.2 cm suspicious mass is identified with ultrasound. Pathology was IDC with focal lobular growth pattern. (**c**) Post-contrast subtraction MRI images: in addition to the cancer in the posterior upper left breast, multiple additional abnormal enhancing masses extending anterior from the known cancer are seen on MRI. The total area of abnormal enhancement measures 6.2 cm. There was no evidence for recurrent disease in the right breast

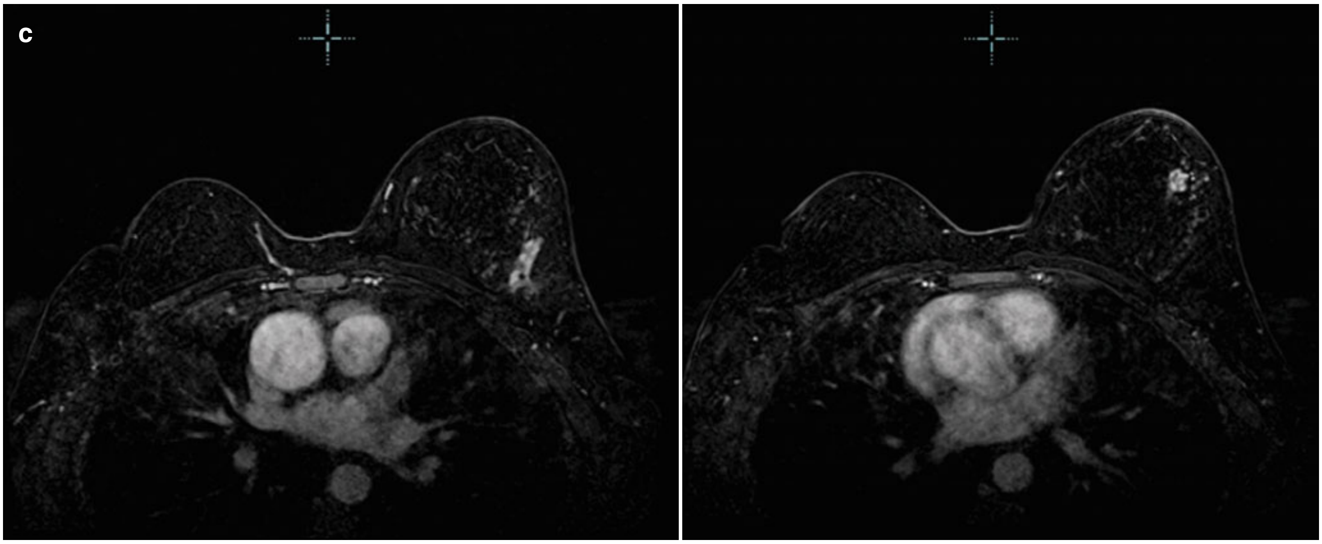

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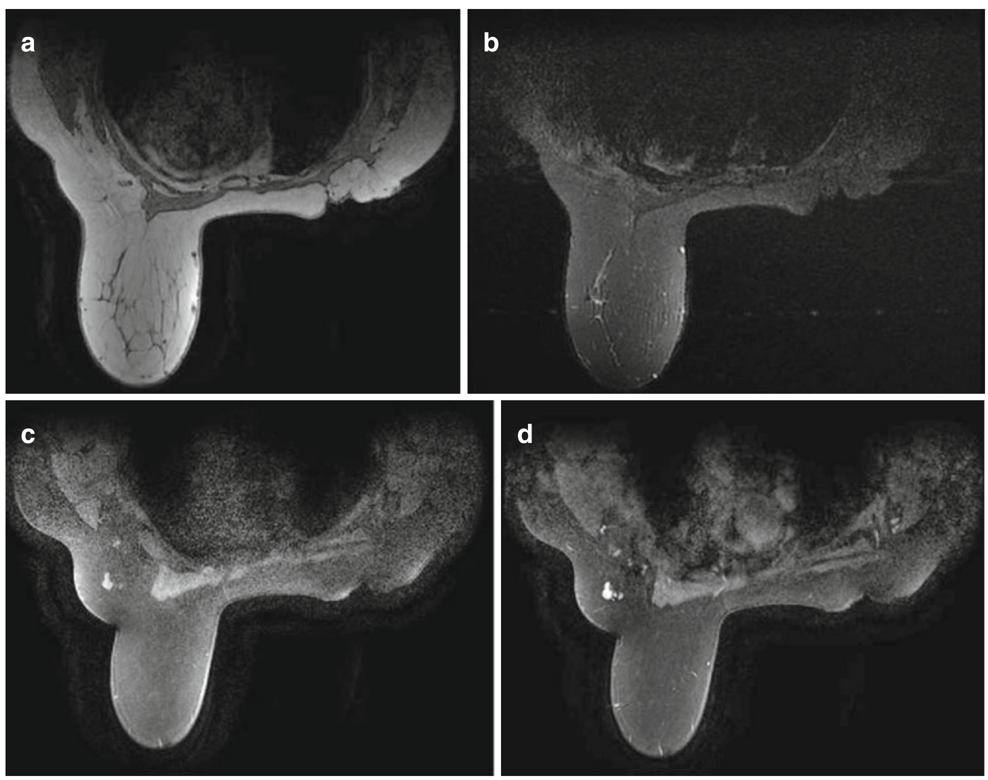
Fig. 16.36 (**a**–**d**) Simple mastectomy. Axial images from a bilateral breast MRI T1 weighted (**a**), T2 weighted (**b**), TI with fat saturation (**c**), and T1 with fat saturation and contrast enhancement (**d**) demonstrate evidence of an absent left breast with susceptibility artifact along the left chest wall consistent with a history of a simple (total) mastectomy



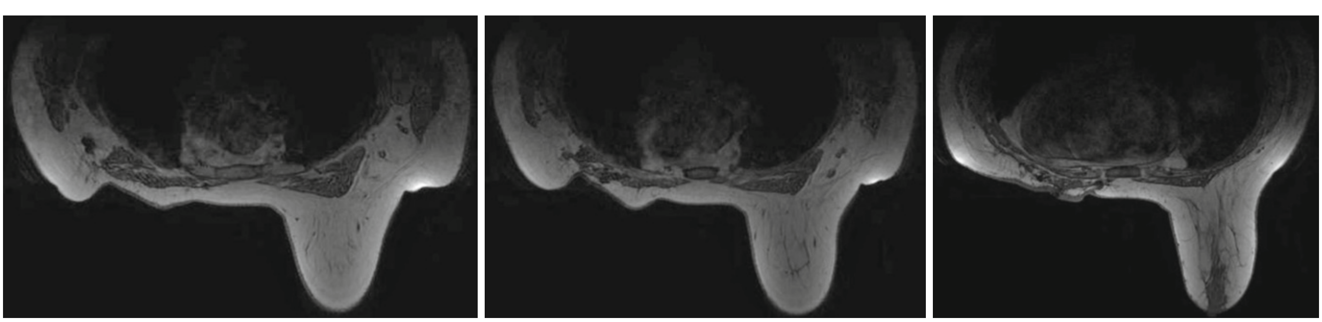


Fig. 16.37 Simple mastectomy with dissection. T1-weighted axial images from a bilateral breast MRI demonstrate evidence of an absent right with susceptibility artifact along the right chest wall and right axilla consistent with a history of a modified radical mastectomy

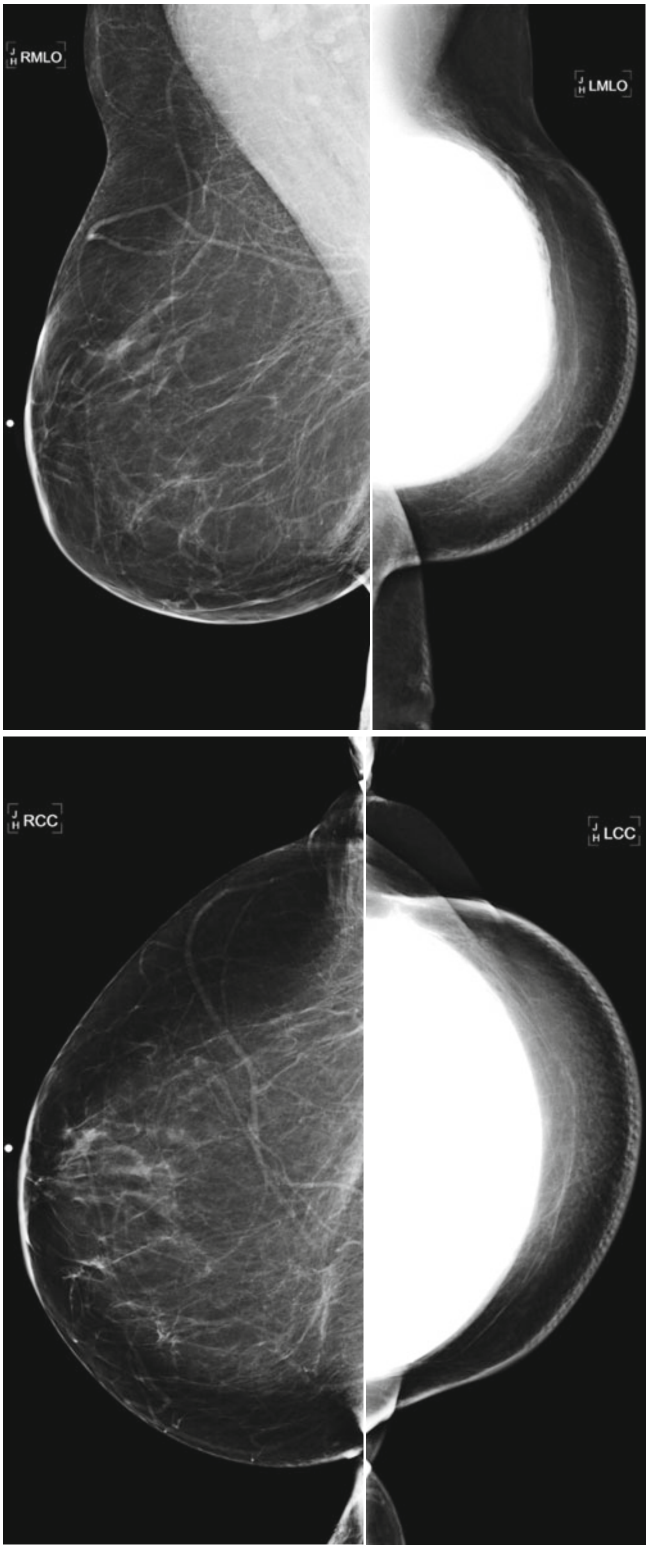


Fig. 16.38 Silicone implant reconstruction. Normal appearance of mastectomy with silicone implant reconstruction. Bilateral craniocaudal (*top*) and mediolateral oblique (*bottom*) images demonstrate evidence of a left mastectomy with silicone implant reconstruction. There is paucity of normal fibroglandular tissue in the reconstructed breast (*)

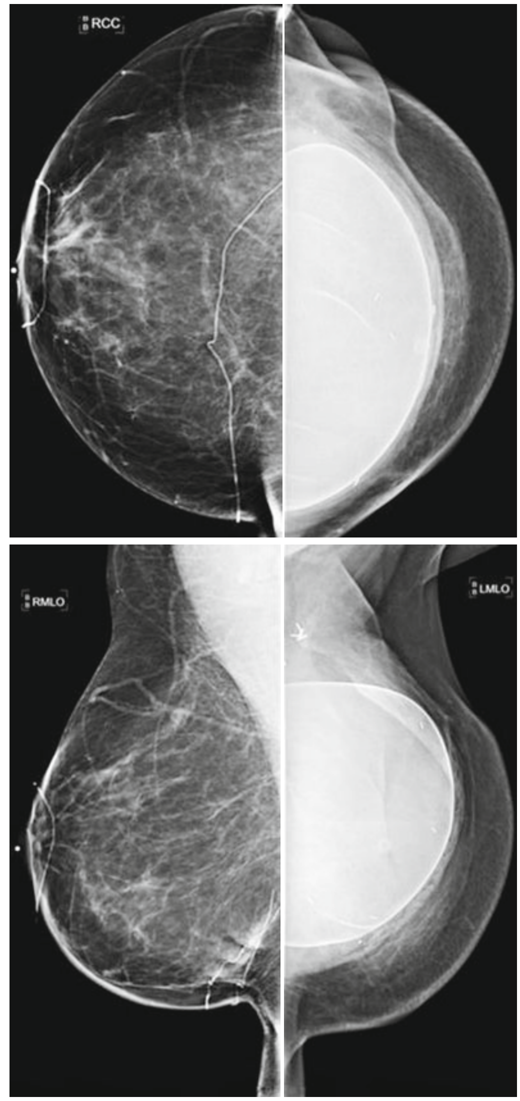


Fig. 16.39 Saline implant reconstruction. Normal appearance of mastectomy with saline implant reconstruction. Bilateral craniocaudal (*top*) and mediolateral oblique (*bottom*) images demonstrate evidence of a left mastectomy with saline implant reconstruction. There is paucity of normal fibroglandular tissue in the reconstructed breast (*). Sequelae of a breast reduction for symmetry are noted on the right breast with scar marker noted on the periareolar and inferior right breast

On MRI, the neobreast is hyperintense on T1-weighted (T1WI) consistent with fat. A thin line of hypointense signal intensity which represents de-epithelialized portion of the abdominal tissue may be seen parallel to the skin surface. The muscle pedicle is hypointense on T1WI and may be visualized inferoposterior location (Fig. 16.42a–f). On contrast-enhanced T1WI images, the vascular pedicle may be visualized. Susceptibility artifact from surgical clips may be seen in the axilla and posterior aspect of the surgical bed. In the immediate postoperative period, there might

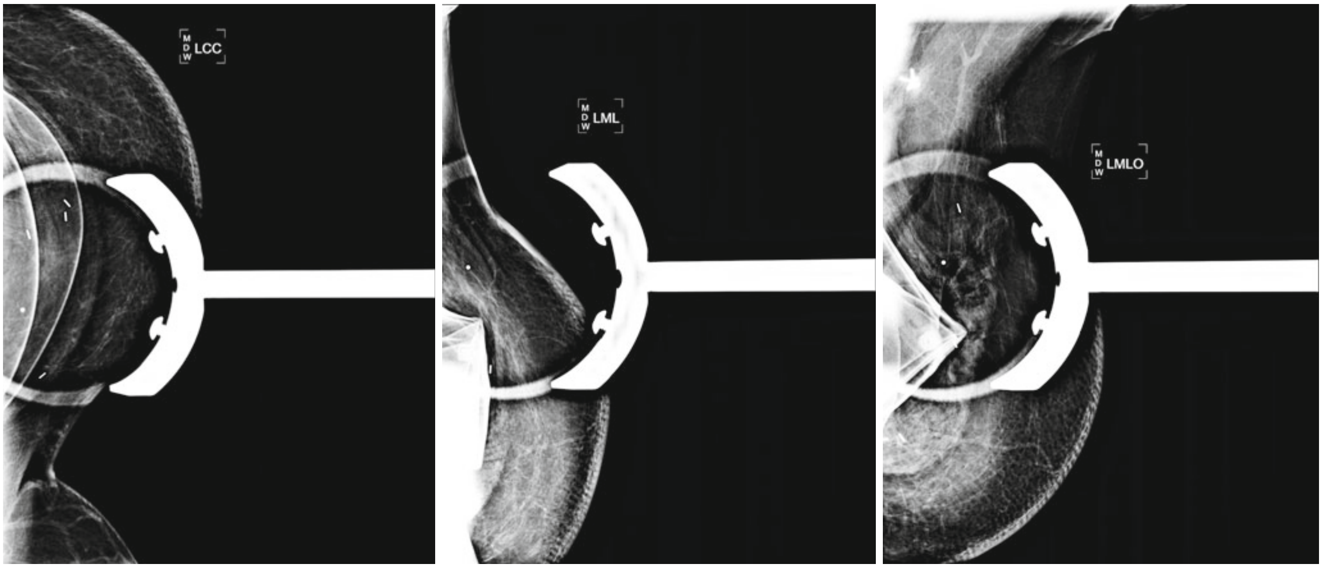


Fig. 16.40 Implant rupture: spot mammographic images in a patient with a left reconstructed breast with saline implants. The patient presented for diagnostic evaluation of a palpable area of concern denoted by a metallic BB. Review of the mammographic images shows the area of palpable concern to correspond with the port of her collapsed saline implant

be increased T2 hyperintensity noted within the skin secondary to edema. Diffuse skin thickening can be seen as a diffuse band of tissue that is hyperintense on T2-weighted images (T2WI) and hypointense on T1W1. If the patient has radiation therapy, uniform enhancement may be seen [43, 46].

Benign findings such as a hematoma, seroma, fibrosis, and fat necrosis can be noted and at times difficult to differentiate from recurrent disease. Early in the postoperative course, a hematoma is hyperintense on both T1WI and T2WI images with a hypointense hemosiderin rim later in the postoperative course. A seroma is hyperintense on T2WI with a smooth rim of enhancement on contrast-enhanced images (Fig. 16.43a–d). Fibrosis, a common sequela of radiation therapy, is often associated with architectural distortion and at times a spiculated mass which mimics malignancy. Postradiation fibrosis has none to very little enhancement on contrast-enhanced images and is hypointense on T2WI. Fat necrosis, a great mimicker on imaging, is reported to have a 25 % incidence in TRAM flap reconstructions. It can have a variable appearance on MRI with slow, gradual, rapid, or washout enhancement kinetics typically at its periphery. In general, it will be hyperintense on T1WI and follow the appearance of fat on T1 fat-saturated (T1FS) images and demonstrate persistent enhancement. A key differentiator of fat necrosis from a malignancy is the presence of central fat signal intensity within a mass (Figs. 16.44a–c and 16.45a, b). Signal void from dystorphic calcifications or findings suspicious for recurrent disease such as irregular and spiculated morphology with rapid enhancement or rim enhancement may also be noted. Given the overlap that exists between benign and malignancy findings, mammographic correlation is often helpful in establishing a diagnosis, but tissue sampling is sometimes still needed to exclude recurrent disease [43, 46, 58].

Recurrence

The incidence of recurrent local disease after a reconstruction is similar to reconstruction with simple mastectomy without reconstruction. Although uncommon, local recurrence can occur in the regional lymph nodes, chest wall, and reconstructed breast itself at sites where residual breast tissue remains (Fig. 16.46a, b). The reported ranges of recurrence in a reconstructed breast range from 2 to 11 % over a 5-year period. Most recurrent tumors occur in the skin or subcutaneous tissue of the flap and are often detected clinically. Recurrence can also occur posteriorly in the chest wall. The incidence of chest wall recurrence has been reported to be 0.2–1 % per year and these patients are more likely to have metastatic disease, a poorer prognosis, and a lower survival rate. The proposed mechanisms for recurrence are residual cancer, tumor seeding at the time of mastectomy, sequestration of tumor cells within the lymphatic system, and unspecified host factors. Benign residual tissue could also be the site of a de novo malignancy at a later time [40, 41, 54, 59–61].

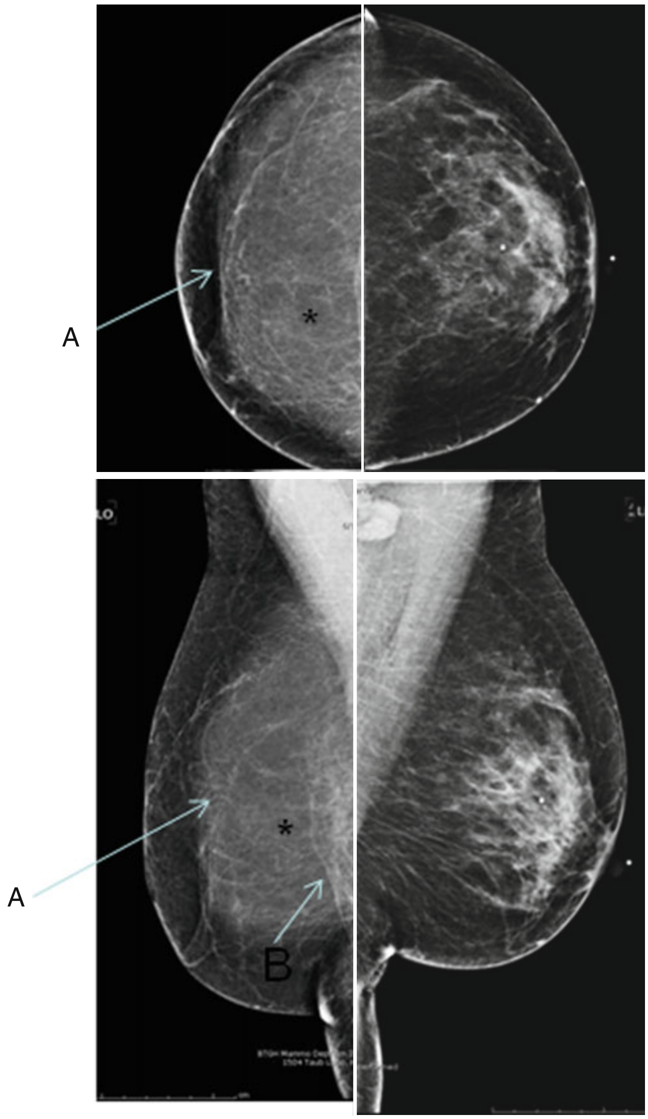


Fig. 16.41 TRAM reconstruction. Normal mammographic appearance of a TRAM flap reconstruction. Craniocaudal (*top*) and mediolateral oblique (*bottom*) views of a patient how has had a right TRAM flap reconstruction. Compared with the left heterogenously dense breast tissue, the right neobreast is entirely composed of fatty tissues (*). A thin line noted at anterior depth of both the CC and MLO views (A) represents superior edge of TRAM flap. The soft tissue in the rectus abdominis muscle can be noted at the posterior aspect of the flap (B)

When there is a clinical suspicion for recurrence, a diagnostic evaluation is performed to interrogate the area of focal complaint such as a palpable mass or pain. If the area of interest is amenable to it, a diagnostic mammogram with spot compression views can be performed. Oftentimes, a targeted ultrasound is the preferred modality of choice especially in the setting of a simple mastectomy without reconstruction where the yield of mammography is low due to lack of compressible breast tissue, hence suboptimal patient positioning and poor patient tolerance as one can imagine [43, 44]. Imaging is helpful to evaluate for fat necrosis which is a common cause for a new palpable abnormality after mastectomy (Fig. 16.47a, b). If suspicious findings are noted, a core needle or surgical excisional biopsy should be performed. Before the performance of an invasive procedure in a patient with a reconstructed breast, it is prudent to be aware of the major vascular supply of the pedicle prior to the procedure. For instance, the vasculature from a pedicle flap from the inferior epigastric vasculature would be located in the lower inner quadrant or the upper outer quadrant if a free flap with anastomosis to the thoracodorsal vasculature is present. MRI is a useful problem-solving tool for recurrent disease when there is a high suspicion for recurrence but findings on mammography or ultrasound are low yield or equivocal or in cases where the site of recurrent disease is located posteriorly and thus less likely to be clinically detectable.

Reduction Mammoplasty

A reduction mammoplasty is a type of plastic surgery performed to reduce the size and volume of the breast through the surgical removal of excess breast tissue. The indications for a breast reduction include macromastia causing physical symptoms such as upper back, chest, neck, and shoulder pain. Patients with macromastia may complain of submammary intertrigo during the summer months and skin pigmentation or grooving from the use of support bras with large shoulder straps. Not-so-common complaints are upper extremity paresthesias from compression of the brachial plexus and chronic headaches [62, 63]. Breast reduction can also be performed in a patient with macromastia for cosmesis to improve self-image and confidence, particularly in younger patients. In patients with breast cancer treated with mastectomy and reconstruction or breast conservation therapy, breast reduction may be performed on the contralateral breast for symmetry. Congenital asymmetry and gigantomastia of pregnancy are rare instances where a breast reduction may be indicated [46].

Incidence

According to the American Society for Aesthetic Plastic Surgery, over 112,000 breast reductions were performed in the United States in 2007, a 539 % increase from 1997. Thus, it is likely that a radiologist would encounter mammographic imaging on patients who have had a breast reduction. In

Fig. 16.42 (**a**–**f**) TRAM reconstruction. Normal MRI appearance of a TRAM flap reconstruction. Axial T1-weighted (**a**), T2-weighted (**b**), T1-weighted with fat saturation (**c**), T1-weighted with fat saturation and contrast enhancement (**d**), MIP reconstruction (**e**), and sagittal T1-weighted (**f**) images demonstrate evidence of left mastectomy with TRAM flap reconstruction. The reconstructed breast is composed entirely of fatty tissue. The thin line within the TRAM reconstruction (*arrow*) represents de-epithelialized skin from the abdominal wall

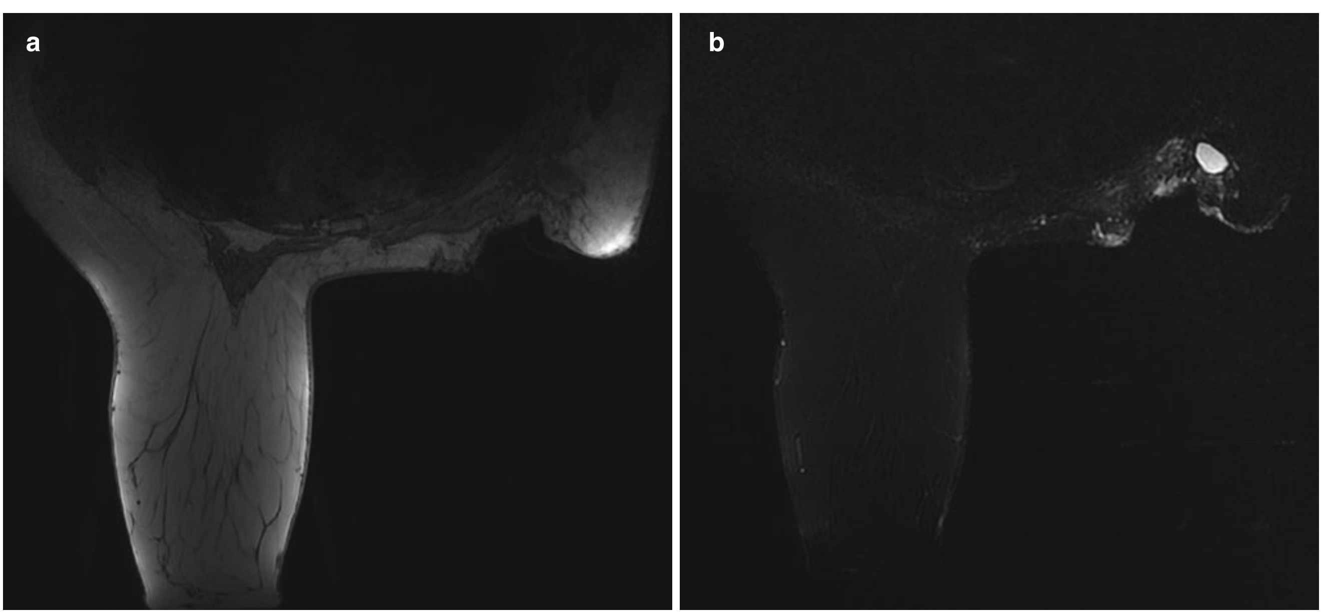


Fig. 16.43 (**a**–**d**) Seroma. Axial images from a patient who has had a left simple mastectomy. A mass is noted in the left mastectomy bed which is hypointense on T1WI (**a**, **c**) and hyperintense in T2 (**b**). No enhancement is present on T1-weighted fat-saturated contrast-enhanced images (**d**)

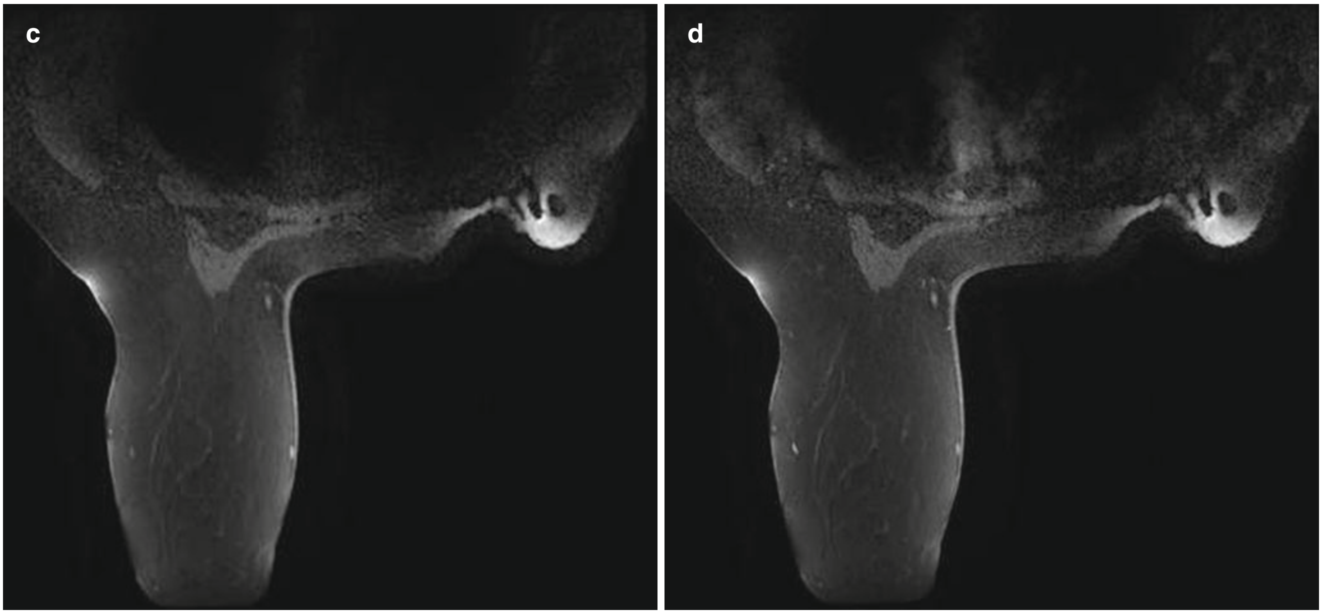


Fig. 16.43 (continued)

order not to perform unnecessary biopsies or miss subtle cancers, the recognition of the postoperative findings associated with this procedure is important [64].

Preoperative Imaging

Although rare, incidental cases of breast cancer have been reported in reduction mammoplasty specimens. This inadvertently complicates and limits treatment options [65]. Therefore, imaging clearance with mammography is recommended in women over the age of 35 presenting for breast reduction surgery. This threshold can be lowered based on risk factors such as family history, genetic disposition, previous biopsy, etc. [46, 63, 65]. Mammographic preoperative imaging can also help identify potential lesions that may need to be addressed at the time of surgery.

Surgical Technique

The general methods used to accomplish breast reduction are a transposition method, where the nipple–areolar complex remains attached to the subareolar ducts and the whole complex is transposed upwards, or a transplantation method, where a full-thickness nipple–areolar graft is severed from its ducts and transplanted upwards [66]. The free nipple graft transplantation method is often preferred when a large volume of breast tissue needs to be removed or in older patients, to decrease the risk of nipple avascular necrosis [46, 62, 66].

Two important components of the breast reduction procedure include selection of a pedicle which provides innervation and vascularity to the nipple-areolar complex and removal of selected quadrants of breast tissue. There are various surgical alternatives for a breast reduction technique. Most described techniques have both a specific pedicle and an incision pattern. The pedicle can be a monopedicle or bipedicle, e.g., McKissock vertical bipedicle technique. The pedicle and skin excision pattern are independent variables. For example, the inverted-T inferior pedicle or Wise pattern, one of the most common reduction techniques, involves an inferior pedicle and reduction of the breast volume from the superior, medial, and lateral quadrants. Other techniques include the short scar (T, vertical, horizontal, or periareolar) technique [63, 67, 68].

Postoperative Imaging

After a woman has undergone a breast reduction, postoperative imaging to establish a new baseline is often performed 6 months after the surgery. Women who have undergone a reduction mammoplasty do not have an increased risk of breast cancer when compared to the general population of women with the same risk factors; thus, the screening guidelines are the same (Fig. 16.48a, b).

Predictable changes occur within the post-reductive breast regardless of the reduction technique. These changes are well demonstrated on mammography, and their identification is essential for the prevention of unnecessary biopsies. Danikas et al. in their retrospective review of 113 patients over the age of 35 found parenchymal distribution 102 (90.2 %) and elevation of the nipple 96 (84.9 %) to be the most common findings on imaging after a breast reduction. A retroareolar fibrotic band from the transposed flap was noted in 23 patients (20.3 %). Calcifications and oil cysts

Fig. 16.44 (**a**–**c**) Fat necrosis. Multiple axial and images with T1- and T2-weighted images with and without contrast (**a**, **c**) demonstrate a mass in the lateral aspect of a left TRAM reconstruction which follows fat signal on T1-weighted images. A smooth surrounding rim of enhancement is noted on contrast-enhanced images. Correlation with mediolateral and mediolateral oblique mammographic views (**b**) confirms the MRI findings of fat necrosis

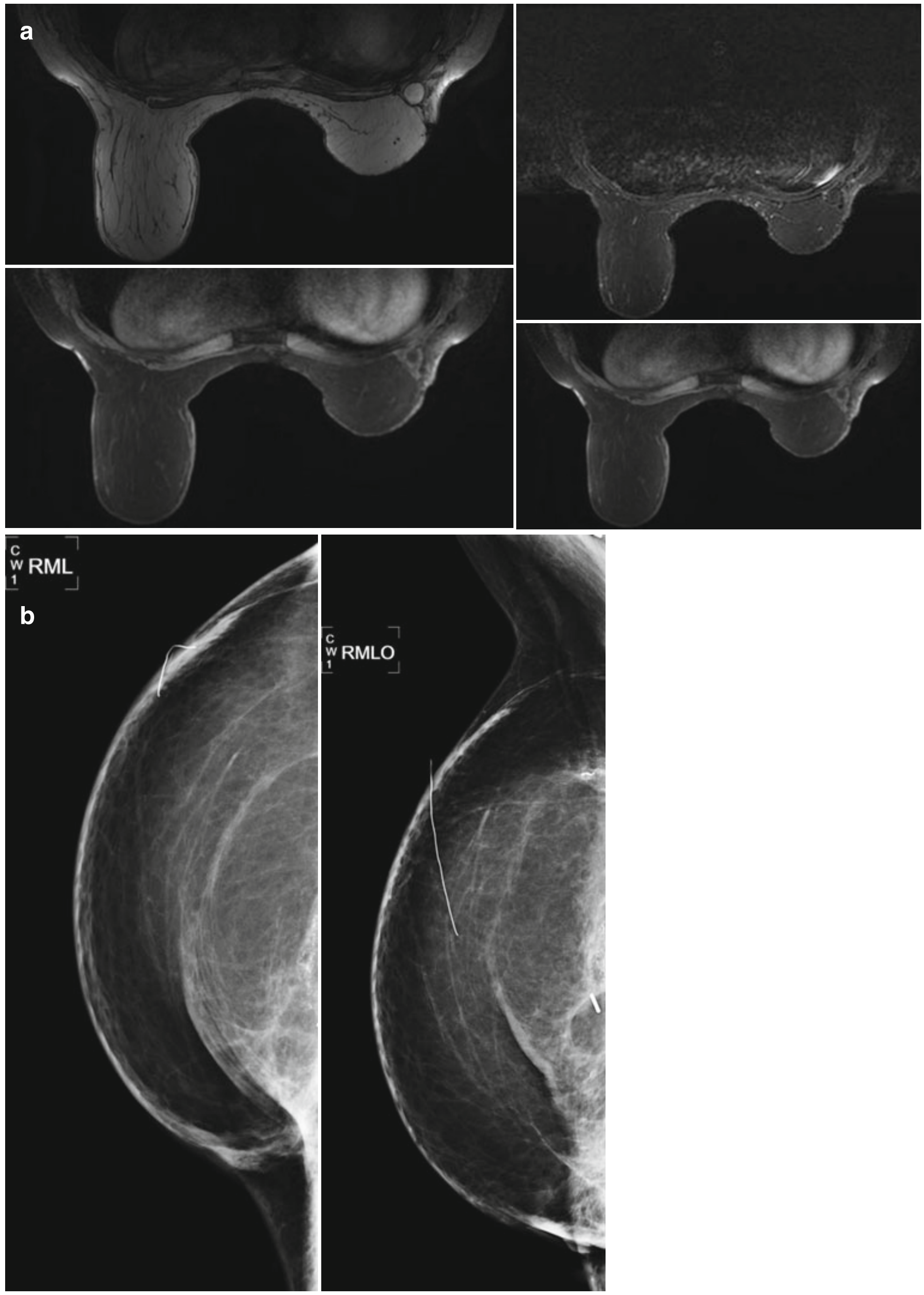
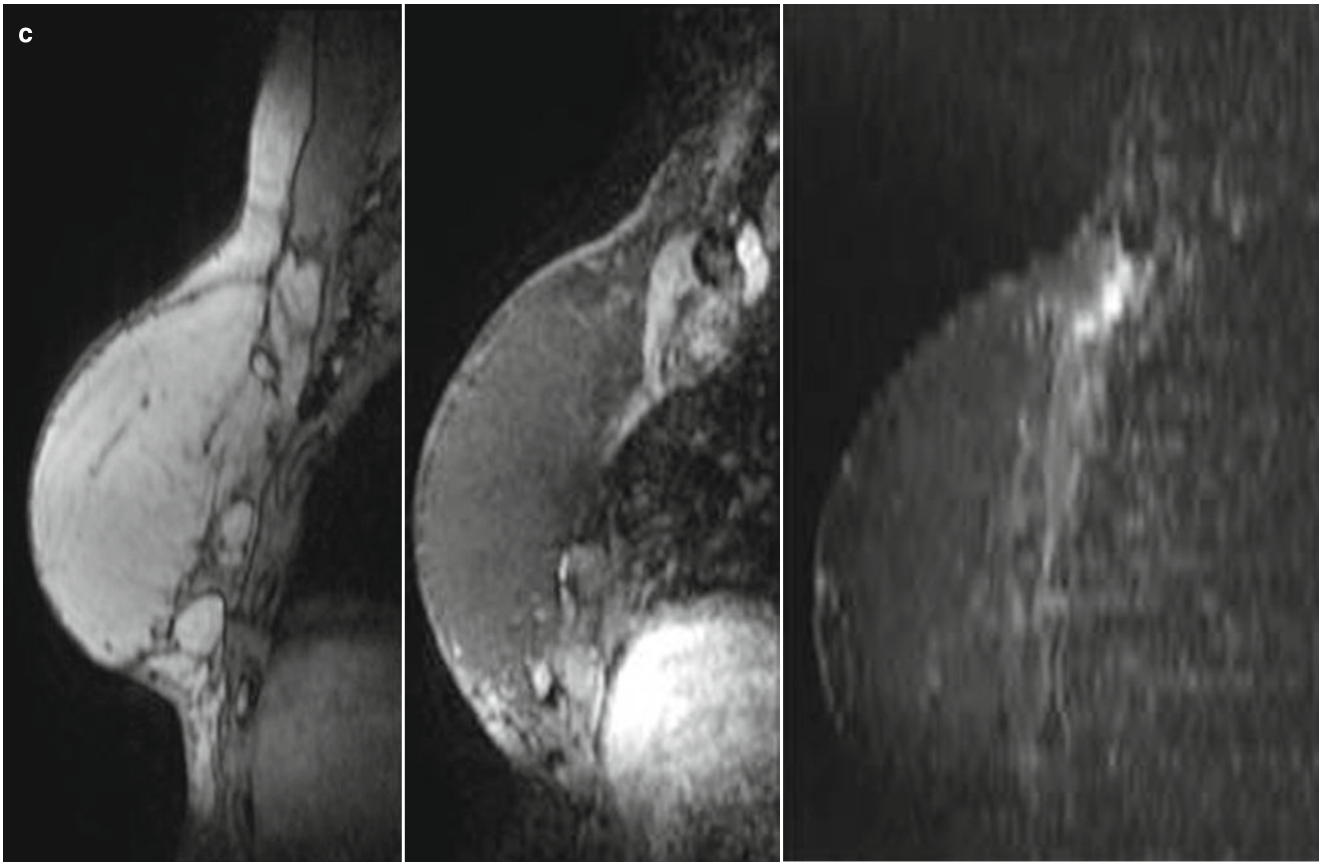


Fig. 16.45 (**a**, **b**) Fat necrosis in TRAM reconstruction. Mammographic and sonographic images (**a**) in a patient with a TRAM reconstruction who presented with an area of palpable concern. The mammogram demonstrates calcified mass with central lucency in the superior quadrant of the mass consistent with fat necrosis. Subsequent imaging (**b**) shows evidence of evolving fat necrosis with curvilinear more coarse calcifications with surrounding lucency



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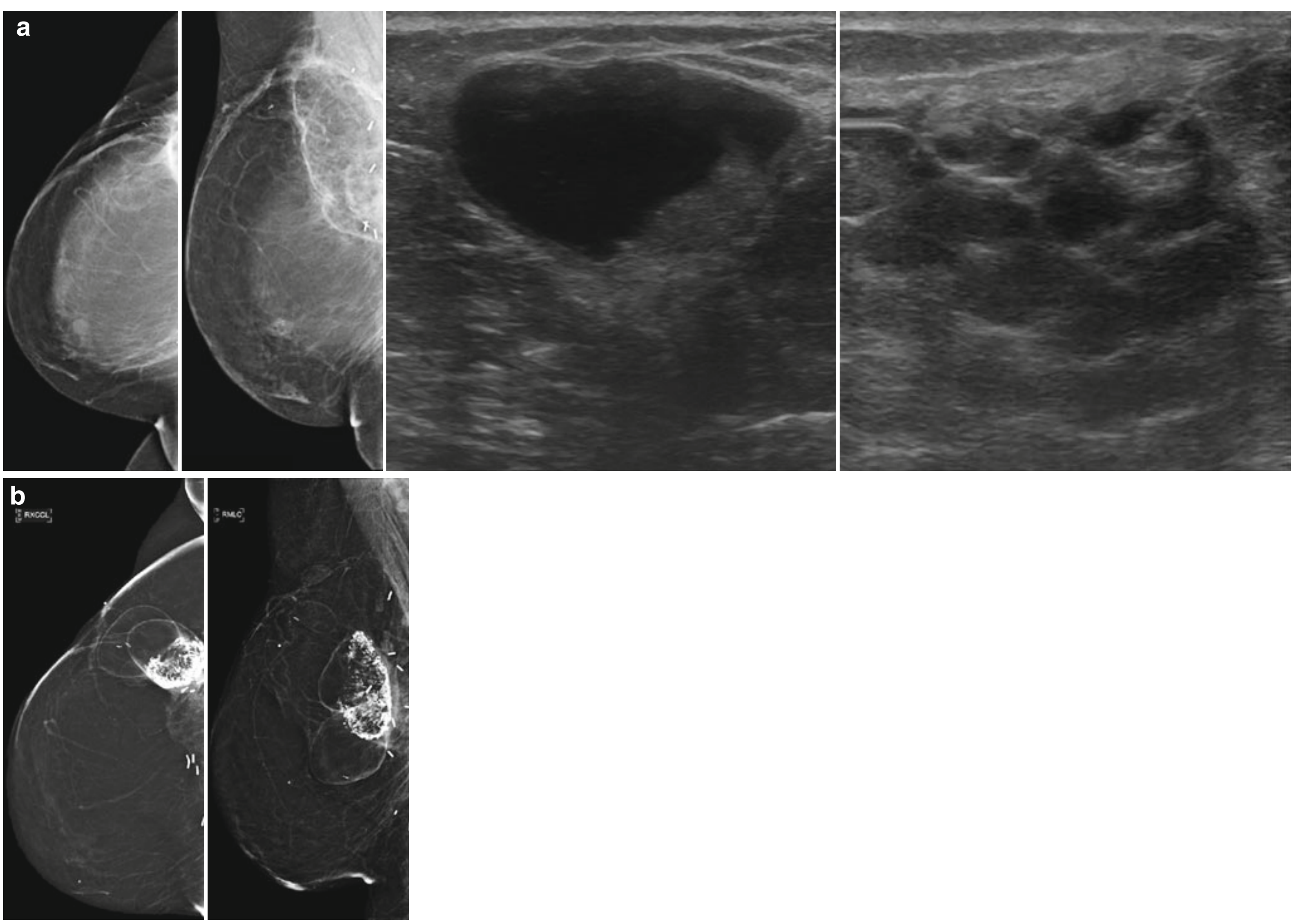


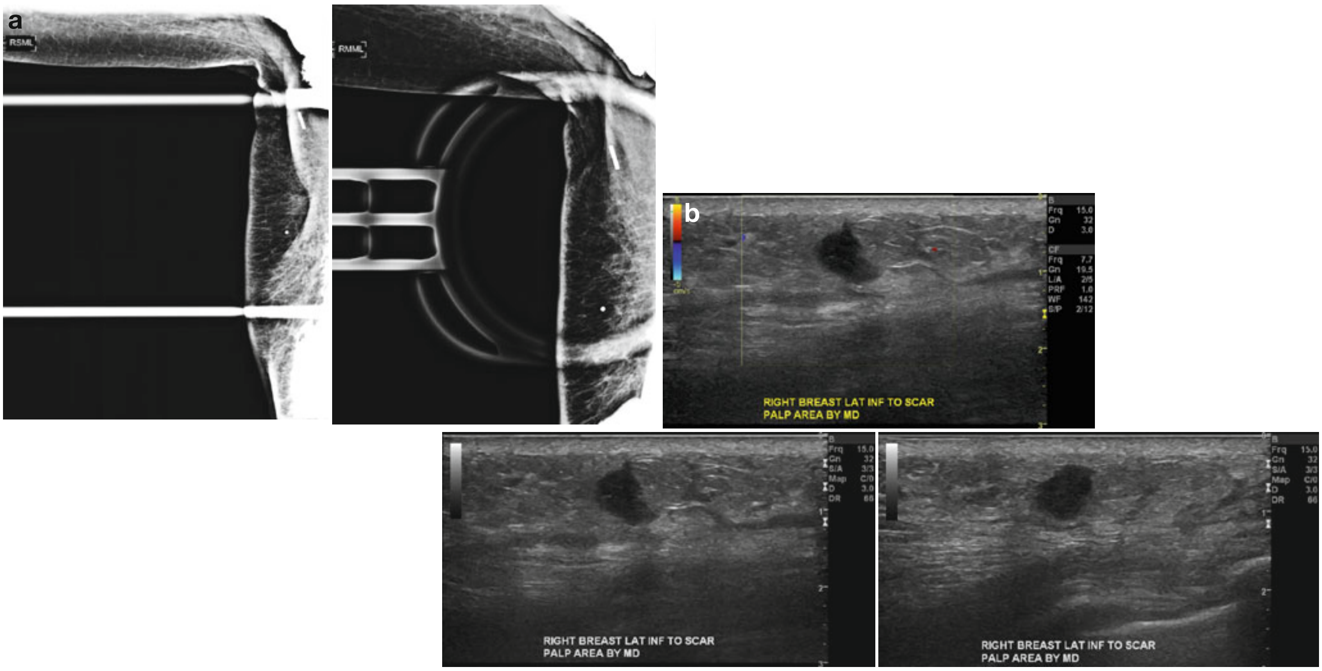
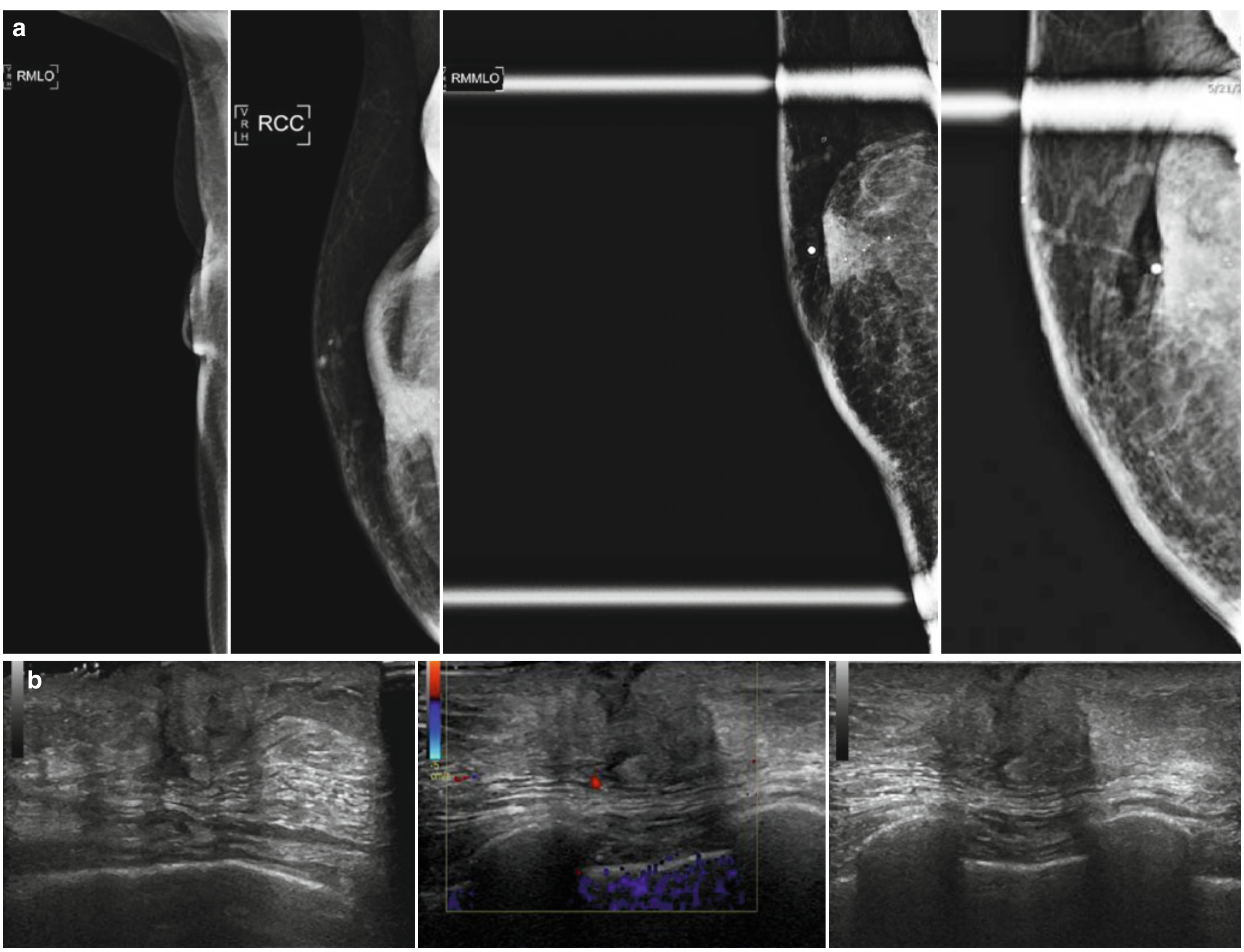


Fig. 16.46 (**a**, **b**) Recurrent malignancy. Spot mammographic images (**a**) demonstrate a focal asymmetry in the area of palpable concern denoted by a metallic BB inferior to the mastectomy scar site. Sonographic images (**b**) in the area of palpable concern show an irregular hypoechoic wider than tall mass. An ultrasound-guided core biopsy of this mass revealed recurrent malignancy



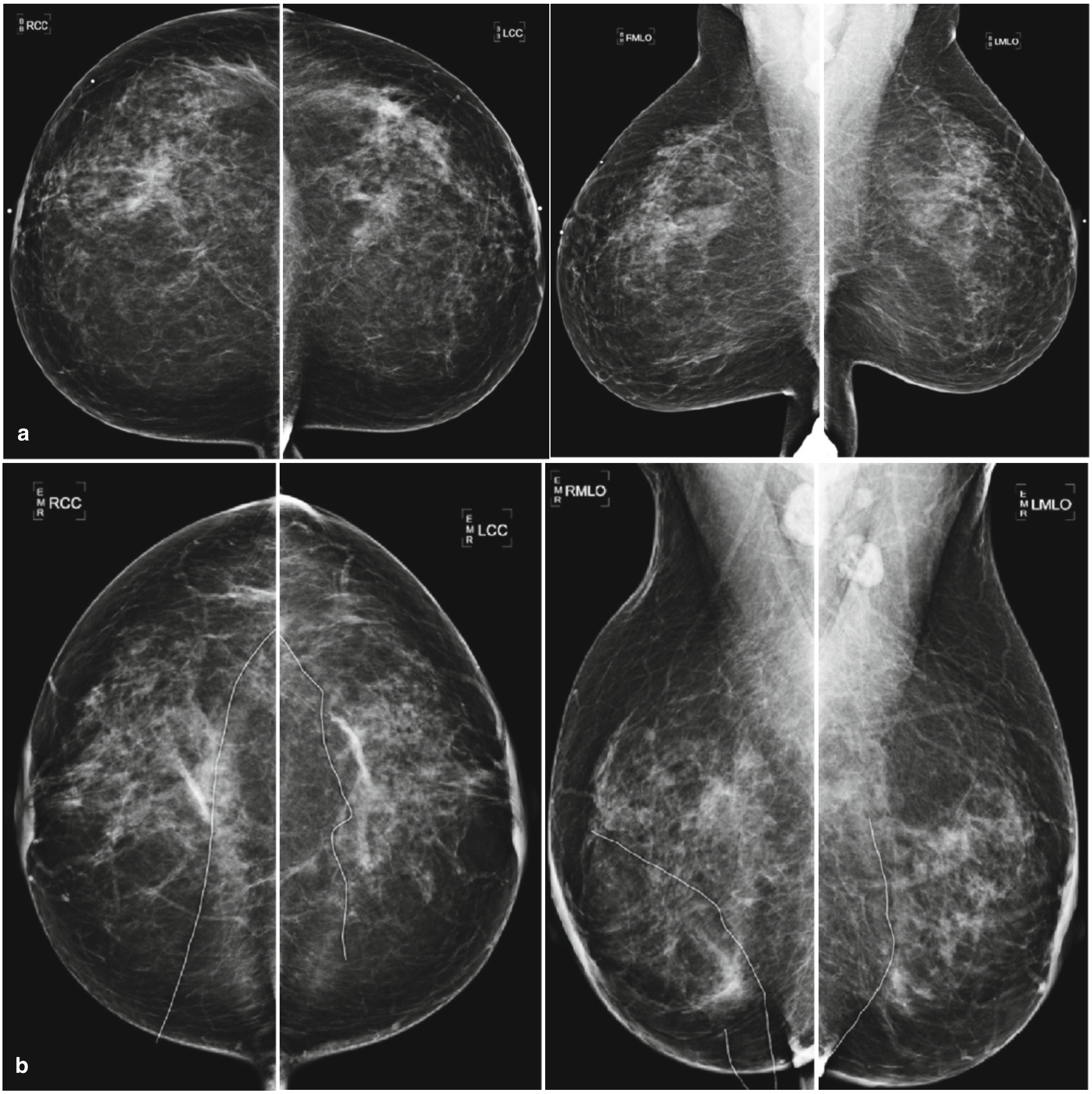


Fig. 16.48 (**a**, **b**) Pre- and postreduction mammographic findings. (**a**) Bilateral mammograms were obtained preoperatively prior to bilateral breast reduction. (**b**) Postreduction mammographic images demonstrate scar markers in the inferior and periareolar regions of both breasts. There is interval reduction in breast size. Parenchymal redistribution is noted with swirling of the breast parenchyma best demonstrated in the inferior breast on the MLO images. Note is also made of an elevated nipple-areolar complex

Fig. 16.47 (**a**, **b**) Fat necrosis. Mammographic (**a**) and sonographic (**b**) images from a patient with history of right breast malignancy treated with a total mastectomy. Clinical exam demonstrated a mass 1 cm below the mastectomy scar denoted by a metallic BB on the mammographic images. A targeted ultrasound of the area of palpable concern showed an isoechoic mass which was suspicious for malignancy. Subsequent ultrasound-guided core biopsy yielded fat necrosis

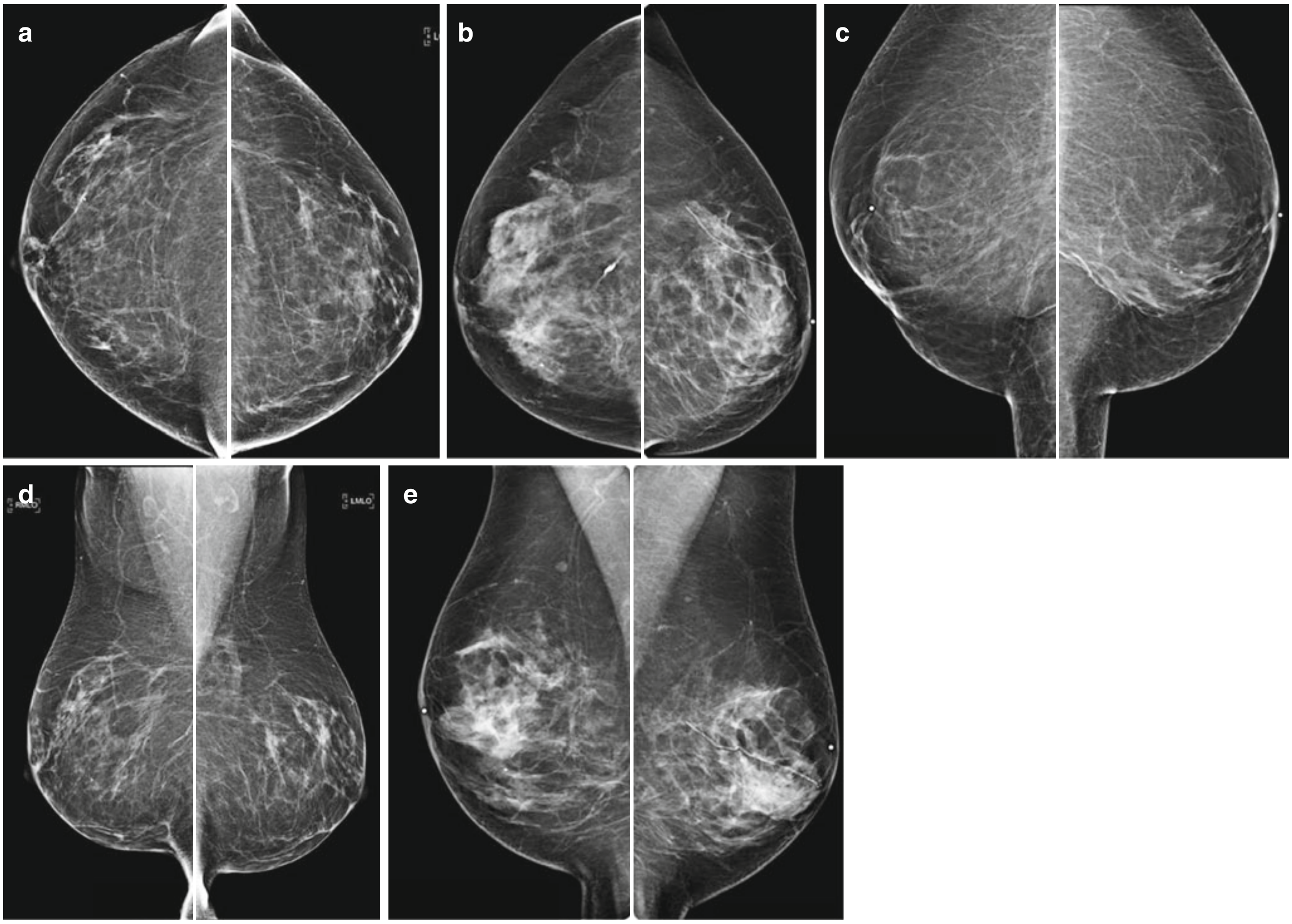


Fig. 16.49 (**a**–**e**) Distortion of breast parenchyma. Bilateral CC and MLO images from annual screening mammograms in multiple patients with history of prior bilateral reductive mammoplasty. There is diffuse distortion and a "swirling" pattern of the breast parenchyma. The nipple-areolar complex (NAC) is also in an elevated position in both breasts. These are two of the most common findings noted mammographically after a breast reduction

caused by fat necrosis were noted in 29 (25.6 %) and 22 (19.4 %) patients, respectively [69].

On imaging, the parenchymal redistribution and architectural distortion presents in a "swirling pattern" most pronounced in the inferior breast. Both of these findings are best demonstrated on the mediolateral oblique or mediolateral views. Elevation of the nipple produced by a shift of the fibroglandular tissue inferiorly will also be noted (Fig. 16.49a–e). The subareolar ducts may be disrupted or not discernible if free nipple graft transplantation was performed [66]. A retroareolar fibrotic bands which parallels the contour of the skin may be seen. Skin thickening at the incision sites in the periareolar, inferior breast, and inframammary fold (Fig. 16.50a, b) can also be seen [46, 66, 70].

Benign findings such as dermal calcifications with lucent centers may be seen at the sutural anastomosis in the periareolar and inferior regions of the breasts (Figs. 16.51 and 16.52). Sequelae of postsurgical hematomas may enhance the formation of dystrophic calcifications (Fig. 16.53) [69].

Fat necrosis, a nonsuppurative inflammatory process where local destruction of fat cells results in the development of variable-sized intracellular vacuoles filled with necrotic lipid material, can have a dramatic imaging appearance which, similar to other iatrogenic procedures and trauma, can also be seen in the setting of breast reductive surgery. Fibroblasts, multinucleated giant cells, and lipid-laden macrophages proliferate between cyst-like areas. The initial necrosis is followed by a fibrotic process where fibroblasts form a dense zone of tissue which encases the central lipid-filled cavities. As the fibrotic reaction progresses, calcifications may form characteristically at the margins of the lipid cysts. This evolving process can have a varied appearance on imaging ranging from single or multiple smooth round masses such as benign "oil cysts," coarse eggshell calcifications, and clustered pleomorphic calcifications, to spiculated masses suspicious for malignancy depending on the

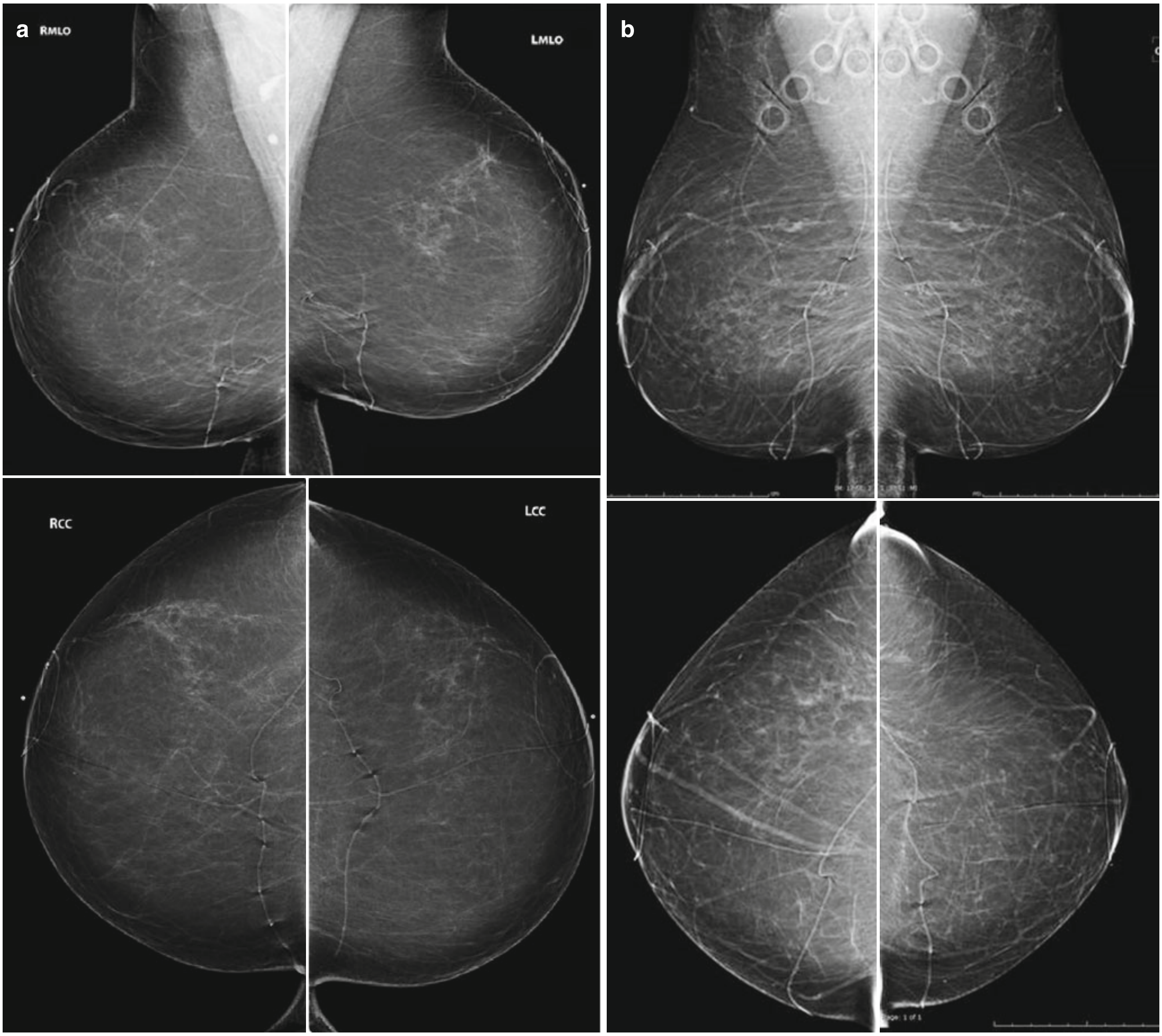


Fig. 16.50 (**a**, **b**) Scar markers. Bilateral annual screening mammogram with CC and MLO projections in two different patients who have had a bilateral reduction mammoplasty. Scar markers are noted in the distribution of the incisions made during the procedure in the periareolar and inferior regions of both breasts. Note is also made of an elevated nipple-areolar complex in both patients

underlying histopathologic changes present [71]. After a breast reduction, fat necrosis will be commonly noted around the areola and at the vertical inferior incision line (Fig. 16.54a–c).

A patient who has a prior breast reduction could present for diagnostic evaluation with an area of palpable concern at a site of developing fat necrosis. It is therefore important for the radiologist to be aware of the expected appearance and distribution of calcifications associated with breast reduction, in order to not perform unnecessary biopsies or attribute truly suspicious findings to expected postoperative changes.

Post-augmentation

There are a variety of commercially available saline and silicone breast implants that are placed surgically for breast augmentation. Less commonly in the United States, some patients will have direct injection of paraffin or liquid silicone into the breast. Although the procedure is not approved in the United States, breast imagers can see these limited mammograms on patients who had the procedure performed abroad (Fig. 16.55). A newer procedure for breast

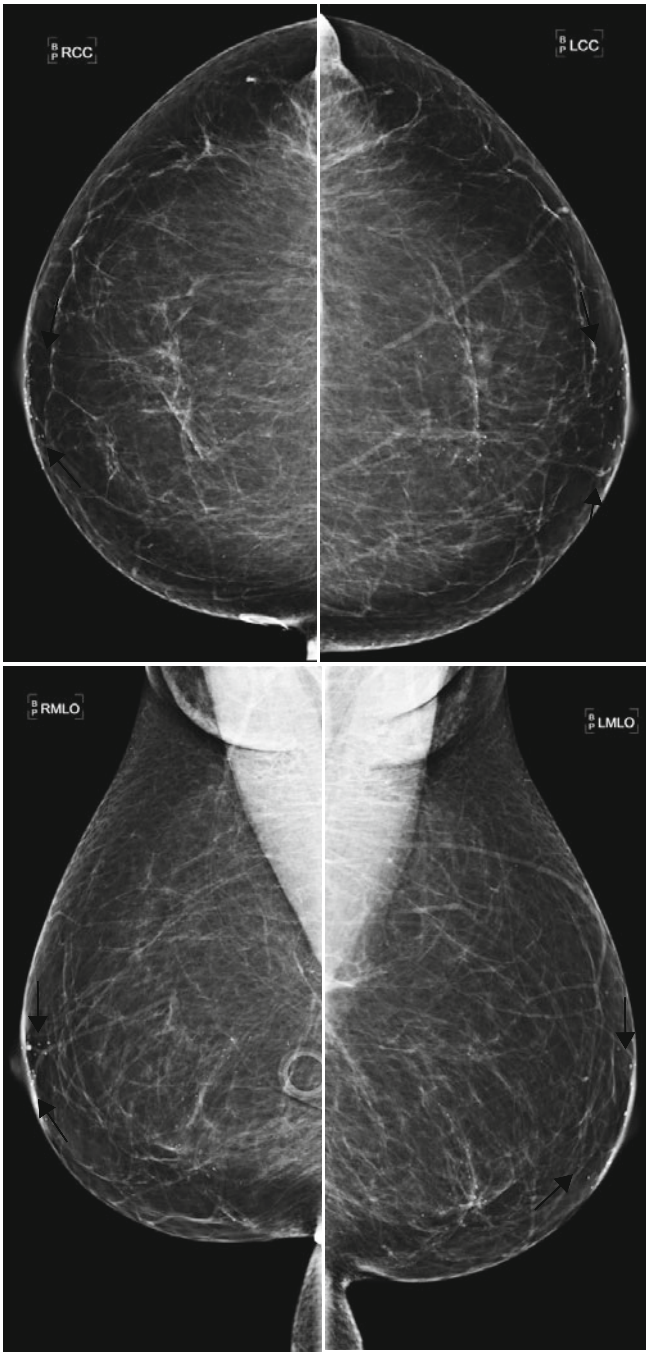


Fig. 16.51 Sutural calcifications. Bilateral CC and MLO mammogram in a patient with a history of bilateral mammoplasty. Sutural calcifications are noted at the periareolar incision site. These can also be seen in the inferior breast and inframammary fold

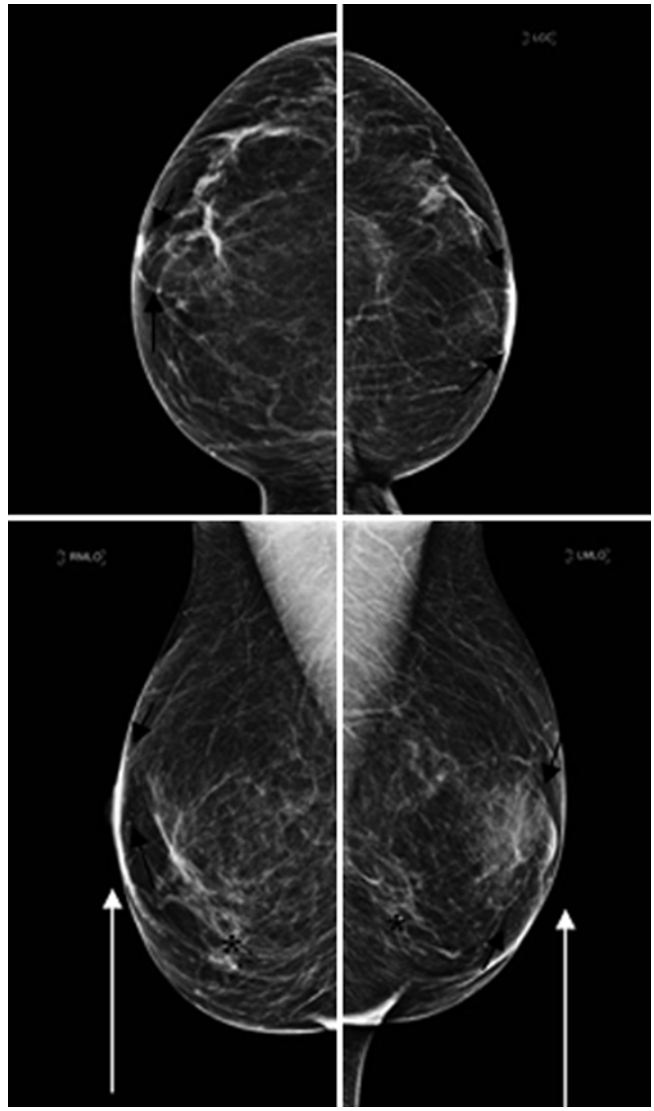


Fig. 16.52 Sutural calcifications (*black arrows*), swirling configuration in lower breast, and elevation of nipple (*white arrows*). CC and MLO views from a bilateral annual screening mammogram in a patient who has had a bilateral reduction mammoplasty. Predictable changes that occur after a reductive mammoplasty are evident. The most common is redistribution of the breast parenchyma in a swirling pattern most notable in the inferior breast (*); another very common finding is the elevation of the nipple to a more high-riding position (*white arrows*). Sutural calcifications can also be noted at the incisional anastomosis sites, namely, the periareolar (*black arrows*) and inferior and inframammary fold regions. *White arrow*, high-riding nipple; *black arrows*, calcifications at the periareolar incision site

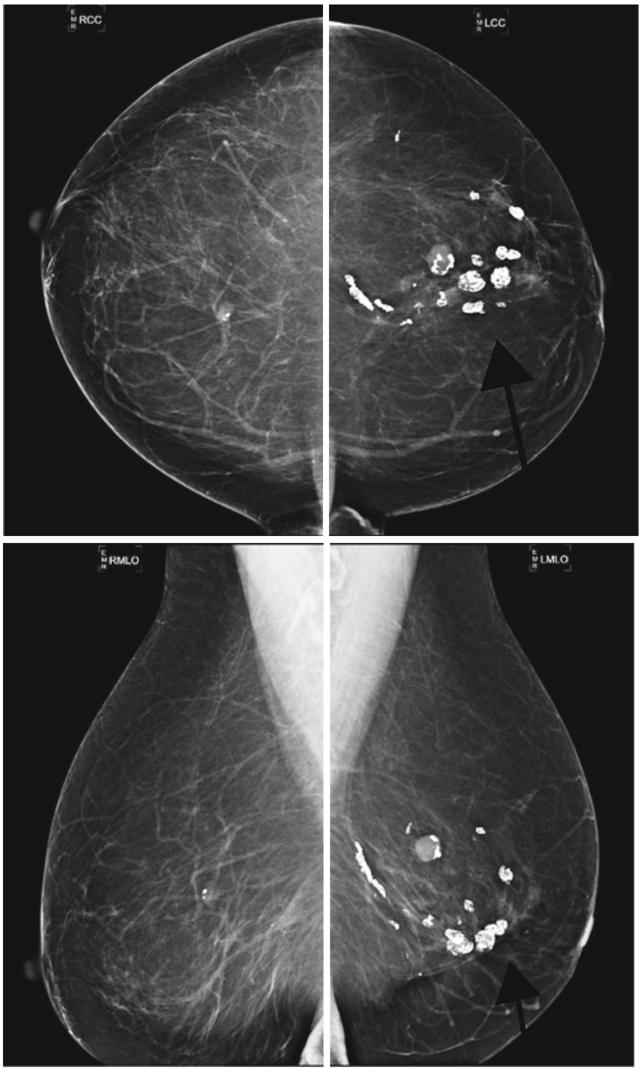


Fig. 16.53 Dystrophic calcifications. Bilateral screening mammogram with standard craniocaudal (CC) and mediolateral oblique (MLO) views. This patient has a bilateral reduction mammoplasty. Dystrophic calcifications (*black arrow*) are noted in the inferior aspects of both breasts, left greater than right. These can be seen in the setting of evolving hematomas or fat necrosis

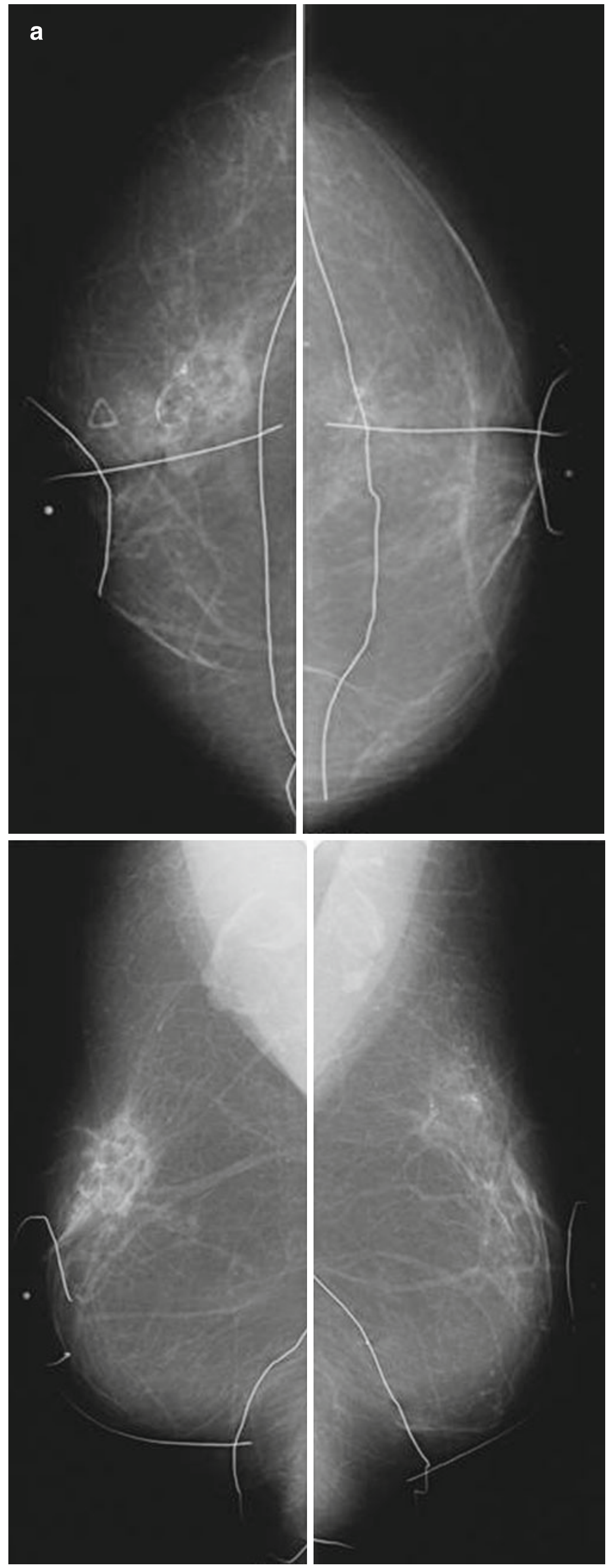
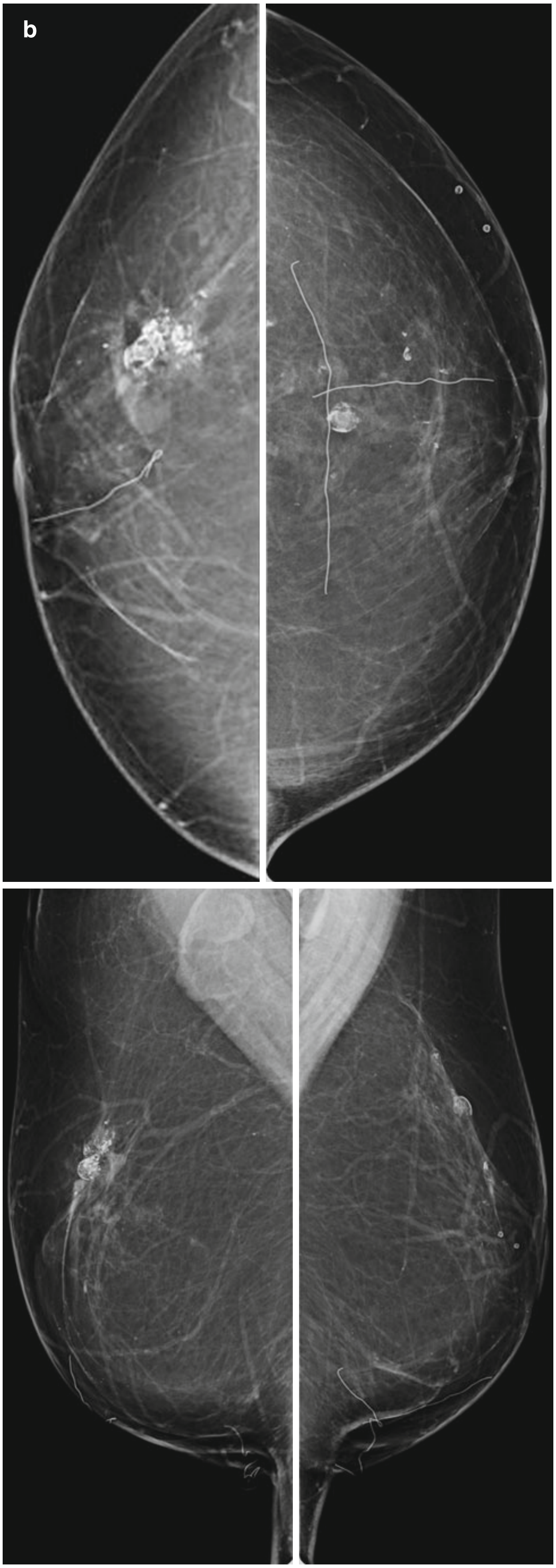


Fig. 16.54 (**a**–**c**) Fat necrosis. (**a**) Patient presents with a palpable area of concern in the upper outer quadrant of the right breast at anterior depth. CC and MLO images from a diagnostic mammogram demonstrate course curvilinear calcifications in both breasts with cystic lucencies, right greater than left. The findings are consistent with benign fat necrosis and correspond to the area of palpable concern. Note is also made of the scar markers in the inferior and periareolar region of both breasts in the typical distribution of incisions used during breast reduction surgery. On subsequent screening mammograms (**b**), the calcifications become more coarse and dystrophic in appearance. (**c**) CC and MLO images from a screening mammogram show a mass with cystic lucencies and few interspersed calcifications in the inferior right breast corresponding to the incisional pattern often used for breast reduction



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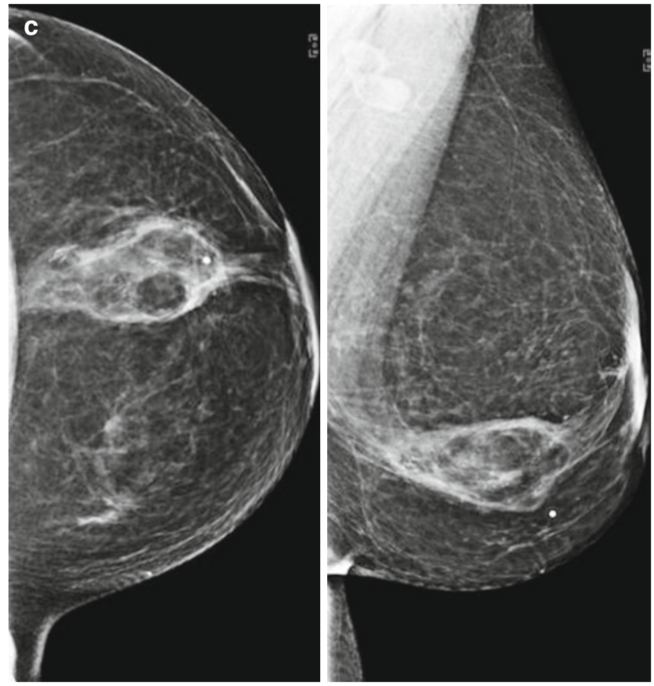

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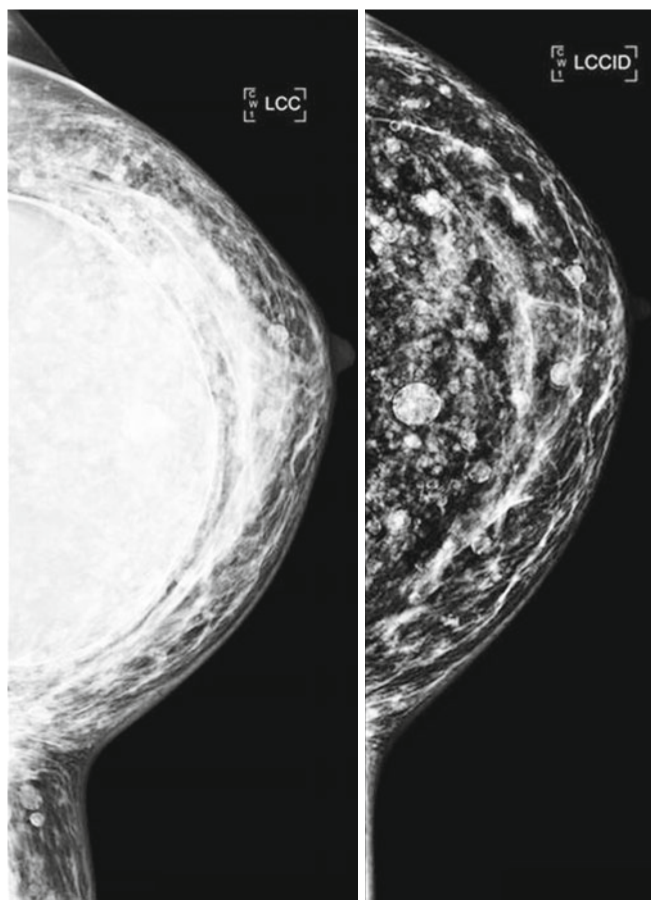


Fig. 16.55 Silicone granulomas on standard and implant-displaced CC views. Granulomas obscure the majority of the breast parenchyma making evaluation for carcinoma suboptimal

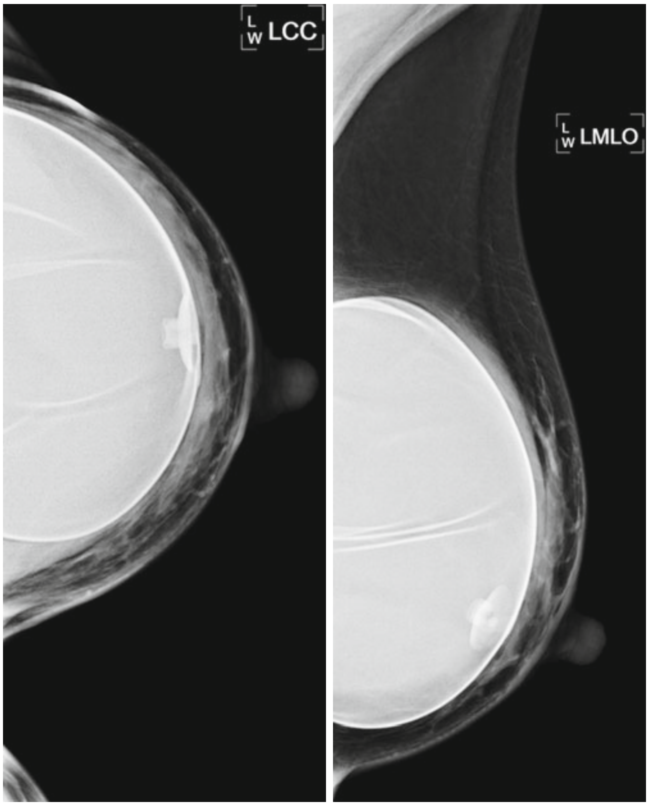


Fig. 16.56 Retropectoral saline implant is less dense than a silicone implant and demonstrates folds of the implant envelope and a valve

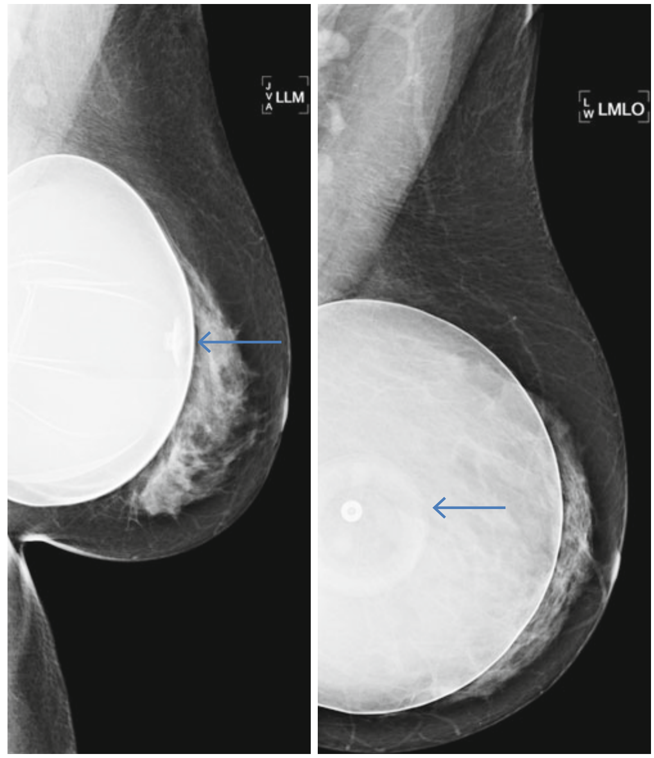


Fig. 16.57 A 67-year-old female underwent exchange of prepectoral saline implants. Images demonstrate the different types of valves that can be seen with saline implants

augmentation is autologous fat injection. This section will focus primarily on the postsurgical appearance after augmentation with implants.

The first use of silicone implants was reported in 1963. In the midst of controversy of possible association with autoimmune disorders, the US Food and Drug Administration (FDA) imposed a ban on the use of silicone implants in 1992. No definitive proof of a cause-effect relationship between implants and autoimmune disorders was ever scientifically established, and silicone implants were again made widely commercially available in 2006. Although cleared from potential harmful autoimmune diseases, implants are associated with other complications including capsular contracture and silicone gel bleed and rupture.

On mammography, saline implants are centrally radiolucent surrounded by a dense silicone outer envelope (Fig. 16.56). Saline implants are less radiodense than silicone implants and sometimes small wrinkles in the envelope and/or the implant valve can be seen (Fig. 16.57). In contrast, silicone implants are mammographically very dense and appear opaque. The presence of radiopaque implants obscures a significant amount of breast tissue on the standard views obtained for screening and decrease cancer detection. The standard CC and MLO views include both the breast tissue and the implant in the same field of view. In order to decrease the compromise in visualization of tissue by the implant, implant-displaced views are performed (Figs. 16.58 and 16.59a–c). The implant-displaced views pull the breast tissue over and in front of the implant while flattening the implant against the chest wall. By moving the implant out of the field of compression as much as possible, the breast tissue can be better compressed.

The ACR Practice Guideline for the Performance of Screening and Diagnostic Mammography recommends that the standard mammographic screening evaluation of the post-augmented breast includes four views of each breast: CC and MLO with the implant and CC and MLO views with the implant displaced. Spot magnification and compression can be performed as needed. Implant-displaced views are important to obtain better compression and visualization of the tissue surrounding the implant as compression is limited on the views with the implant. Implant integrity can be evaluated on the views with the implant. The standard views also provide better visualization of the posterior tissue that is not well seen on implant-displaced views, particularly in patients where the implant is encapsulated. Inspection of both the tissue adjacent to the implant on the nonimplant-displaced views and the tissue separated from the implant on the implant-displaced views should be performed for the most thorough screening for breast cancer.

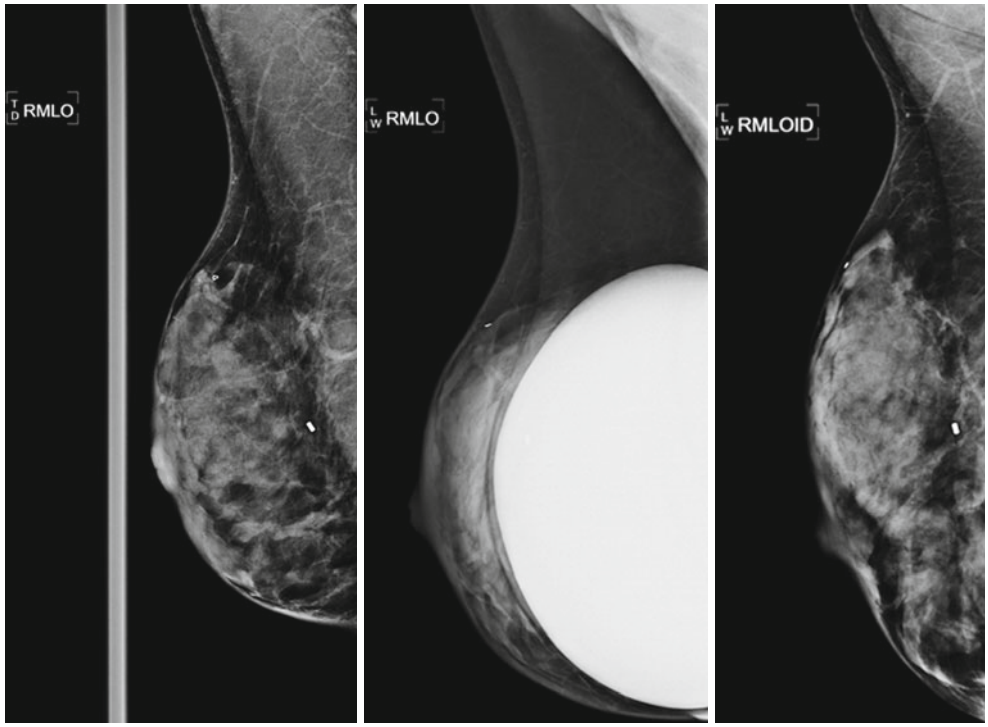


Fig. 16.58 Patient prior to and after augmentation with a retropectoral silicone implant. Implant and implant-displaced views following augmentation demonstrated decreased visualization of breast tissue following implant placement

Implants can be placed in front of or behind the pectoralis muscle (Figs. 16.60 and 16.61). In prepectoral implants, the pectoralis muscle can be seen coursing posterior to the implant. A strip of pectoralis muscle will overlie the upper position of the implant in retropectoral implants. In either position, the implant incites a foreign body reaction in the body that leads to the formation of a fibrous capsule around the implant. Initially the fibrous capsule is soft and nonpalpable but with time can undergo contraction and become hard, immobile, and noncompressible. This process is reported to be more common in prepectoral implants compared to retropectoral placement. Lobulation of the silicone implant contour or in the envelope of the saline implant is a mammographic sign of contracture. Usually a capsule is not visualized on the mammogram unless it becomes calcified which can contribute to the hardness. A calcified fibrous capsule usually demonstrates dystrophic calcifications along the implant surface (Figs. 16.62, 16.63, and 16.64).

Implant rupture usually results from aging and decomposition of the implant shell. Direct trauma can also cause rupture. When a saline implant ruptures, the saline diffuses into the breast tissue and the envelope collapses against the chest wall (Fig. 16.65a, b). Not only is the rupture evident clinically, but there is also clear change in the appearance of the implant on mammography. Silicone implant rupture can be more subtle mammographically and is classified as intracapsular rupture, extracapsular rupture, or intact implant with gel bleed. Intracapsular silicone implant rupture is defined as implant envelope rupture with silicone gel contained within the fibrous capsule. Extracapsular silicone implant rupture is defined as implant envelope rupture with silicone gel extruded outside the fibrous capsule. Gel bleed is defined as a process where silicone gel leaks through an intact semipermeable elastomer shell of the implant, although some believe that this actually represents leakage of gel through small, undetected implant ruptures. This process explains why silicone can be seen within the breast parenchyma or in the axilla, despite a radiographically intact implant on MRI. This should be differentiated from extracapsular silicone gel which can only be seen outside the implant or capsule if there is rupture.

The clinical diagnosis of silicone implant rupture is more clinically challenging than saline implants, creating a more important role for imaging in diagnosis. While there can be subtle signs of silicone implant rupture on mammography, such as small collections of extravasated radiodense silicone adjacent to the implant, within the breast parenchyma, or in the axillary lymph nodes (Figs. 16.66, 16.67, and 16.68), the most useful tool for evaluation of silicone implant integrity is MRI. Mammography is particularly limited in evaluation of posterior implant rupture near the chest wall or intracapsular rupture.

Ultrasound evaluation of breasts with extravasated silicone can be very difficult. The free silicone will produce a classic "snowstorm" appearance where a hyperechoic line with posterior acoustic shadowing will be seen

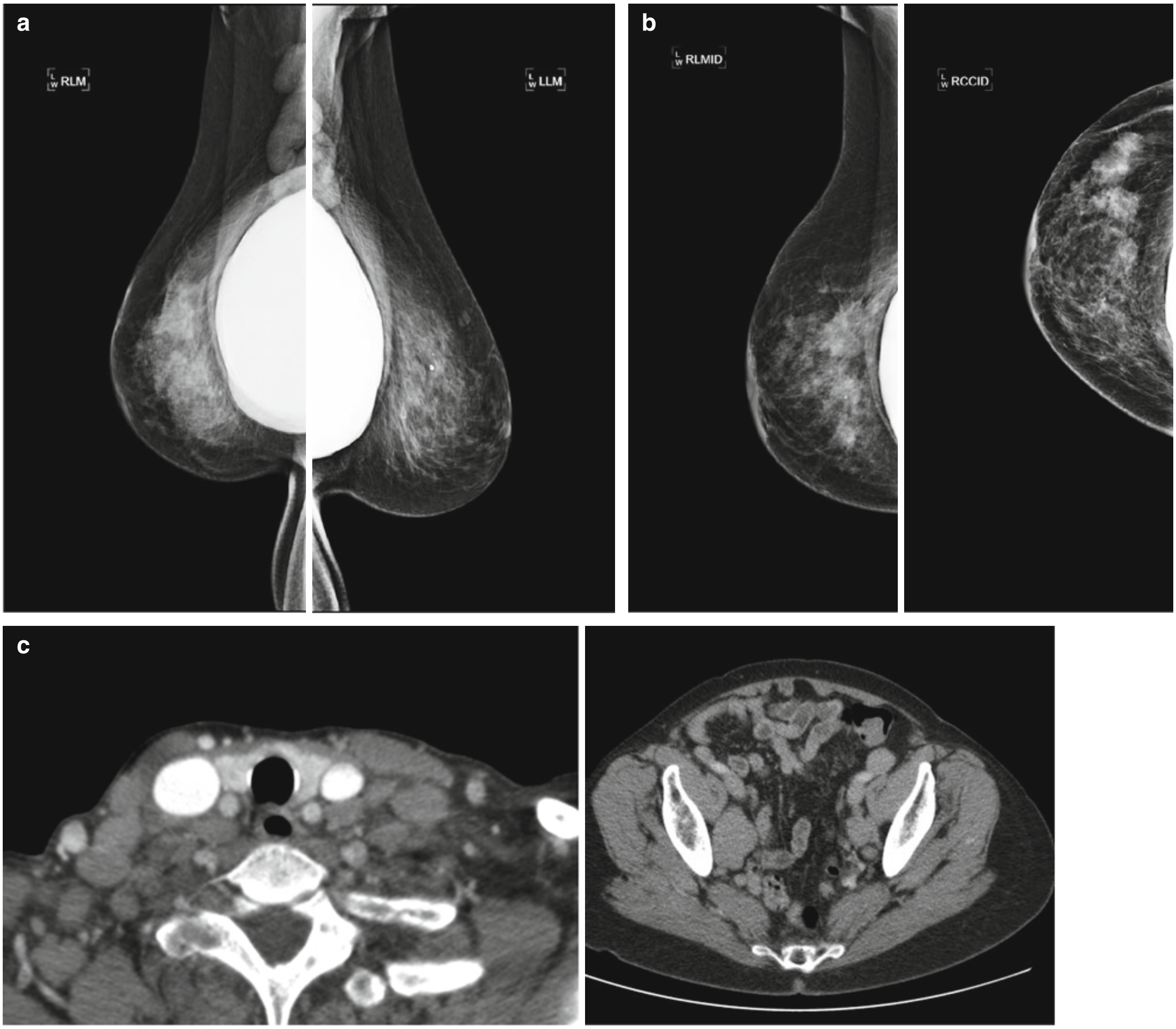


Fig. 16.59 (**a**) A 77-year-old female presents for screening. Bilateral retropectoral silicone implants are present. Multiple obscured masses are seen in the right breast. Bilateral enlarged axillary lymph nodes are seen. (**b**) Multiple masses in the upper right breast are better visualized on the implant-displaced views. Ultrasound-guided core needle biopsy of right breast masses had pathology of invasive ductal carcinoma with metaplastic features. (**c**) In addition to bilateral axillary lymphadenopathy, staging CT demonstrates extensive cervical and abdominal/pelvis lymphadenopathy. Surgical biopsy of an axillary lymph node yielded pathology of follicular lymphoma

(Fig. 16.69a–f). This appearance is secondary to the slow velocity of sound in silicone versus surrounding breast parenchyma. The shadowing produced by the silicone obscures the majority of the surrounding breast tissue and makes evaluation for possible malignancy limited. It can be helpful to place a skin marker in the region of the sonographic abnormality with subsequent mammogram performed for direct sonographic-mammographic correlation. If the patient is presenting with a new palpable abnormality, and the mammogram and ultrasound do not clearly define free silicone as the etiology, breast MRI is recommended to exclude underlying malignancy.

Breast MRI

Breast MRI is not used in the evaluation of saline implants as this is usually clinically evident and seen on mammography, as discussed previously. While contour deformities, implant bulges or herniations, capsular calcifications, and some extracapsular silicone can all be seen mammographically, intracapsular rupture and silicone gel bleed can only be visualized on MRI. Evaluation of integrity of silicone implants with MRI is the only instance when breast MRI is performed without contrast. Since gadolinium contrast is required for evaluation of malignancy, implant studies are nondiagnostic

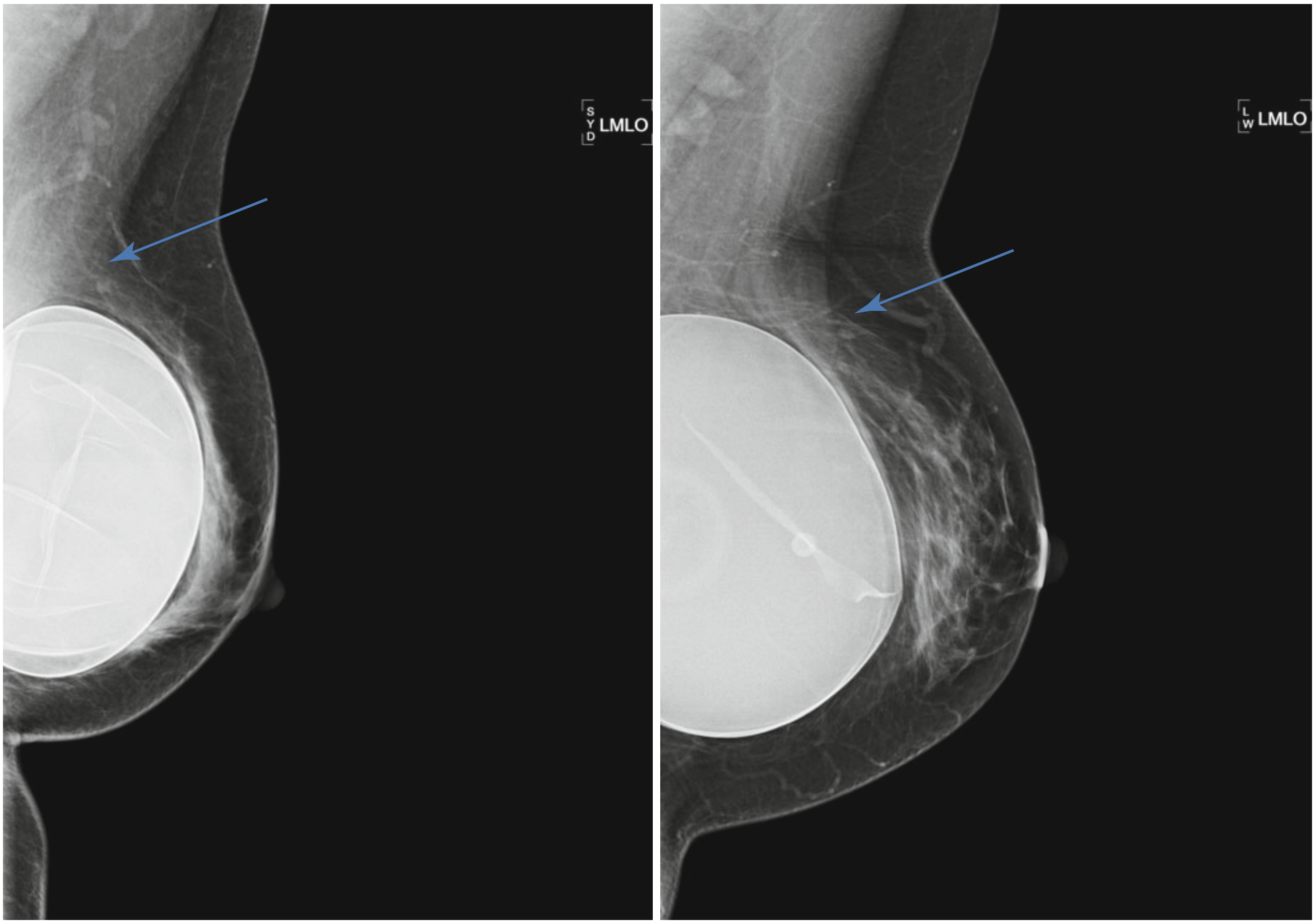


Fig. 16.60 Prepectoral versus retropectoral saline implant. Note the saline implant is less dense than silicone implants, and wrinkles and valves are seen within the saline implant

for cancer detection. In our patients with implants that undergo MRI for high-risk screening or for extent of disease in new cancer diagnosis, we perform silicone-sensitive sequences prior to the contrast portion of the study to assist in problem solving if abnormalities are seen on the contrast study that could be attributed to free silicone. This also helps to provide information on the implant integrity for preoperative planning.

Silicone-sensitive MRI sequences are utilized to differentiate silicone from water and fat. These sequences are usually T2 weighted with water suppression. Intact silicone implants will be bright on silicone-sensitive MRI sequences and may demonstrate small peripheral folds, without internal alterations (Fig. 16.70). Intracapsular rupture is diagnosed by the presence of the "linguine sign" which is created by the shell of the implant collapsing within the capsule. The fibrous capsule will be dark, as will the wavy lines of the collapsed ruptured implant which will be surrounded by the bright signal of silicone. The "keyhole" sign (or teardrop sign) is also useful in diagnosing intracapsular rupture. In this finding, silicone intersperses between dark folds in the collapsing implant shell (Figs. 16.71a, b and 16.72a–d). Extracapsular rupture is diagnosed by detecting silicone outside the capsule, within the breast parenchyma, or in the axilla. High T2 signal material will be seen surrounding the implant, within the breast parenchyma, or extending to axillary lymph nodes. It should be noted that there are double-lumen implants that can mimic rupture and knowing the implant type prior to image interpretation is essential to avoid false positives. It is also helpful to obtain a history of whether there is known prior rupture and removal/replacement for accurate assessment.

Explantation

Some women choose to remove breast implants. If the woman elects to not have another set of implants placed, typically, minimal architectural distortion will be seen in the posterior central aspect of the breast on mammography, where the implants once resided. In rare cases, the implant cavity can fill with fluid and produce a small residual mass posteriorly. If the fibrous capsule is not removed, portions of the capsule may be seen as curvilinear densities in the site previously occupied by the implant. If the capsule is calci-

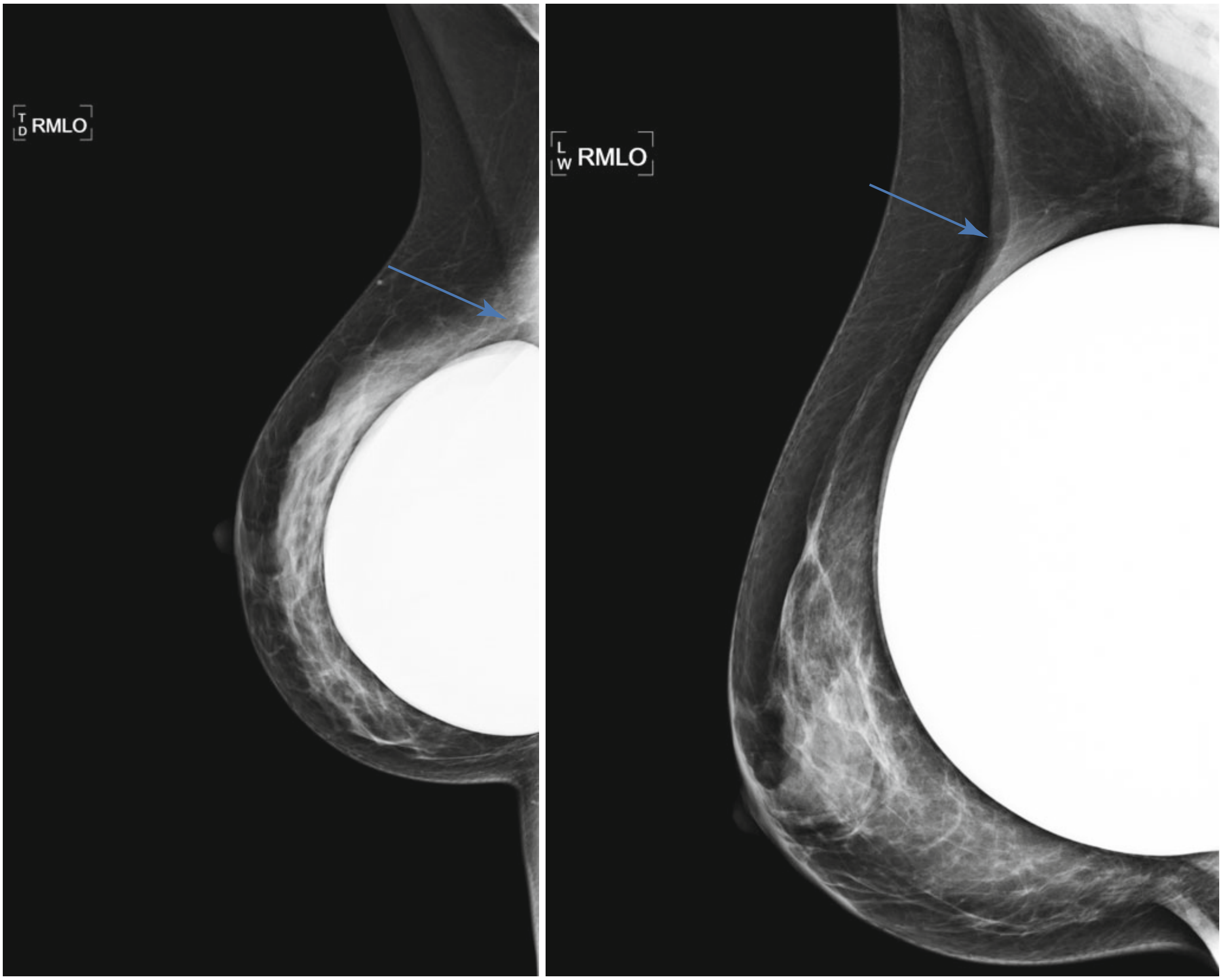


Fig. 16.61 Appearance of prepectoral versus retropectoral silicone implants. Note the pectoralis muscle coursing over the silicone implant in retropectoral implants rather than behind as seen in prepectoral implants. These findings are best visualized on the MLO view

fied, residual dystrophic calcifications in the retained fibrous capsule will be seen on mammography (Figs. 16.73, 16.74, and 16.75a, b). If the removed implants were silicone and there was prior extracapsular rupture, extravasated silicone is often left in the breast parenchyma as it is very difficult to completely remove surgically without removing a large amount of breast tissue. If the patient chooses to have another set of silicone implants placed, the residual free silicone can make diagnosing rupture of the new implants difficult.

Summary

Mammographic interpretation of the postprocedure breast requires familiarity with the various procedures and temporal changes expected following surgery. Surgical breast interventions include excisional biopsy, lumpectomy, mastectomy, reduction, and augmentation. Postsurgical imaging findings including masses, fluid collections, increased breast density, skin thickening, architectural distortion, and calcifications have characteristic sequences of evolution toward stability. Although there is overlap between post-treatment changes and breast carcinoma on imaging, recognizing characteristic post-treatment sequela and comparing interval findings on serial studies will assist in discriminating the two. Breast imagers should be informed of the spectrum of expected postoperative imaging findings, and any changes in the imaging findings after stabilization should raise concern for recurrent carcinoma and prompt biopsy. Awareness of expected findings will minimize unnecessary recall and permits early detection of recurrent breast cancer.

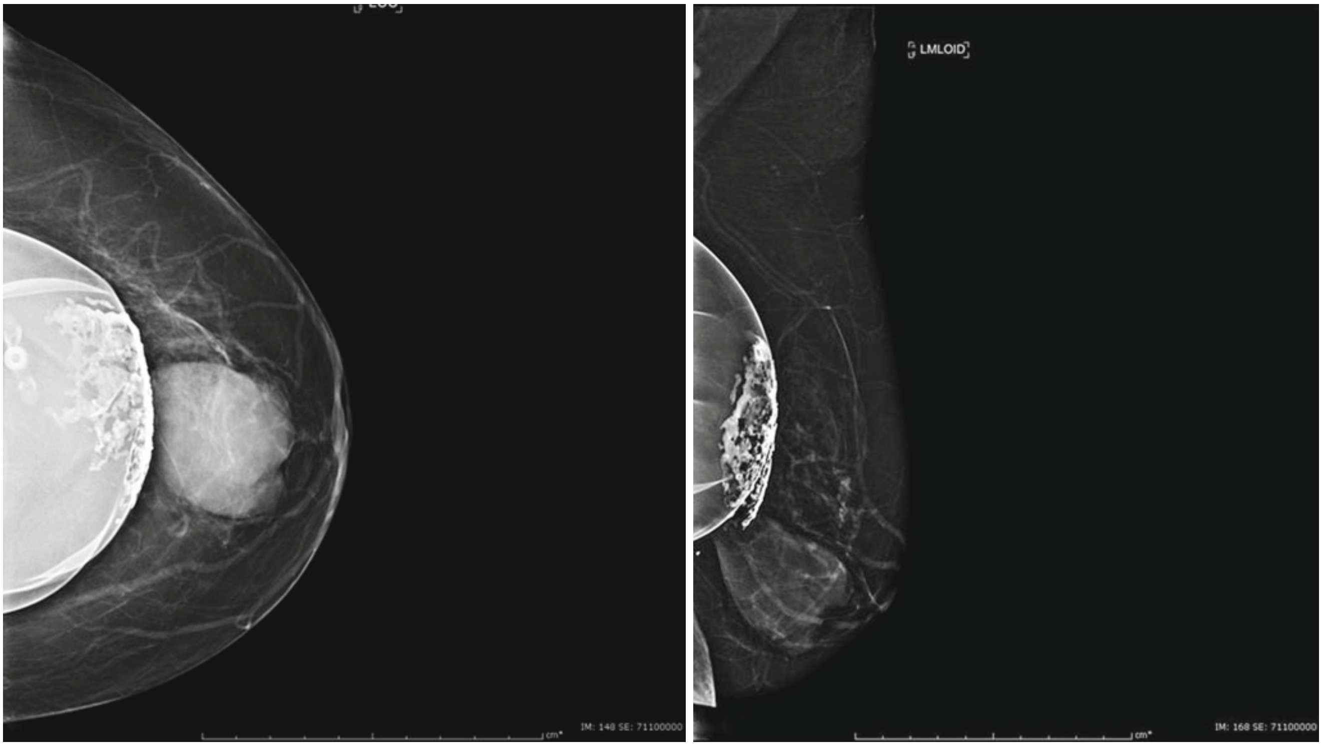


Fig. 16.62 Coarse capsular calcifications on a prepectoral saline implant. The coarse calcifications are best seen along the anterior aspect of the implant on the implant-displaced view. The mass in the lower central breast was stable over several years

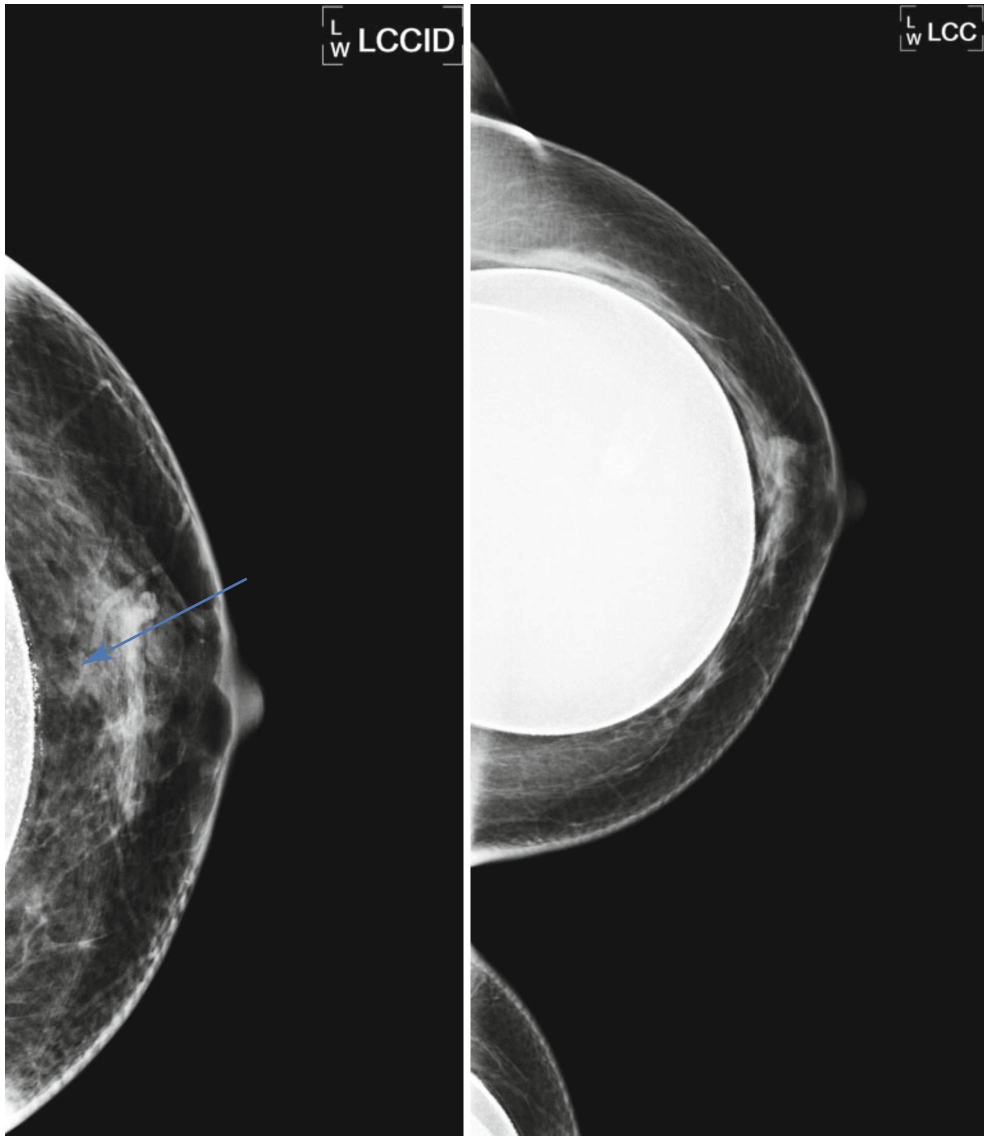


Fig. 16.63 Tiny capsular calcifications seen along the anterior aspect of a prepectoral saline implant in the implant-displaced view

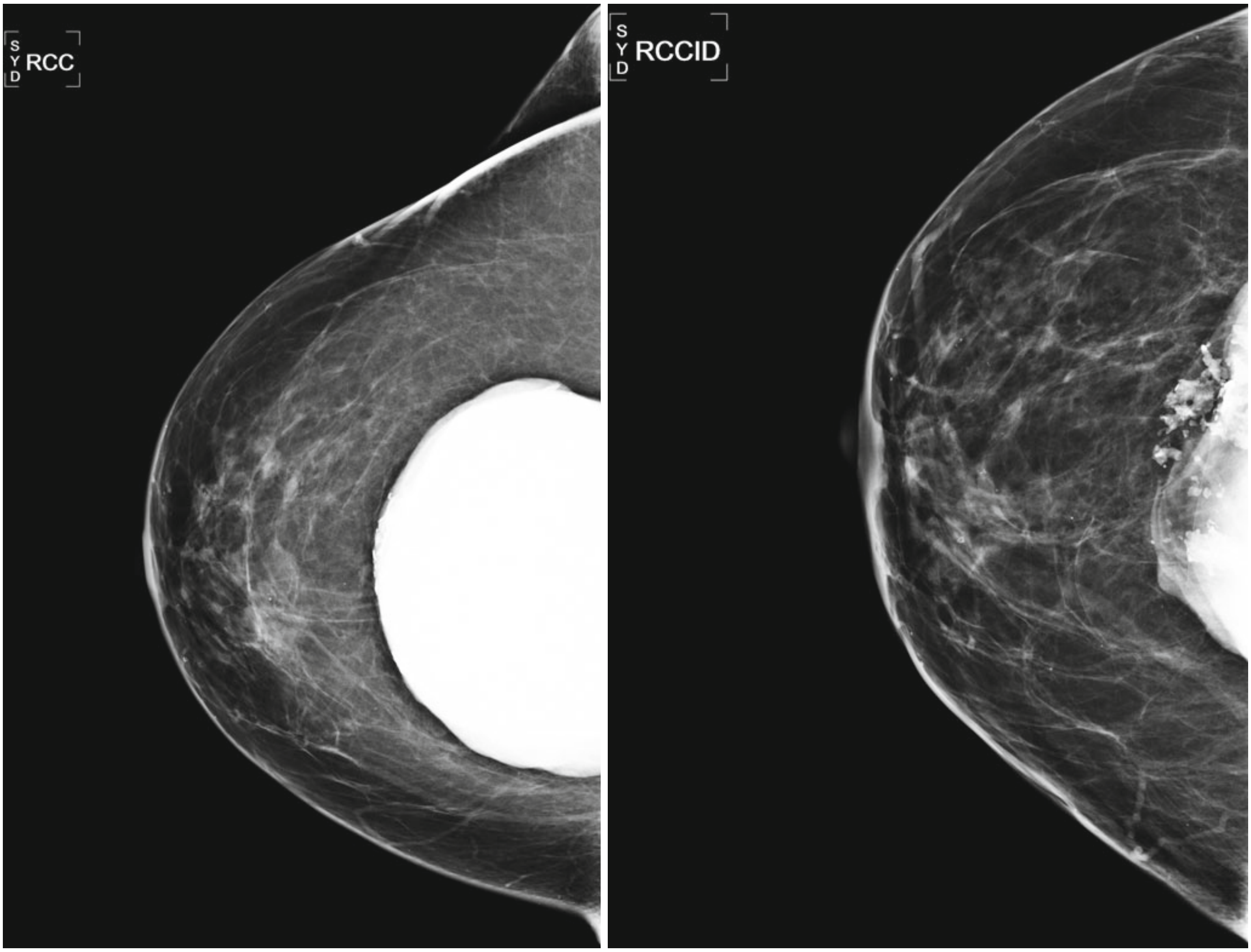


Fig. 16.64 A 77-year-old female with prepectoral silicone implant placed 25 years prior. The implant has a lobulated contour and is firm on the chest, suggesting encapsulation. Implant-displaced view demonstrates coarse capsular calcifications

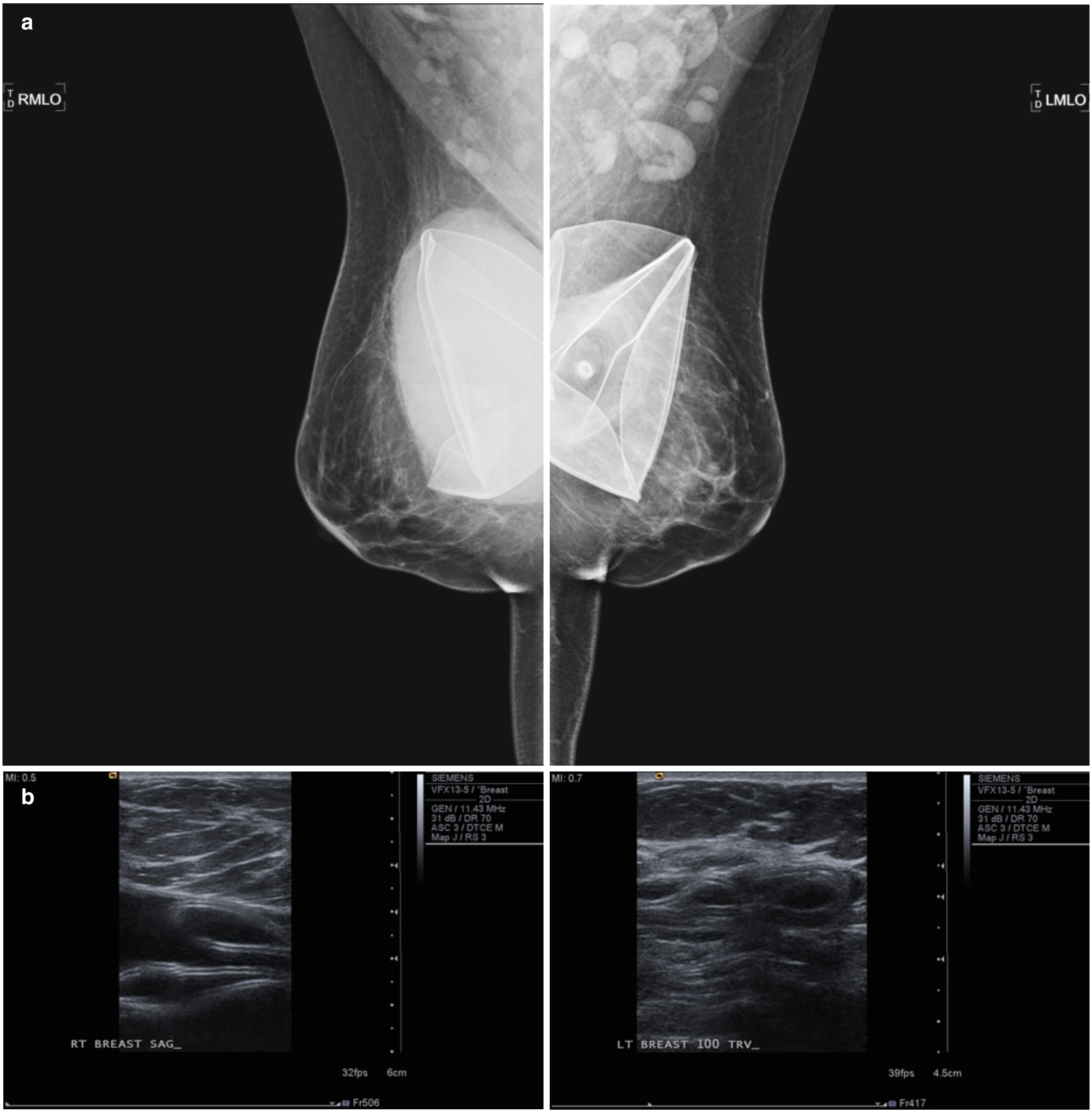


Fig. 16.65 (**a**) A 44-year-old female presents for evaluation of right breast lump. Bilateral prepectoral saline implants are ruptured. The implants were placed 17 years prior to the exam. (**b**) Residual fluid is present within the capsule on the right making the collapsed envelope more visible sonographically. The left implant is completely collapsed

Fig. 16.66 Small collections of free silicone inferior to a prepectoral silicone implant. Dense axillary lymph nodes suggest probable silicone within the axillary lymph nodes

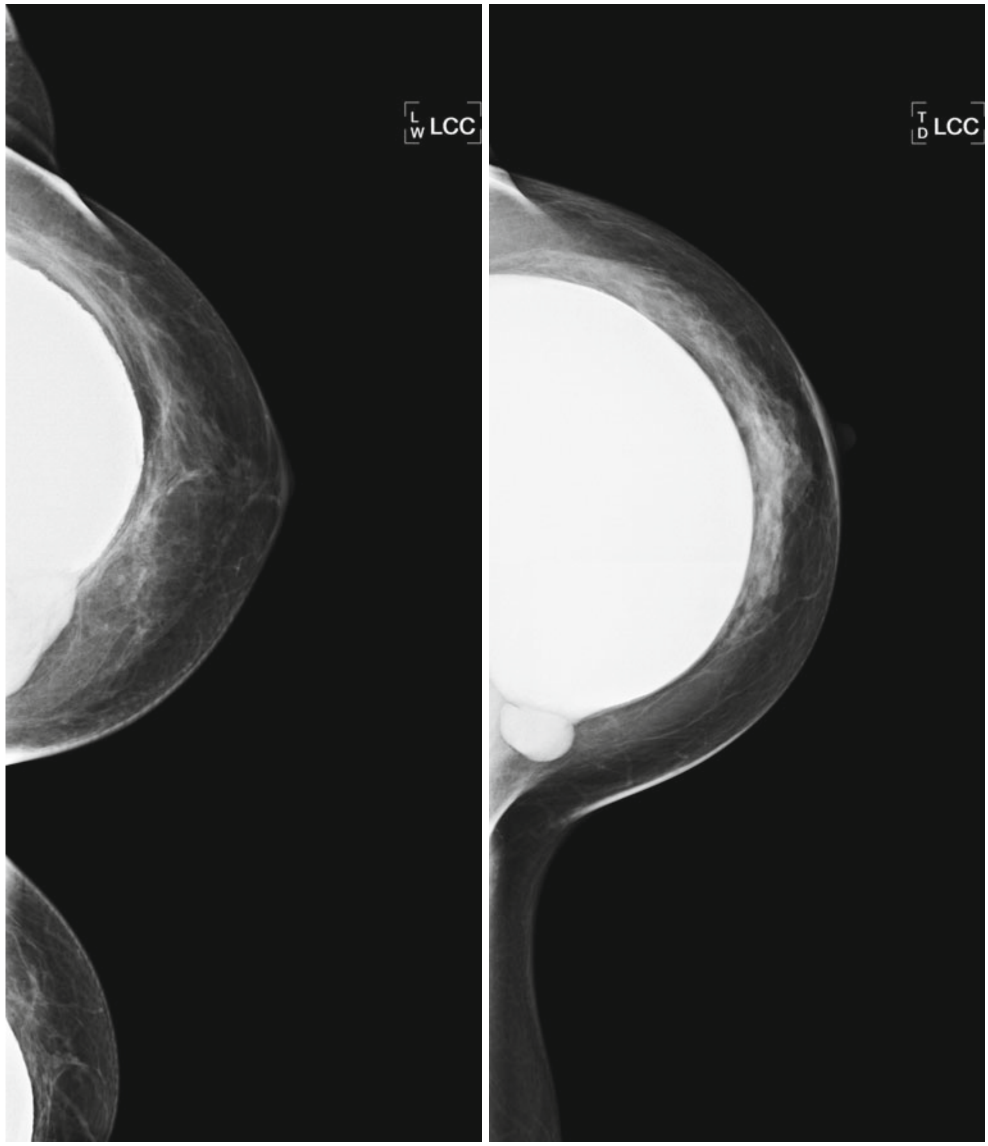


Fig. 16.67 Mammographic evidence of extracapsular rupture with free silicone within the breast parenchyma medial to the implant in two different patients

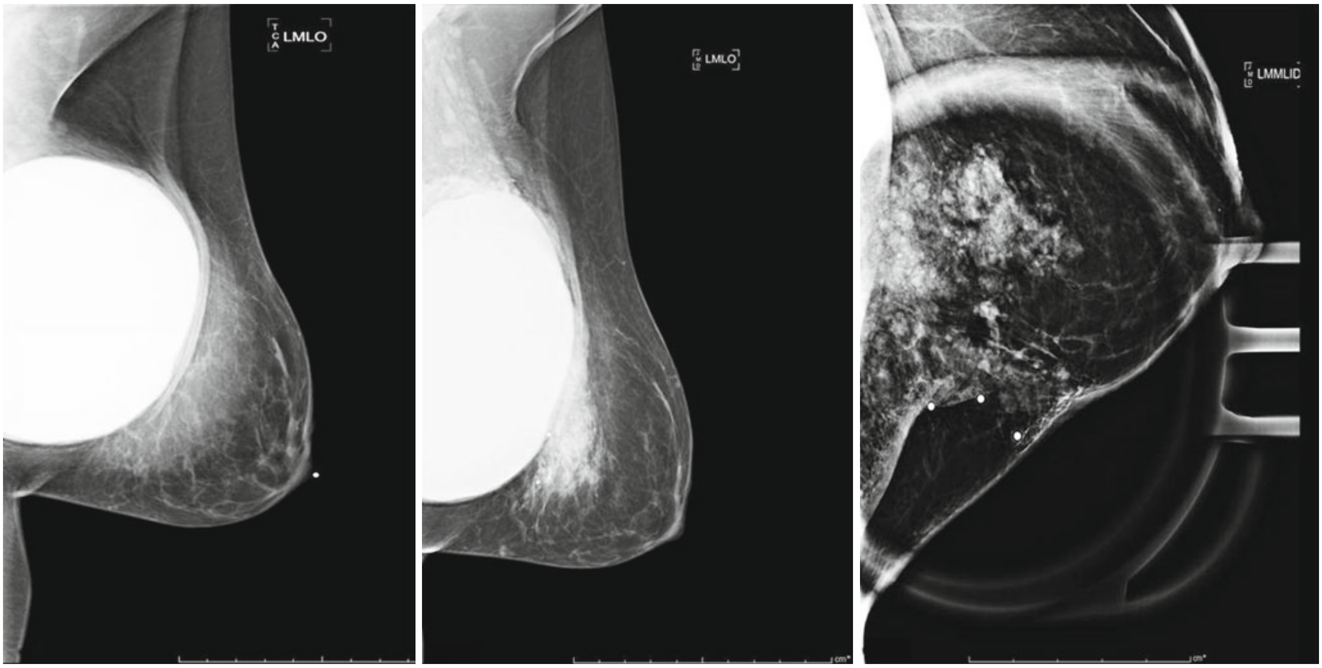


Fig. 16.68 Initial mammogram demonstrates retropectoral silicone implant. The patient returns 2.5 years later with new palpable abnormality in the lower breast. High-density material anterior to the implant in the area of complaint is consistent with extracapsular silicone

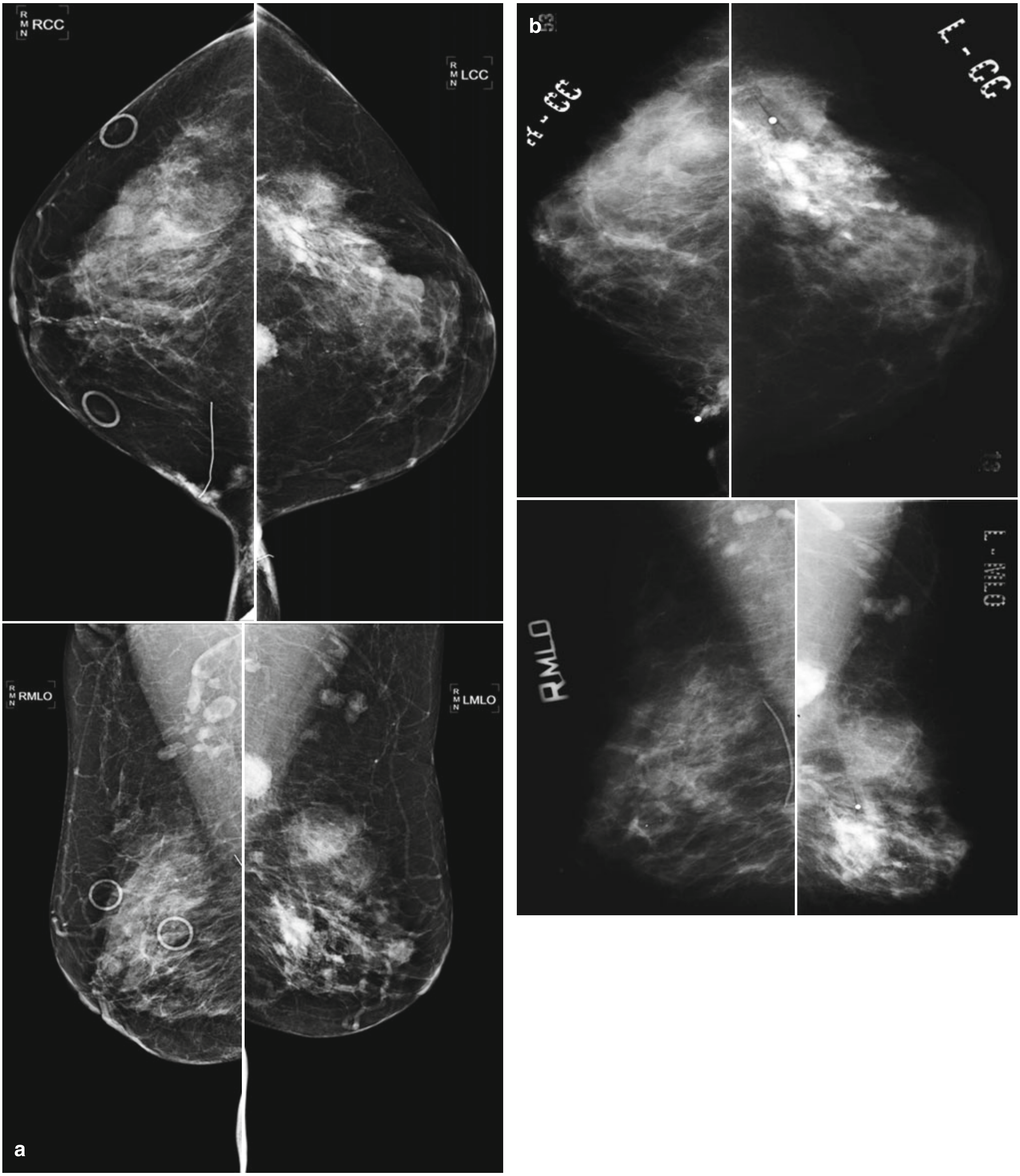


Fig. 16.69 (**a**) A 50-year-old female with history of ruptured silicone implants. Physician detects palpable abnormalities in the upper outer and lower outer left breast and upper inner right breast. (**b**) An outside mammogram from 2 years prior shows no significant change in high-density masses in area of free silicone. (**c**) Multiple silicone granulomas documented in both breasts on ultrasound. (**d**) However, ultrasound of the area of palpable complaint documents a 1.6 cm hypoechoic mass that is different in appearance from the silicone granulomas and has sonographic features of malignancy. Ultrasound-guided core needle biopsy was performed with pathology yielding invasive ductal carcinoma. (**e**) Post-procedure mammogram documents a clip in the mass in the upper outer breast. Note the higher density of the silicone granulomas. (**f**) Axial MRI silicone-sensitive sequence demonstrating high signal in one of the silicone granulomas. Note the absence of increased signal in the area of known cancer in the posterior outer breast. Post-contrast T1 images with fat saturation show enhancement in the known cancer and no enhancement in the area of the silicone granuloma

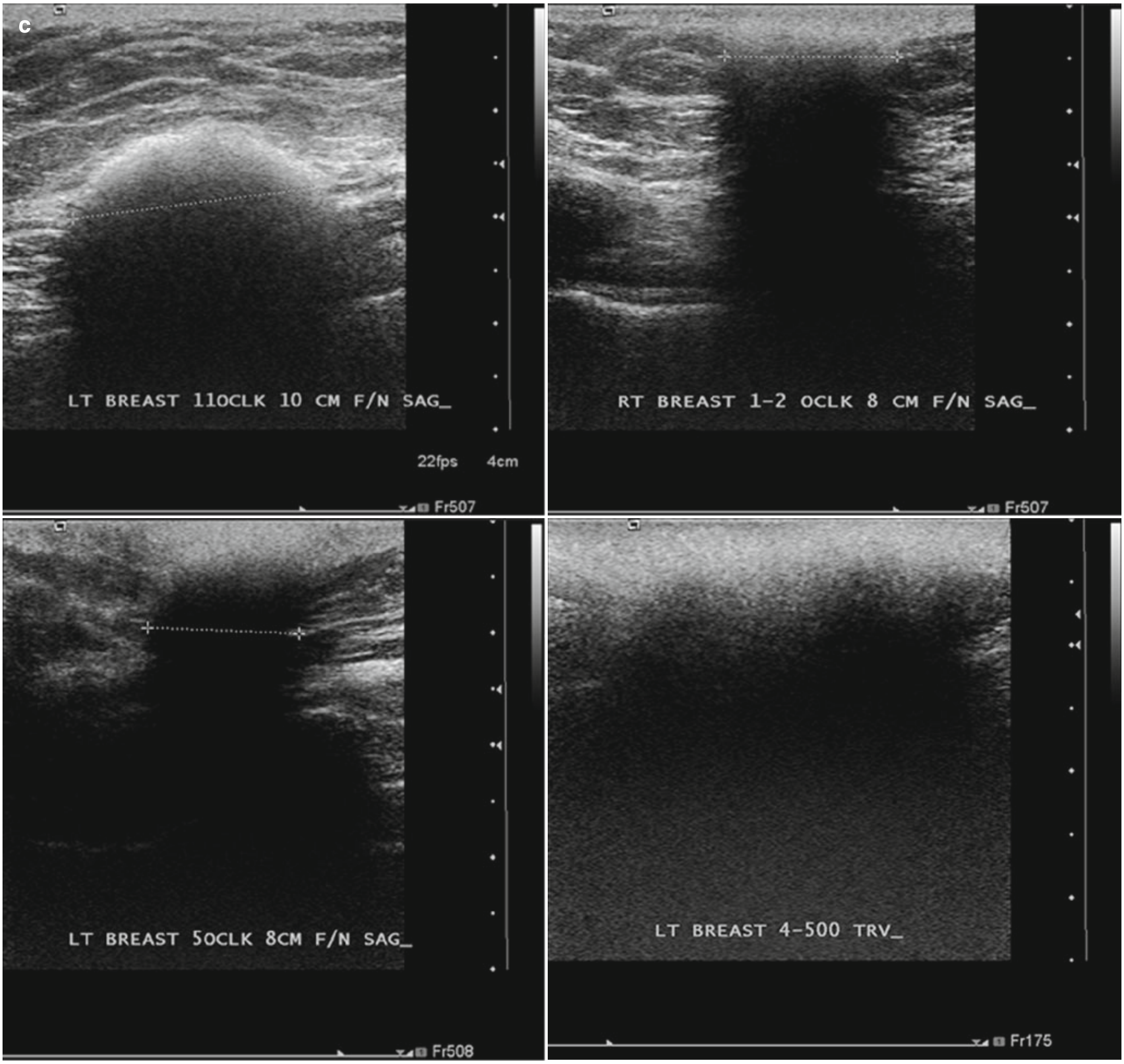
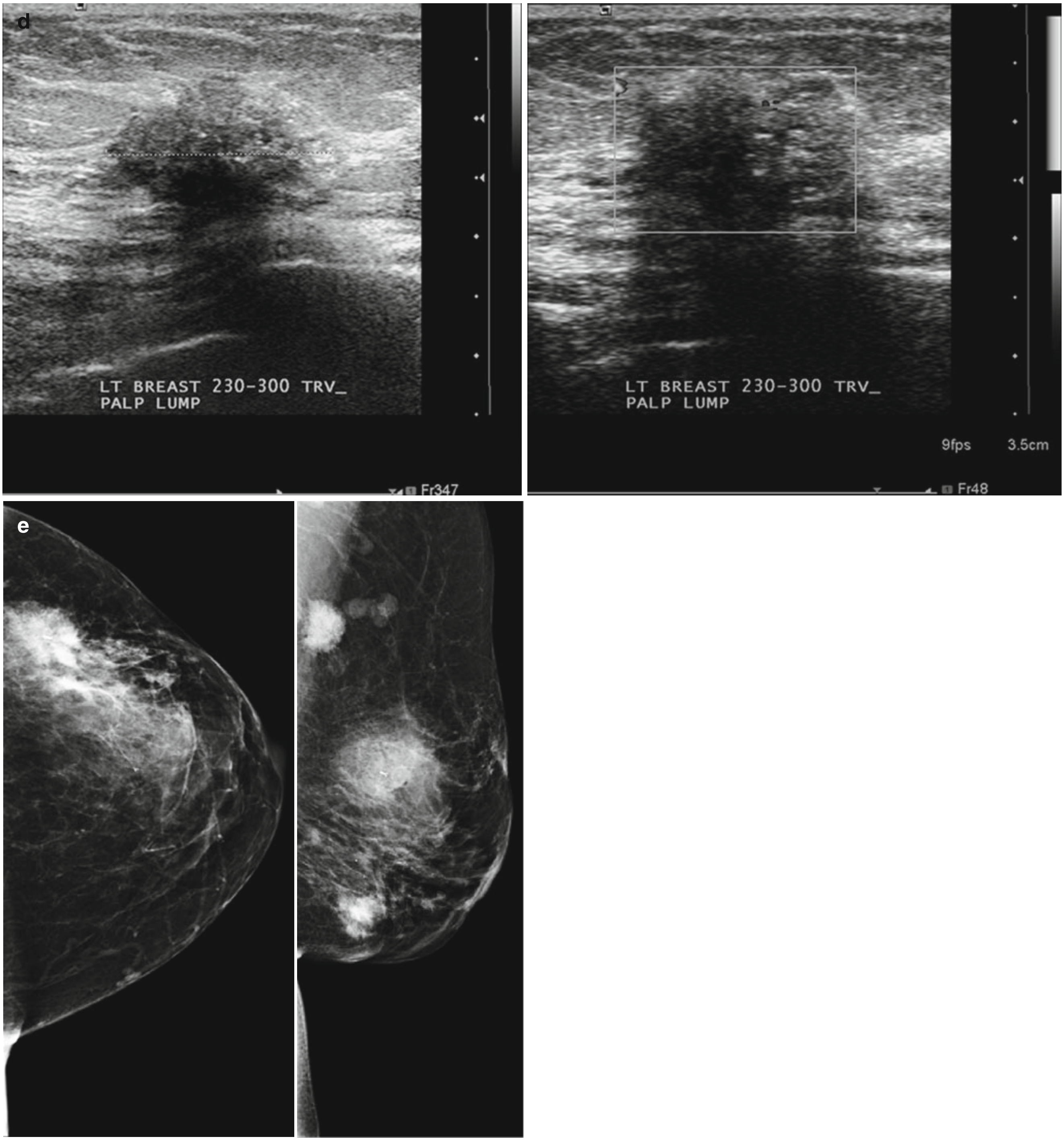


Fig. 16.69 (continued)



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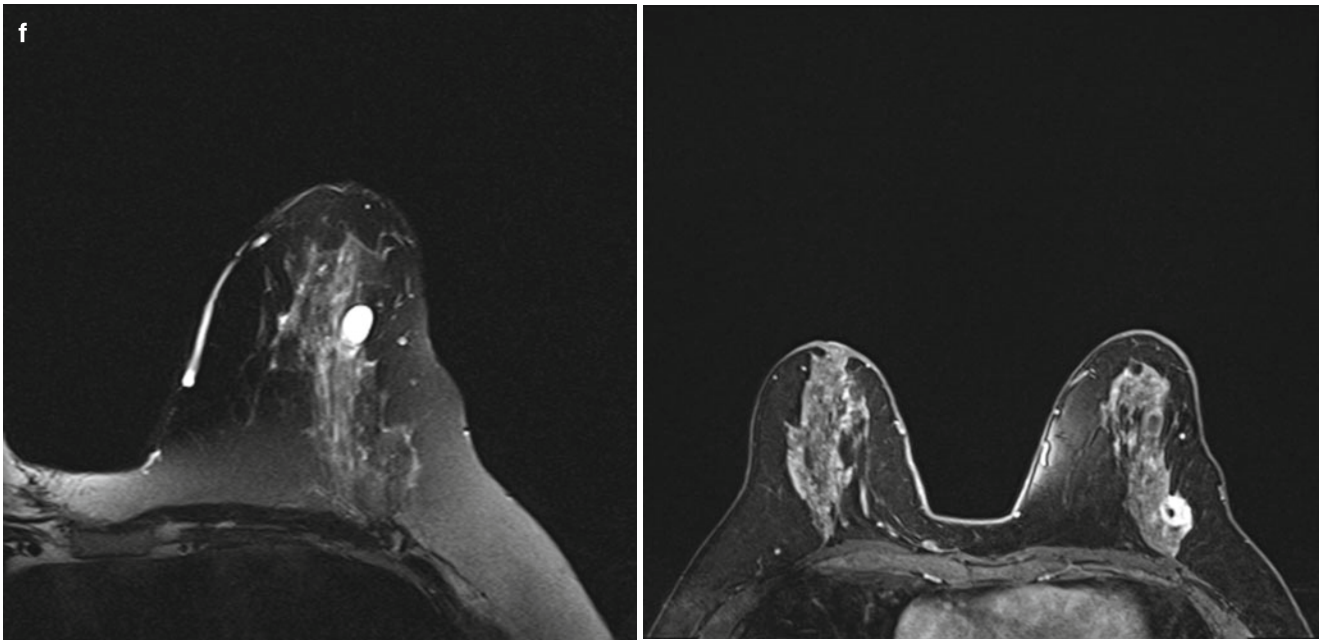

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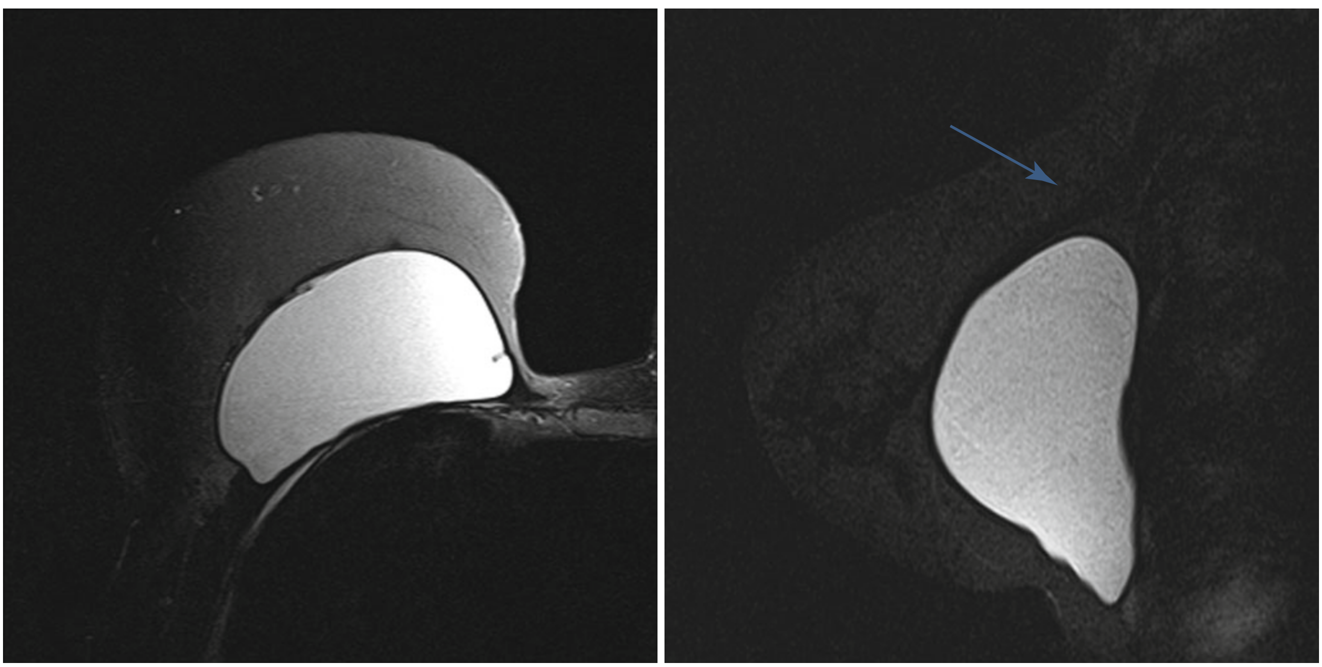


Fig. 16.70 Breast MRI with silicone-sensitive sequences demonstrates an intact retropectoral implant without evidence of intracapsular or extracapsular rupture. The pectoralis muscle (*arrow*) is visualized as a dark structure overlying the implant on the sagittal view

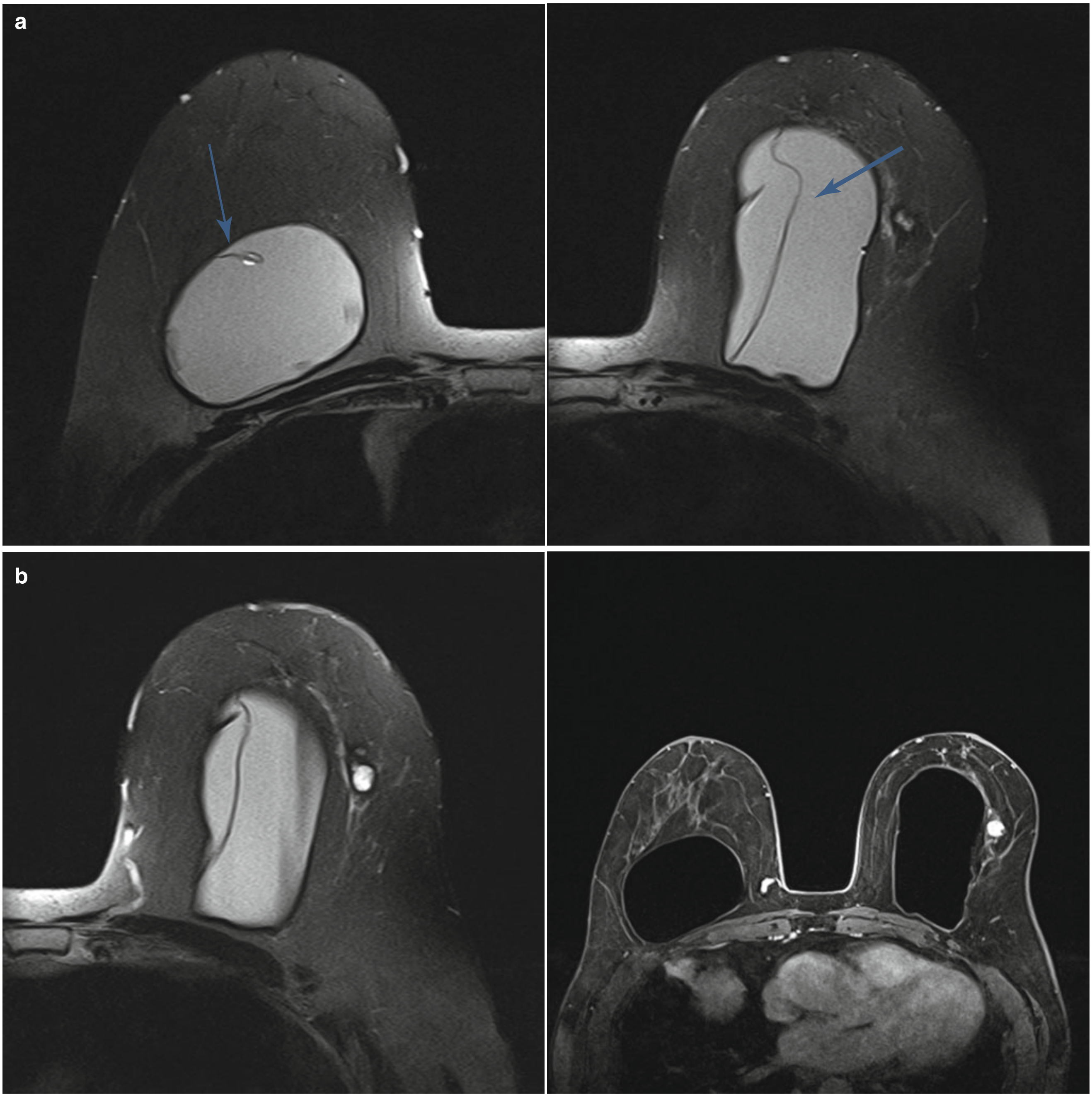


Fig. 16.71 (**a**) Bilateral prepectoral silicone implants with intracapsular rupture. The right implant demonstrates the "keyhole sign" (*arrow*) with silicone seen within a portion of free-floating envelope. The right implant demonstrates the classic "linguini" sign (*thick arrow*). Increased T2 signal lateral to the left implant raised the question of possible extracapsular silicone. (**b**) Correlation with the post-contrast study provided clarification. A 1 cm known cancer in the central outer left breast had increased T2 on a silicone-sensitive sequence. However, enhancement is present on the T1 post-contrast image with fat saturation. Free silicone should not enhance confirming the presence of malignancy rather than extracapsular silicone

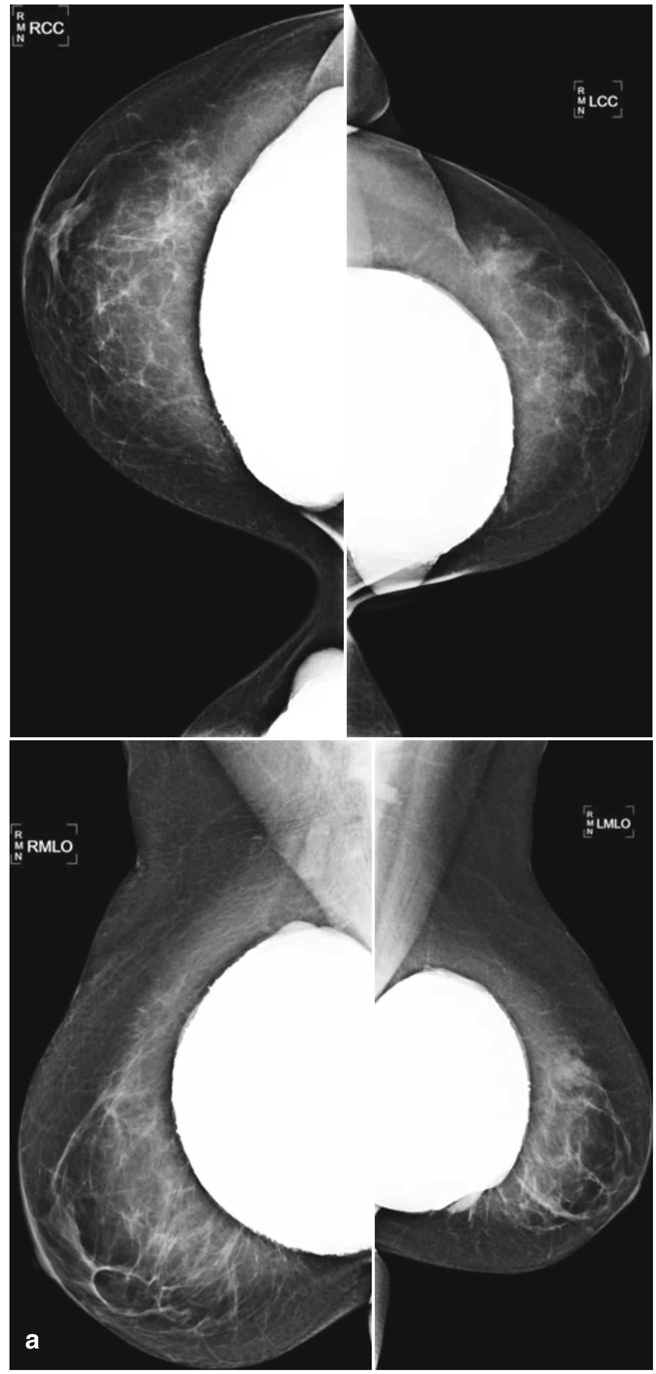


Fig. 16.72 (**a**) A 60-year-old female with prepectoral silicone implants and new palpable abnormality in the medial left breast. Mammography demonstrates a focal bulge in the medial aspect of the left implant. High-density material is visualized within the breast parenchyma along the inferior aspect of the left implant. (**b**) Silicone-sensitive MRI sequences demonstrate both intracapsular and extracapsular implant rupture. A focal bulge of the implant is visualized in the medial left breast corresponding to the palpable complaint. Extracapsular silicone is also visualized anterior to the implant on the sagittal view. (**c**) Axial T2 images demonstrate intracapsular rupture bilaterally. (**d**) The patient subsequently elected for implant explantation with postsurgical changes in the posterior central breast. Note coarse capsular calcifications and nodular silicone granulomas

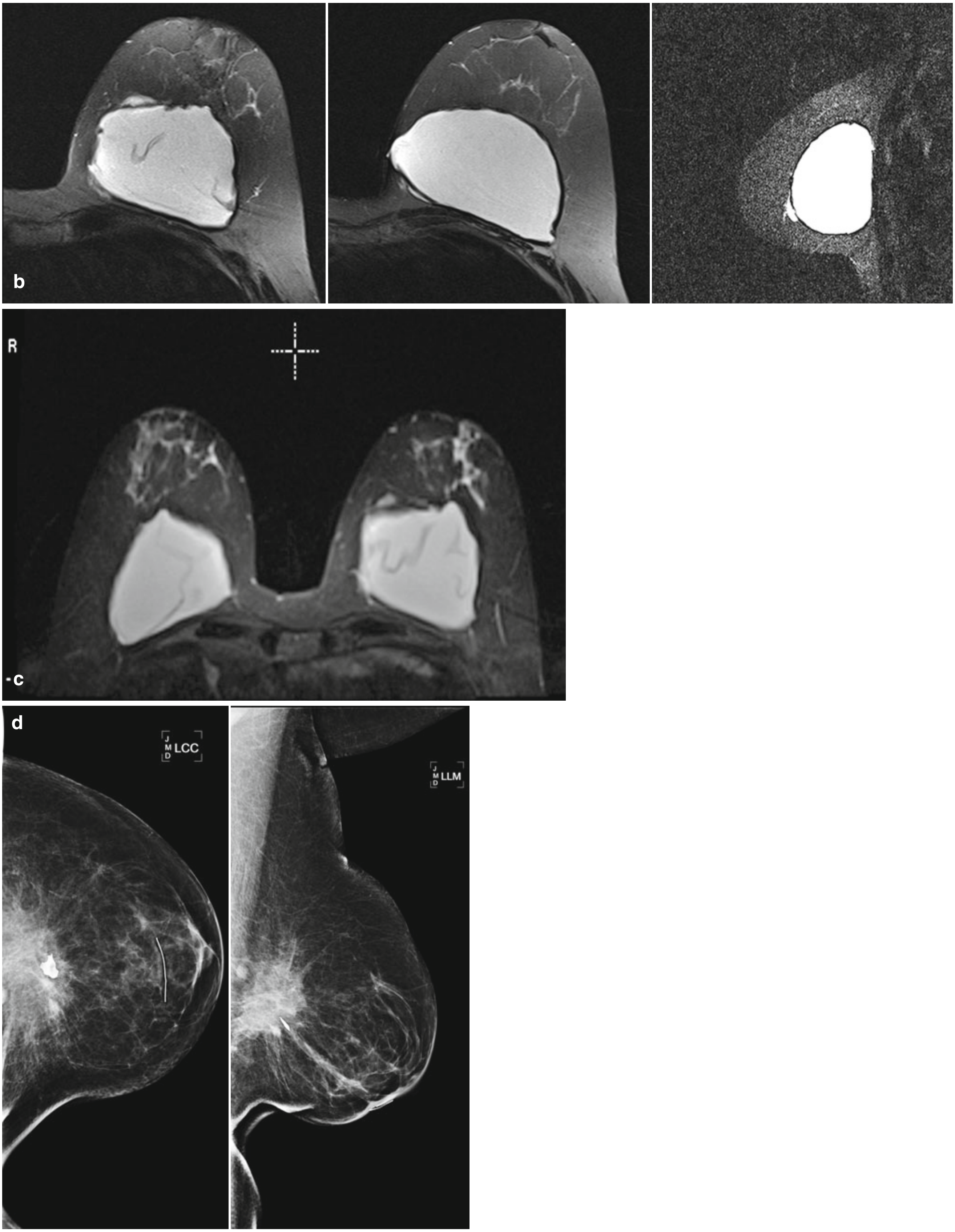


Fig. 16.72 (continued)

Fig. 16.73 A 57-year-old woman status post left lumpectomy. History of bilateral breast implant explantation 10 years prior to cancer diagnosis. Post-lumpectomy changes are present in the anterior left breast. Postsurgical calcifications and coarse capsular calcifications are visualized in the posterior central left breast. No significations that residual changes are present in the right breast

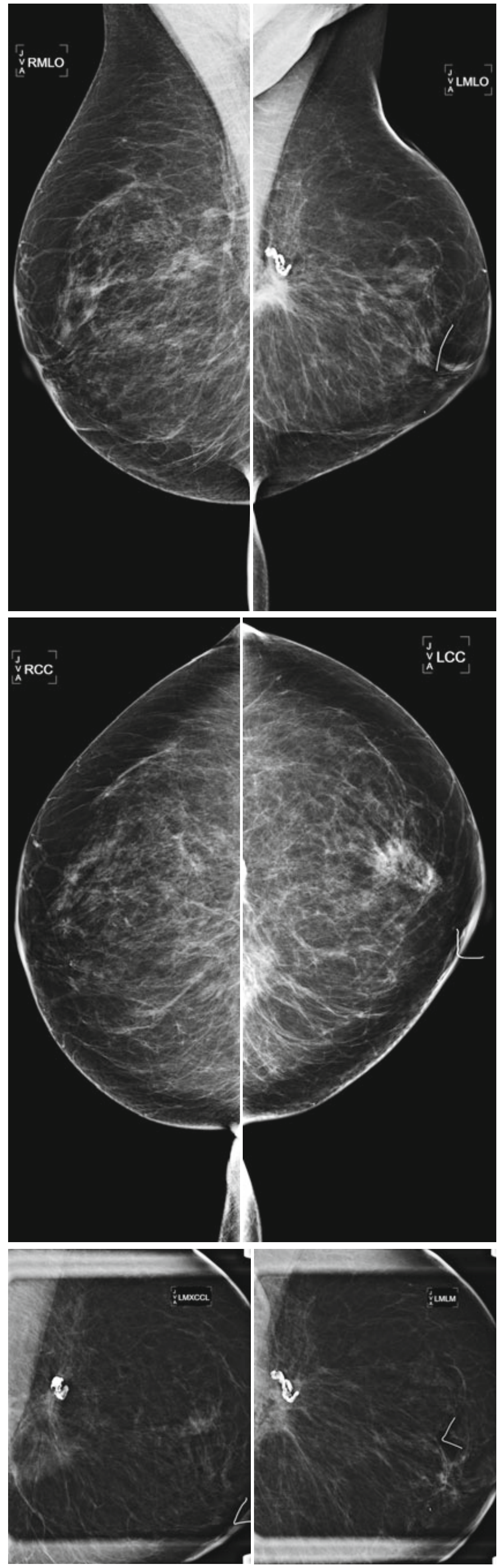
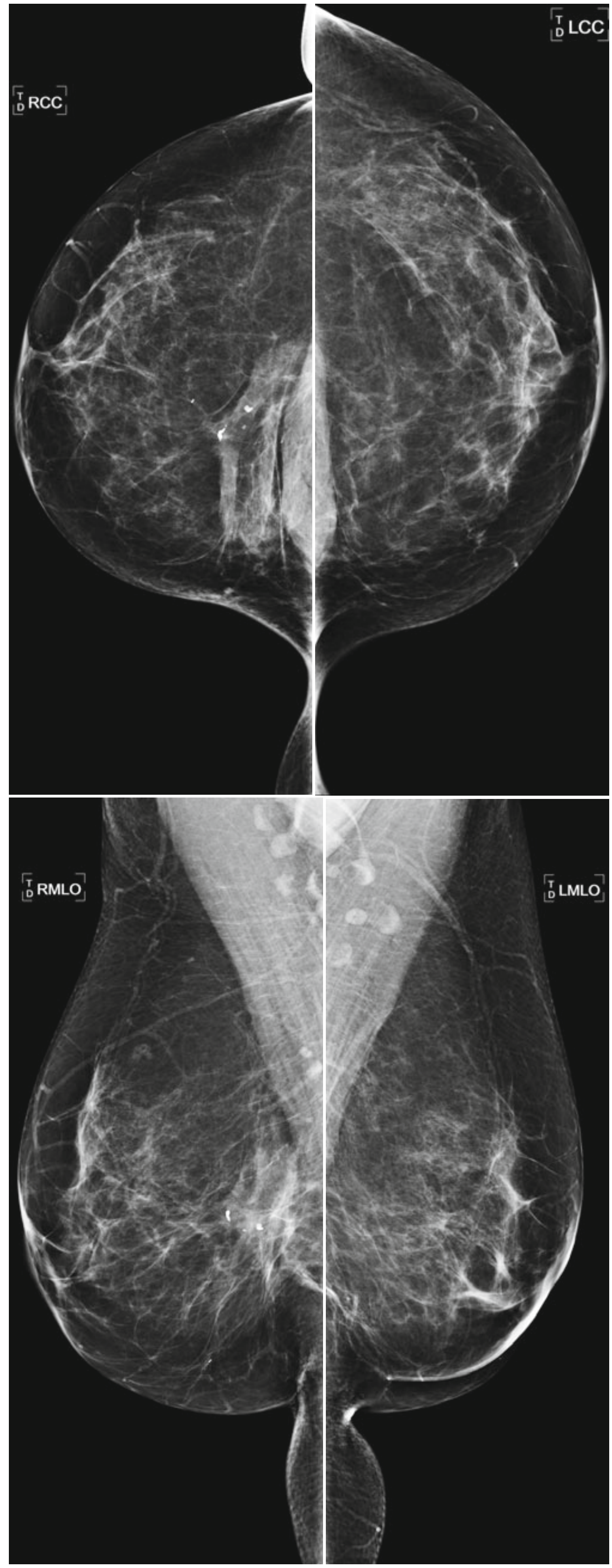


Fig. 16.74 Screening exam in a 50-year-old female with history of implant explantation. The patient had a strong family history of breast cancer in a premenopausal sister. The posterior central right breast is obscured by postsurgical changes



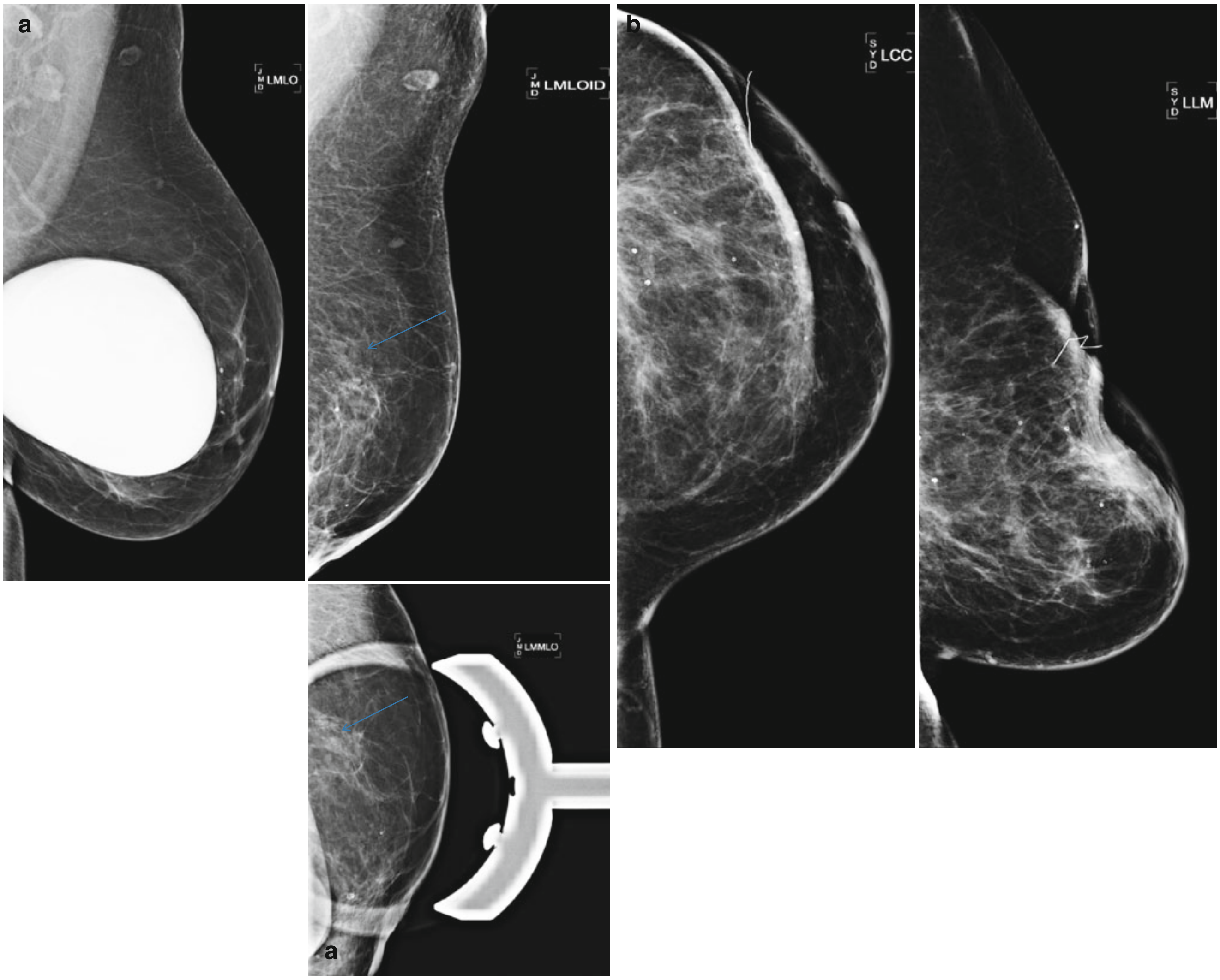


Fig. 16.75 (**a**) A 70-year-old female with faint calcifications barely perceptible on MLO implant displaced view (*arrow*) prompted spot magnification views. Spot magnification view demonstrates 8 mm of very faint heterogenous calcifications (*arrow*) just anterior to the implant. Stereotactic biopsy was performed with pathology yielding DCIS. (**b**). Six-month follow-up mammogram following lumpectomy demonstrates significant distortion of the upper outer breast at the site of lumpectomy. The silicone implant was ruptured on MRI and was removed at the time of surgery with minimal post-explantation change also noted in the posterior central breast

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