Mammographic Findings after Breast Conservation Therapy[1]

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LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

- Outline the time course of mammographic findings after breast conservation therapy.
- Identify common mammographic findings after breast conservation therapy.
- Identify recurrent malignancy in women who have undergone breast conservation therapy.
- Assess the role of mammography in evaluating the treated breast.

Breast conservation therapy for breast cancer involves lumpectomy or segmental mastectomy followed by radiation therapy. Masses, fluid collections, architectural distortion, scarring, edema, skin thickening, and calcifications are posttreatment findings that may mimic or mask local tumor recurrence. Despite the overlap between posttreatment changes and tumor recurrence, the two entities can usually be distinguished by the characteristic mammographic appearances of posttreatment sequelae and by comparing interval findings on successive studies. Postoperative masses and fluid collections slowly diminish in size and usually resolve by 1 year after surgery. Radiation-induced edema gradually resolves; increasing edema may be due to recurrent cancer. Postsurgical scarring usually appears as a poorly marginated soft-tissue mass with interspersed radiolucent areas. Recurrent cancer is usually seen as a mass with no central radiolucent areas. Pleomorphic and granular microcalcifications are important markers for recurrent cancer and can usually be distinguished from the thick, calcified plaques and elongated dystrophic calcifications associated with scarring.

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■ INTRODUCTION

Breast conservation therapy, which involves lumpectomy or segmental mastectomy followed by radiation therapy, for treatment of breast cancer has gained increased acceptance in the United States. Equivalent survival rates have been demonstrated for breast conservation therapy and mastectomy (1,2). Tumor recurrence rates after breast conservation therapy have been reported at 7% at 5 years and 14% at 10 years (3). Detection of local recurrence is important, as mastectomy to treat recurrence after breast conservation therapy is associated with a 5-year actuarial survival rate of 84% (4).

This article briefly describes breast conservation therapy and follow-up mammography and discusses the common mammographic findings in women who have undergone this treatment. Although these findings may mimic or mask local tumor recurrence, radiologists who are familiar with the characteristic appearances of posttreatment sequelae on serial mammograms and who understand the concept of stabilization of mammographic findings should be able to differentiate between benign and malignant entities. The article emphasizes a tailored mammographic approach, aimed at detection of recurrent tumor and assessment of posttreatment complications.

■ BREAST CONSERVATION THERAPY

In breast conservation therapy, the malignant lesion is removed by wide local excision or segmental mastectomy. Three to eight weeks following surgery, the patient undergoes radiation therapy.

Cosmesis is an important objective of the conservative surgical approach. In most women, a curvilinear incision is made directly over the lesion, and the lesion is removed along with a rim of grossly normal breast tissue. Only the subcutaneous fat and subcuticular layers are sutured. The deeper tissues are allowed to fill in with fluid gradually or are injected with sterile saline intraoperatively.

The breast is irradiated (Fig 1) by using tangential radiation fields to a total dose of 5,000 cGy (200-cGy fractions, five times a week, over a 5-week period). A 1,000-cGy boost dose to the tumor bed may be added for close tumor margins of less than 5 mm (5).

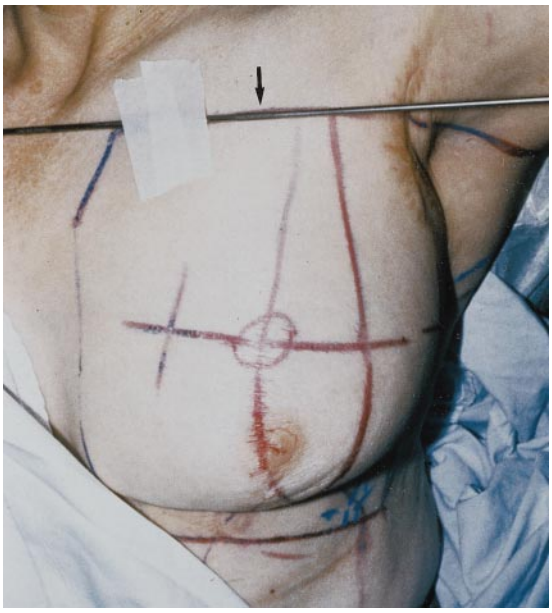


Figure 1. Preparation for radiation therapy. Photograph shows a breast that has been marked for radiation therapy. The metal bar (arrow) marks the upper edge of the radiation field. (Courtesy of Eric A. Strom, MD, University of Texas M.D. Anderson Cancer Center, Houston, Tex.)

■ POSTTHERAPY MAMMOGRAPHY

Mammography is performed after breast conservation therapy (*a*) to confirm removal of the lesion, (*b*) to identify postprocedural fluid collections, (*c*) to detect residual and recurrent cancer, and (*d*) to screen for metachronous cancers in the ipsilateral breast and the contralateral breast (6).

The treated breast is a rapidly changing organ, and early postoperative mammograms may demonstrate many findings, which usually evolve and resolve over time. Masses, fluid collections, architectural distortion, scarring, edema, skin thickening, and calcifications are posttreatment findings that may mimic or mask local tumor recurrence. Radiation therapy not only exacerbates these changes but also delays resolution.

Despite the significant overlap between the mammographic appearances of posttreatment changes and tumor recurrence, it is usually possible to distinguish between the two entities based on the characteristic appearances of posttreatment sequelae on serial mammograms and by understanding the concept of stabilization of the mammographic findings. *Stabilization* is defined as the lack of interval change on two

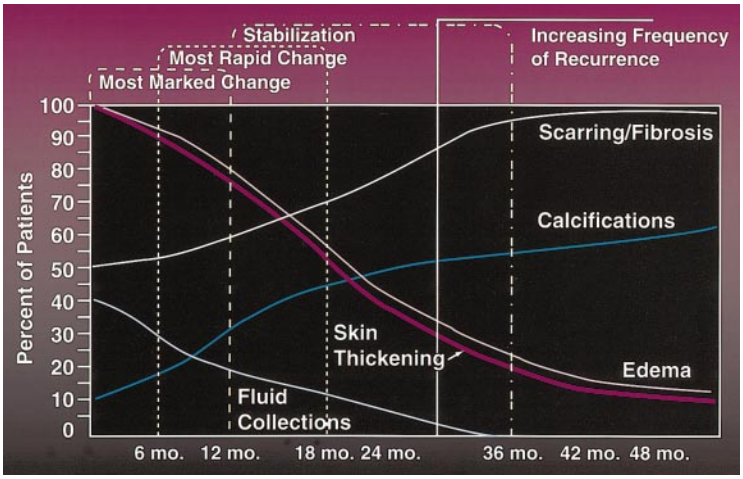


Figure 2. Graph depicts the frequency of characteristic mammographic findings in 6- and 12-month intervals after breast conservation therapy. (Adapted, with permission, from reference 6.)

successive studies. After stabilization has been achieved, a new mass, new microcalcifications, architectural distortion, or an area of increased soft-tissue density at the lumpectomy site should be investigated for possible tumor recurrence (6).

● Screening Intervals

Mammography performed 6–12 months after tumor excision will demonstrate the greatest postprocedural changes (7). Resolution of postoperative mammographic findings takes place over broad time intervals (6) (Fig 2). Mammographic stability is usually achieved around the time that tumor recurrences first begin to appear, which is 2–3 years after breast conservation therapy.

Protocols for posttreatment mammographic surveillance vary. At many centers, postsurgical mammograms are obtained before the initiation of radiation therapy. At our center, postsurgical, pre–radiation therapy mammograms are not obtained routinely unless there are long delays in the treatment sequence. At our center, the first mammograms of the treated breast are usually obtained 6 months after the completion of radiation therapy, along with mammograms of the contralateral breast. Thereafter, both breasts are imaged annually.

● Mammographic Techniques

When examining patients who have undergone breast conservation therapy, the mammographer should be aware of the types of treatment, the dates of the treatment procedures, and the presence of early postsurgical complications, such as hematomas or seromas. Some surgeons deploy clips at the margins of the lumpectomy site to focus follow-up mammography and to guide radiation therapy planning. Palpable masses, dermal lesions, and scars should be marked with small radiopaque markers or with thin wires taped to the skin.

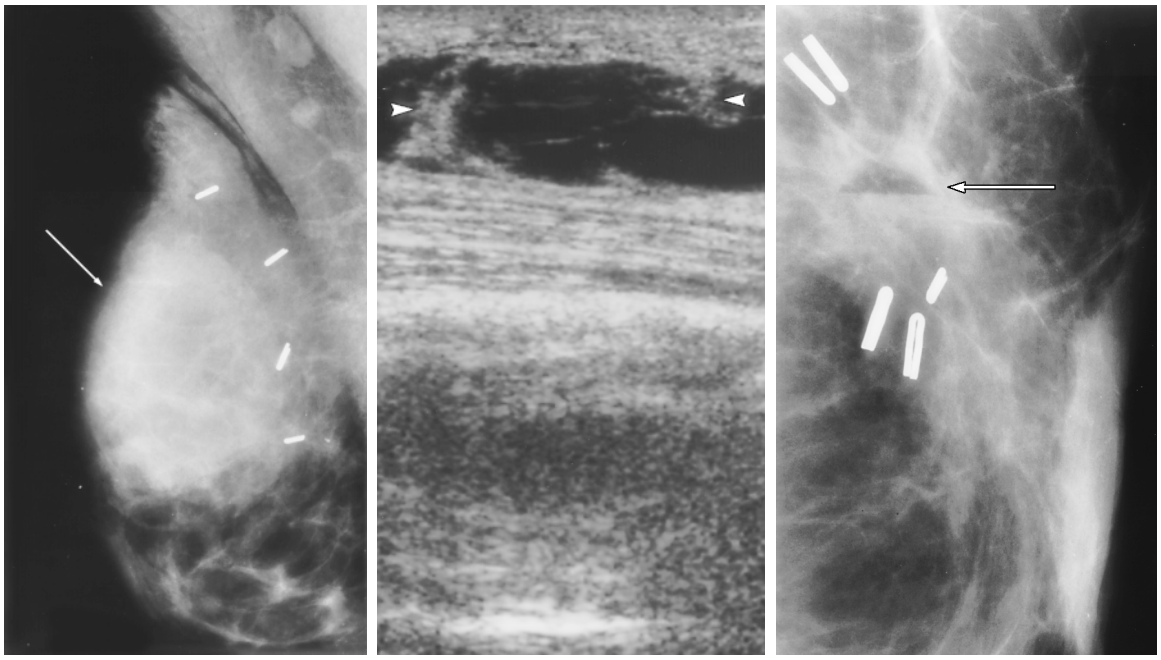
Mammographic interpretation requires familiarity with the temporal changes in the appearance of the conservatively treated breast. Mammograms are evaluated in sequence and are compared with several earlier studies and not just the most recent mammograms. Additional images, such as spot compression, magnification, and tangential views, are useful in many patients.

■ COMMON POSTTHERAPY MAMMOGRAPHIC FINDINGS

● Masses and Fluid Collections

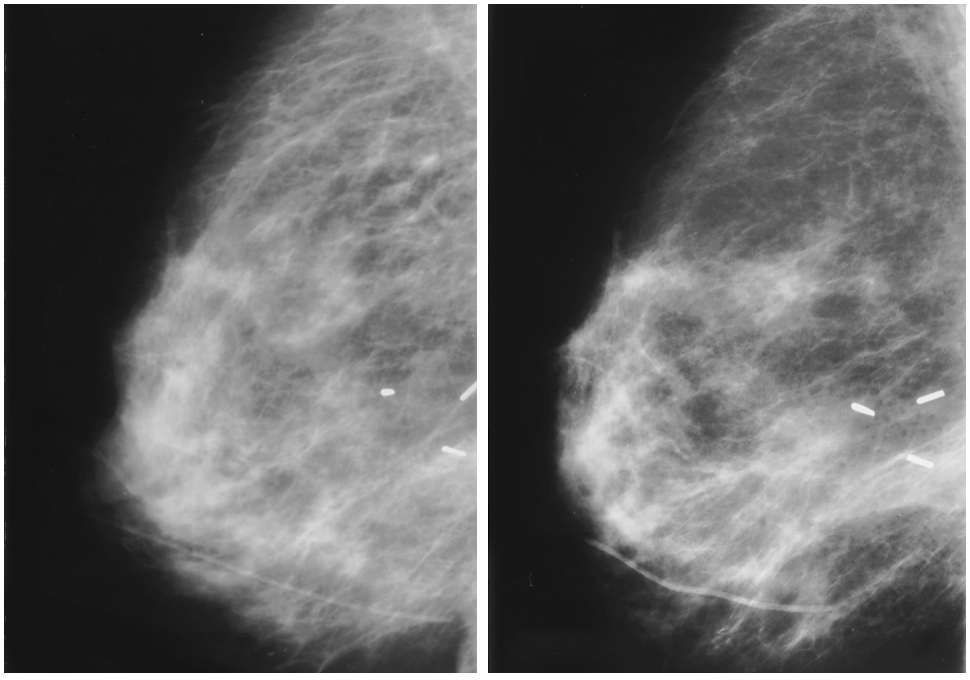
Hematomas, seromas, abscesses, fat necrosis, and fibrosis may manifest as palpable or mammographically detected masses in patients who have undergone breast conservation therapy (8). Abscess formation is suspected when the mass is tense and tender and when the patient exhibits systemic symptoms such as fever and chills.

At mammography, postoperative fluid collections are identified in 50% of patients at 4 weeks and in 25% of patients at 6 months after surgery (6). Most postoperative fluid collections resolve by 12 months. Fluid collections are usually characterized as oval, dense, well-defined masses with few spiculations or irregularities (6,9) (Fig 3). Layering of air and fluid may be present on the 90° lateral view (Fig 4) in the early postoperative period. Sonography can be helpful for



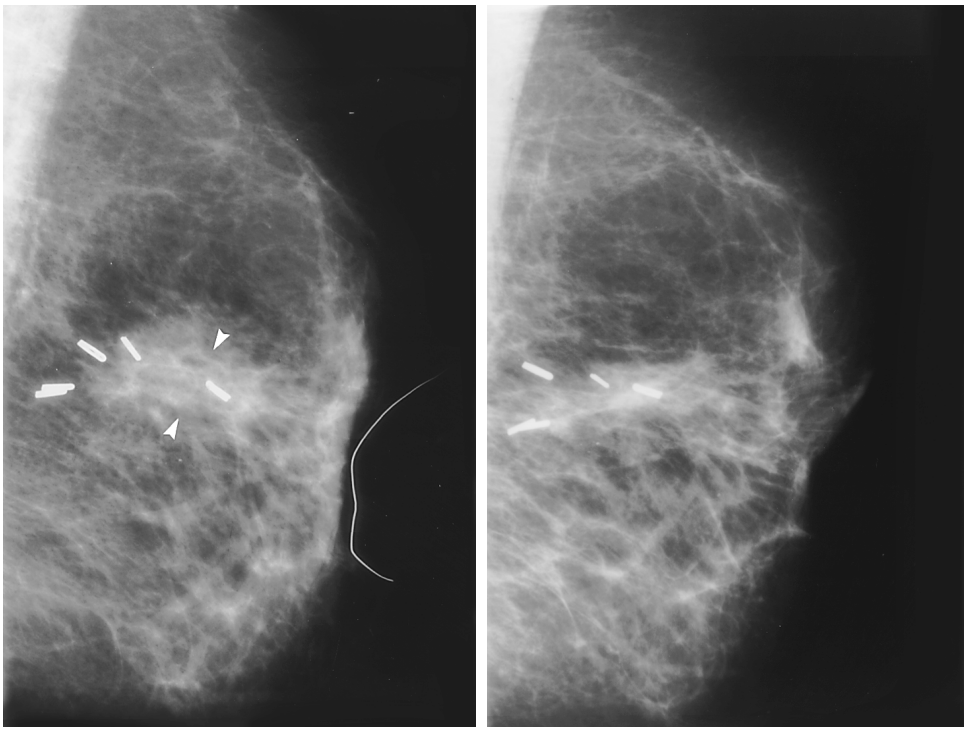
3a. 3b. 4.

Figures 3, 4. **(3)** Postoperative seroma. **(a)** Mediolateral oblique view shows a large, dense round mass (arrow) in the upper right breast. **(b)** Sonogram of the upper outer right breast shows a large fluid collection with septations (arrowheads). **(4)** Layering of air and fluid. Magnified mediolateral view demonstrates an air-fluid level (arrow).



a. b.

Figure 6. Increased breast density due to edema. **(a)** Mediolateral oblique view shows diffuse increased density secondary to radiation-induced edema. **(b)** Mediolateral oblique view obtained 1 year later shows decreased density, consistent with resolving edema.



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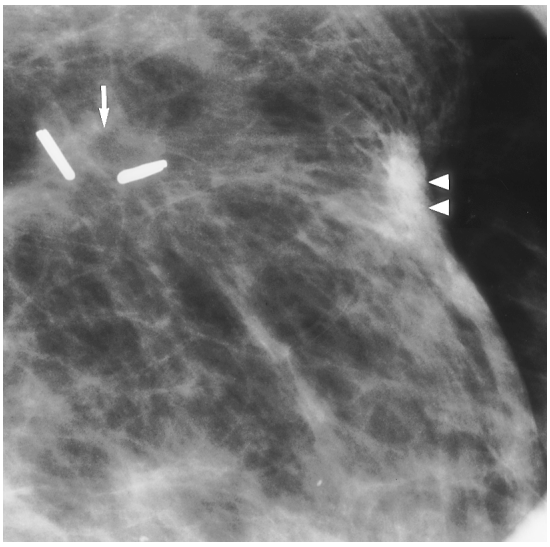


c.

Figure 5. Scar diminishing over time. **(a)** Mediolateral oblique view from 1995 shows scar (arrowheads) and skin thickening. **(b)** Mediolateral oblique view from 1998 shows contraction and shrinkage of the scar. **(c)** Magnified lateral medial view demonstrates fat (arrow) entrapped within the scar and skin thickening (arrowheads).

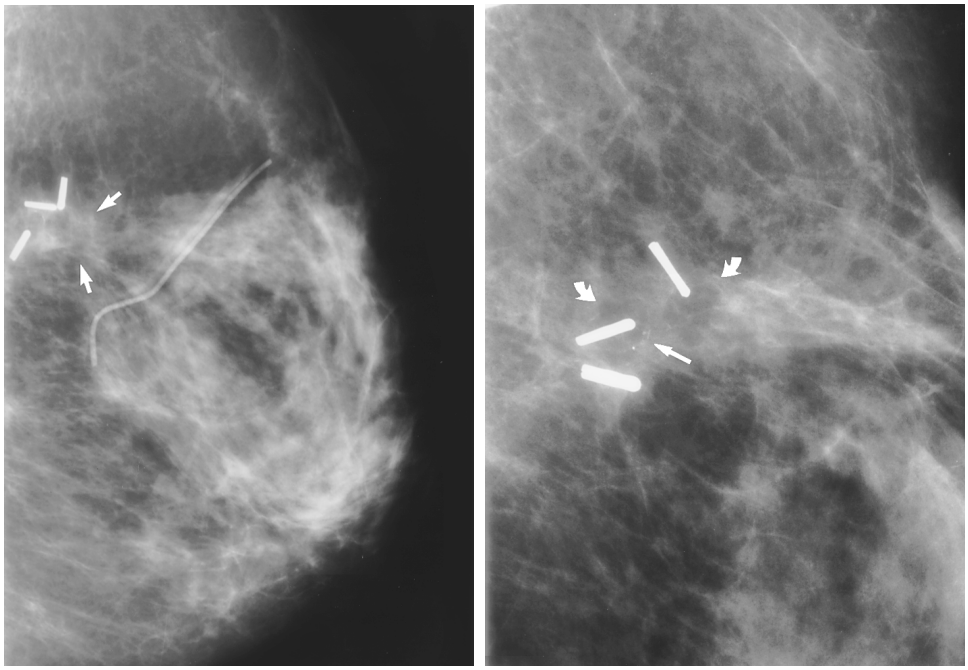
guiding drainage of postoperative fluid collections and for identifying echogenic components within the collections (Fig 3). Most masses slowly diminish in size and evolve into scars by 1 year after surgery (Fig 5).

• Increased Breast Density

At mammography, radiation-induced edema manifests as diffuse increased density (10) (Fig 6). Trabecular thickening may also be seen secondary to edema. Edema that increases after stabilization is a suspicious finding. The differential diagnosis of recurrent edema includes lymphatic spread of cancer, congestive heart failure, and infection.

• Skin Thickening

In patients who have undergone radiation therapy, clinical examination usually reveals skin thickening. The normal skin thickness is 2 mm. Following radiation therapy, the skin thickness may



a. b.

Figure 8. Architectural distortion at the surgical site. **(a)** Lateral medial view shows increased density at the surgical site (arrows). **(b)** Magnified laterally exaggerated craniocaudal view demonstrates architectural distortion with fat entrapment (curved arrows) at the surgical site. Faint rim calcifications (straight arrow) outline the entrapped fat.

measure up to 1 cm (6) (Fig 7). At mammography, maximal skin thickening is usually identified in the first 6 months after completion of radiation therapy. Skin thickening then gradually resolves over 2–3 years to attain stability (6,11) (Fig 5c).

• Architectural Distortion

The differential diagnosis for architectural distortion includes parenchymal scarring, fat necrosis, and recurrent cancer. Postsurgical scarring usually manifests clinically as induration rather than as a distinct mass. In addition, scars contract and shrink as they mature and stabilize. On mammograms, parenchymal scarring is usually identified as a spiculated, poorly marginated soft-tissue density characterized by interspersed radiolucent areas (12) that represent entrapped fat (Fig 8).

Architectural distortion is also characterized by the absence of a central mass, a changing appearance on different projections (6) (Fig 9), and thick, curvilinear spicules (13). In a study of mammographic findings after surgical excision, Mitnick et al (12) distinguished 17 cases of benign scar from seven cases of carcinoma on the basis of central lucencies in benign cases and central densities in malignant cases.

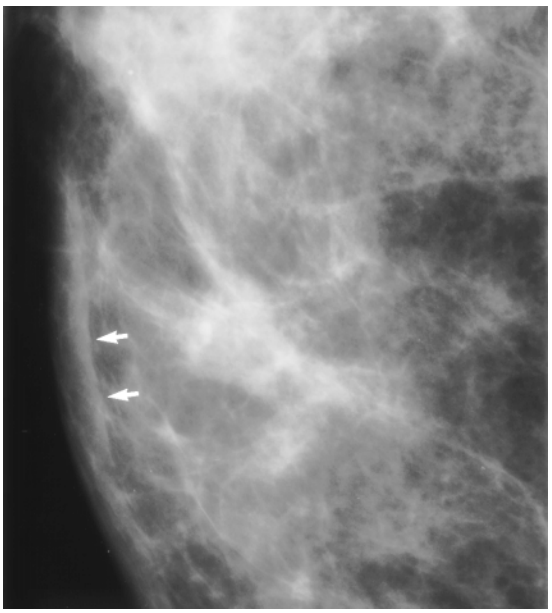
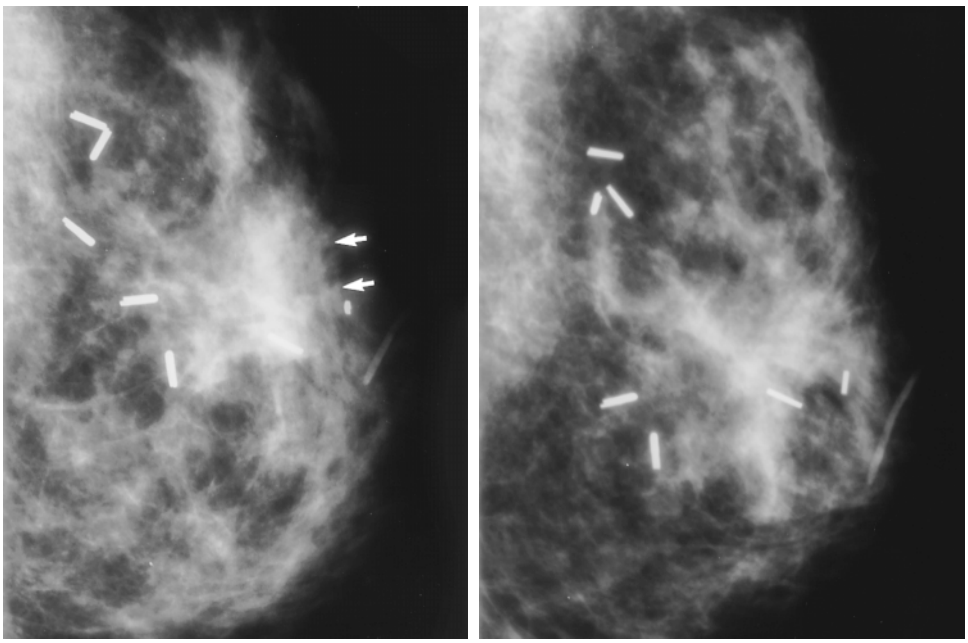


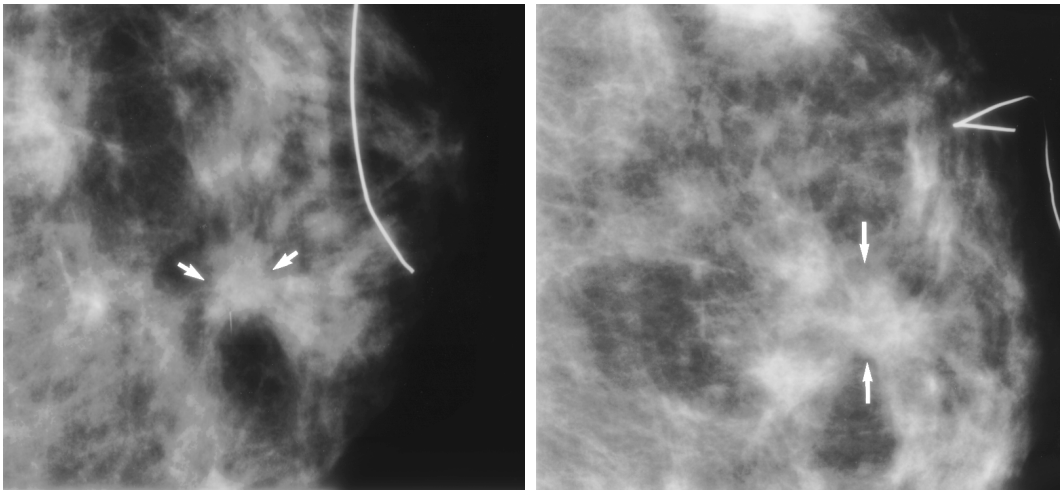
Figure 7. Skin thickening. Magnified craniocaudal view demonstrates skin thickening (arrows).

Mammographic findings suggestive of recurrent cancer include lack of central radiolucent areas; a central mass (Fig 10); fine, straight spiculations; skin retraction; and an increase in size or nodularity of the scar.



a. **b.**

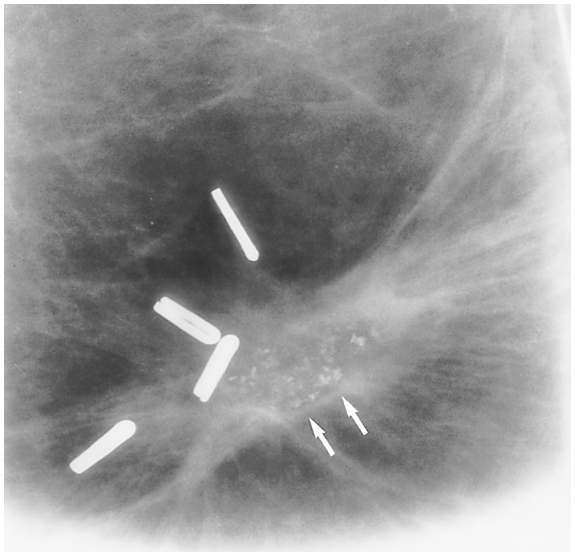
Figure 9. Postoperative architectural distortion. **(a)** Left medial lateral view demonstrates increased density (arrows) in the anterior breast. **(b)** Left mediolateral oblique view shows a changed appearance, suggestive of architectural distortion rather than a mass.



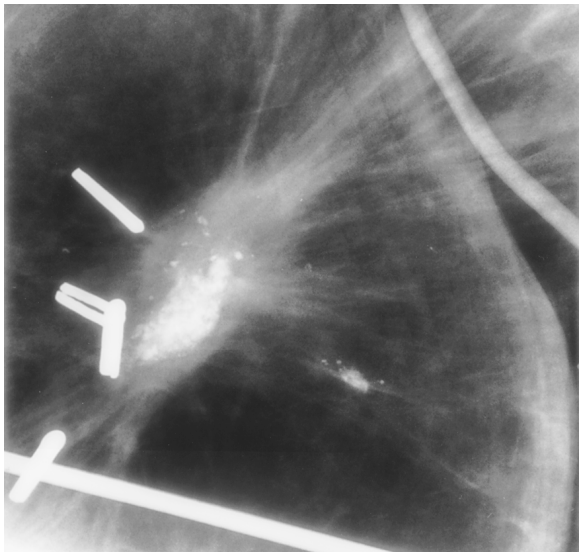
a. **b.**

Figure 10. Recurrent cancer at the surgical site. **(a)** Left craniocaudal view shows an irregular mass with fine spiculations (arrows) at the surgical site. **(b)** Left medial lateral view demonstrates the mass (arrows). Analysis of the surgical specimen obtained at mastectomy revealed invasive lobular carcinoma.

Placement of radiopaque markers over the skin incision and supplemental mammographic views are recommended for the evaluation of architectural distortion in the treated breast. The use of tangential views or ultrasonography may help optimally demonstrate the surgical bed separate from a region of skin thickening. Approximately 18 months after breast conservation therapy, magnetic resonance (MR) imaging may be useful in distinguishing scar from recurrent tumor in indeterminate cases (14). Within the first 18 months, contrast material–enhanced MR imaging may yield false-positive results because of postsurgical reaction, abscess formation, or fat necrosis. Fine needle aspiration, core biopsy, or surgical excision may be used to confirm recurrent tumor.

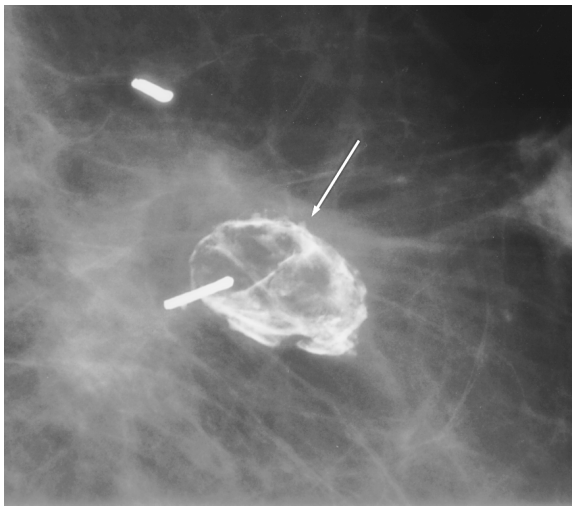


11a.



11b.

Figures 11, 12. **(11)** Progressive fat necrosis at the surgical site. **(a)** Magnified craniocaudal view shows scattered pleomorphic calcifications (arrows) at the surgical site. **(b)** Magnified craniocaudal view obtained 2 years later demonstrates conglomerate, coarse calcifications, consistent with fat necrosis. **(12)** Fat necrosis. Magnified craniocaudal views shows eggshell calcification (arrow) at the surgical site, characteristic of fat necrosis.



12.

• Calcifications

The differential diagnosis for calcifications at the surgical site includes suture calcifications, necrotic tissue, fat necrosis (Figs 11, 12), and recurrent cancer. New benign calcifications are found in the conservatively treated breast with a reported incidence of 28% within 6–12 months after therapy (6). Microcalcifications are also an important marker for new or recurrent cancer after breast conservation therapy, and it has been reported that 43% of mammographically detected cases of recurrent cancer manifested as microcalcifications (15).

Benign calcifications, including needlelike calcifications, thick calcified plaques, and thin arcs of calcium around radiolucent oil cysts (16) (Fig 8b), may occur 2–44 months after breast conservation therapy (6). Benign small, smooth, round, or elongated dystrophic calcifications (Fig 13) may be seen close to the surgical site, and coarse, plaquelike angular calcifications may be associated with parenchymal and subcutaneous scars. Calcified knots (Fig 14), thick branching linear forms, and double tracks may also be seen on mammograms; these findings represent calcified suture material (17).

The presence of pleomorphic or granular microcalcifications is suggestive of recurrent or residual malignancy (Fig 15). Unless new calcifications at the surgical site are unequivocally benign, biopsy should be considered.

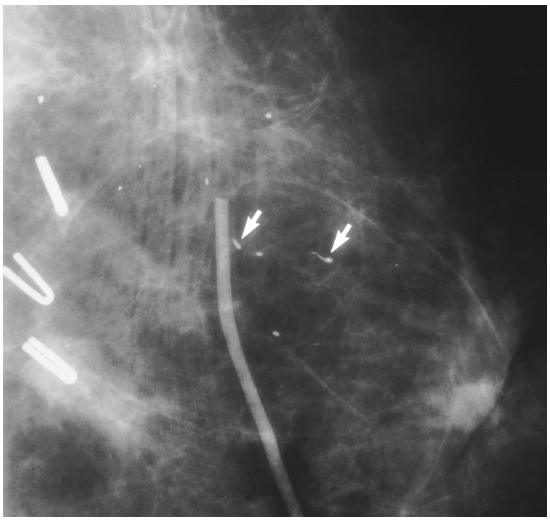


Figure 13. Dystrophic calcifications. Magnified craniocaudal view shows scattered linear dystrophic calcifications (arrows) at the surgical site.

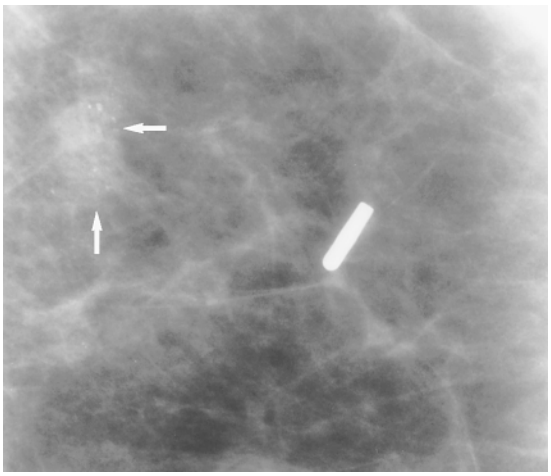


Figure 15. Residual ductal carcinoma in situ. Magnified lateral medial view demonstrates faint calcifications and a vague mass (arrows) near the surgical site. Analysis of the biopsy specimen revealed residual ductal carcinoma in situ.

■ CONCLUSIONS

Routine screening mammography has led to an increase in the detection of small cancers that are amenable to breast conservation therapy.

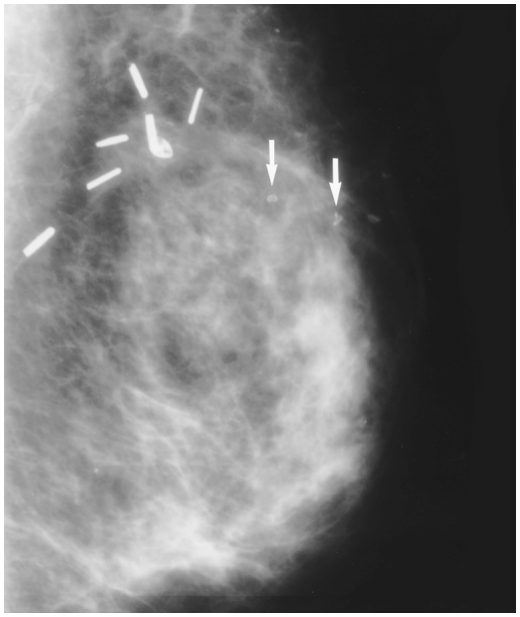


Figure 14. Suture calcifications. Medial lateral view shows scattered, curved and knotted calcifications (arrows), which represent suture calcifications.

Radiologists should be acquainted with the spectrum of mammographic findings commonly seen in women who have undergone conservative treatment for breast cancer. Following breast conservation therapy, mammographic findings such as masses, fluid collections, increased breast density, skin thickening, architectural distortion, and calcifications have characteristic sequences of evolution toward stability. Changes in the mammographic appearance after stabilization should raise suspicions for tumor recurrence.

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