Invasive ductal carcinoma NOS, or no special type, is the most common type of breast cancer representing 65% to 75% of mammary carcinomas (1,2). Depending on the size of the lesion, size of the breast, and proximity of the lesion to the skin, patients can present with a hard, fixed, palpable mass that may cause skin thickening and retraction (Fig. 8.1). If the cancer is in the subareolar area, patients may describe progressive flattening of the nipple, nipple deviation, inversion, or retraction (Fig. 8.2) or changes in the periareolar area (Fig. 8.3). When more advanced, the patient may present with skin ulceration (Fig. 8.4), a mass that protrudes or fungates through the skin (Fig. 8.5), more...
diffuse breast deformity and ulcerations, (Fig. 8.6) or areas of necrotic tissue focally or more diffusely involving the breast (Fig. 8.7). Localized or more diffuse edematous or erythematous changes (peau d’orange) may be apparent; skin nodules reflecting metastatic disease may be seen in patients with locally advanced breast cancer (Fig. 8.6A). Rarely, patients present with spontaneous nipple discharge, and less than 1% of patients present with metastatic disease to the axilla but no clinically or mammographically detectable primary breast lesion. As discussed in Chapter 5, magnetic resonance imaging (MRI; see Fig. 5.27) is useful in depicting the primary lesion in the breast in this group of patients (3).

With the increasing use of screening mammography, patients with invasive ductal carcinomas are diagnosed before signs of cancer are detected clinically or symptoms have developed. A mass with spiculated margins (Figs. 8.1B and 8.8) is one of the most common presentations in asymptomatic women. Less frequently, invasive ductal carcinoma presents as a round (Fig. 8.9), oval (Fig. 8.10), or irregular mass with indistinct margins, less often, circumscribed margins. Although cancers are more commonly iso to high in density, some are low in density, and as such, the density of a mass alone cannot be used to distinguish benign from malignant masses. Likewise, size...
**FIG. 8.4** Skin ulceration, invasive ductal carcinoma NOS, moderately differentiated. Skin ulceration (arrow) with surrounding erythema is present in the upper inner quadrant of the right breast in a 78-year-old patient with an underlying hard fixed mass on palpation. (From Cardeñosa G. *Breast Imaging (The Core Curriculum Series)*, Philadelphía, PA: Lippincott Williams & Wilkins; 2003.)

**FIG. 8.5** Fungating mass, invasive ductal carcinoma NOS, high nuclear grade. **A:** A fungating, necrotic mass is evident in the upper inner quadrant of the left breast in a 54-year-old patient. **B:** Craniocaudal (CC) views. A dense, round mass with indistinct margins posteriorly (short arrows) is partially imaged medially in the left breast; the portion of the mass that extends beyond the skin (long arrows) is outlined by air and therefore appears circumscribed. **C:** MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. An irregular mass (short arrows) with heterogeneous enhancement and central necrosis (long arrow) is imaged protruding from the upper inner quadrant of the left breast. Diffuse skin thickening and edematous changes are also apparent in the subcutaneous tissue. Following neoadjuvant therapy, residual non-enhancing soft tissue is imaged on MRI (see Fig. 5.29B) at the site of the original tumor; no residual malignancy is evident at the time of the mastectomy (e.g., complete pathological response [cPR]) and no metastatic disease is identified in two sentinel lymph nodes.
Additional mammographic presentations for invasive ductal carcinoma include focal parenchymal asymmetry (Fig. 8.11), distortion (Fig. 8.12), or diffuse changes (Fig. 8.13; also see Figs. 9.14 through 9.16). All of the presentations may be found in isolation or in combination (e.g., a mass with associated distortion). They may also be associated with malignant-type calcifications that often reflect the presence of intraductal disease. It is important to describe the calcifications particularly when they extend away from the primary finding. If the calcifications are in tissue extending a distance from the mass, a separate biopsy of the calcifications may be appropriate to establish the extent of disease accurately. In planning preoperative wire localizations in these patients, bracketing may be needed to include the area of the calcifications (Fig. 8.14; also see Figs. 7.2B and 7.3).

Breast cancers occur anywhere in the breast but are reportedly more common in the upper outer quadrants. The upper inner quadrants and subareolar area are the next most common sites for the development of breast cancer. Kopans and coworkers (4) have described a predilection for cancer to develop at the periphery of the glandular tissue just deep to the subcutaneous fat or in the glandular tissue interfacing with retroglandular fat. Stacey-Clear et al. (4) reported that in women under the age of 50, more than 70% of cancers develop in this peripheral zone. Since accessory nipples and glandular tissue (see Fig. 9.23) can be found in some women along the milk lines extending bilaterally from the axillae to the groins, breast cancer can rarely develop outside of the breast proper along these milk lines.

In many women, the mammographic features of the mass (e.g., mass with spiculated margins in a patient with no history of trauma or surgery, or a round mass with linear, casting-type calcifications) are such that an ultrasound may not add additional information with alone is not a reliable criterion in distinguishing benign from malignant masses.

FIG. 8.6 Skin ulceration, metastatic disease to skin, invasive ductal carcinoma NOS, poorly differentiated. A: Deformed right breast in a 97-year-old patient presenting with locally advanced breast cancer. The right breast is smaller, with skin thickening and several areas of ulceration (long arrow) laterally as well as lateral displacement of the nipple areolar complex. Raised, erythematous nodules (short arrows) on the right breast and medially in the left breast represent skin metastases. B: Right mediolateral oblique (MLO) view demonstrating a diffusely abnormal right breast with decreased compressibility as well as skin and trabecular thickening. Skin thickening is particularly prominent at the site of ulceration (arrows). Some of the mammographic findings may be attributable to ipsilateral axillary adenopathy with resulting lymphatic obstruction. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
Invasive ductal carcinoma NOS, low nuclear grade, and DCIS, cribriform pattern. Spot compression view, right breast CC projection in a 51-year-old patient. Round iso dense mass with spiculated margins. This is a common mammographic presentation for invasive ductal carcinoma. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. When the mass has spiculated margins, it is more commonly a low- to intermediate-grade invasive lesion (e.g., infiltrative pattern). When low-grade invasive lesions have associated DCIS, it is typically low- to intermediate-grade DCIS. In this patient, the tumor is estrogen- and progesterone-positive and HER2/neu-negative. The sentinel lymph node (LN) biopsy (0/3 LNs) is negative.

FIG. 8.7 Necrotic breast, invasive ductal carcinoma NOS, locally advanced with metastatic disease to the contralateral axilla. A: The right breast is necrotic and completely replaced by a locally advanced breast cancer in a 50-year-old patient. No nipple areolar complex is evident with necrosis extending into the subclavicular area and the mid-axillary line. Hard masses are palpated in the contralateral (left) axilla. B: CT scan image demonstrating a mass almost completely replacing the right breast with involvement of the skin, as well as the pectoralis and anterior serratus muscles; axillary adenopathy is present bilaterally but because of patient positioning, it is only seen in the left axilla (arrow) on this image. The patient’s management will, in large part, depend on the physical findings and ultrasound features of the palpable area. Marked hypoechoicinity, spiculation, microlobulation, vertical orientation, angular margins, a thickened echogenic rim, calcifications, extension of tumor into ducts extending toward the nipple, and branching of tumor away from the nipple with variable amounts of shadowing are findings on ultrasound (see Figs. 4.39 through 4.43) associated with malignant lesions (5). In patients with predominantly fatty tissue, less commonly glandular tissue, the ultrasound study may be normal because the lesion is isoechoic to the surrounding tissue (Fig. 8.15D).

It is important to recognize that patients with breast cancer have a higher risk of concurrent ipsilateral or bilateral breast cancer, or developing subsequent breast cancer. The presence of multiple lesions at the time of diagnosis is something that has been described by pathologists for years and is now also evident when breast MRIs are done routinely in patients with known breast cancer. Multifocal lesions are defined as multiple cancers occurring in the same quadrant (Figs. 8.9C and 8.16). Multicentric cancers are those occurring in different quadrants of the involved breast, or if more than 5 cm apart in the same quadrant (Fig. 8.13; also see Figs. 2.50, 5.21, and 5.22). Bilateral cancers are synchronous when diagnosed at the same time (Fig. 8.17; also see Figs. 2.51 and 5.23) or within 6 months of each other, and metachronous (Fig. 8.18; also see Fig. 2.47 and 10.11) when they occur bilaterally at different times (diagnosed more than 6 months apart). The reported
The frequency of multifocality varies depending on study design and meticulousness of histological evaluation, and may be as high as 33% to 50% (6,7). The described frequency of synchronous lesions is 0.1% to 2% compared with 1% to 12% for metachronous lesions. In the general population, 0.1% of women per year are expected to develop breast cancer. In comparison, the frequency of developing a second breast cancer among patients with a history of breast cancer is 0.53% to 0.8% per year (7). Nielsen and colleagues (8) reported on 86 women with a diagnosis of invasive ductal carcinoma in whom at autopsy invasive and in situ lesions were identified in the contralateral breast in 33% and 35% of patients, respectively. In a separate study, done by the same investigators on an age-matched population, autopsy results identified 14 patients with in situ lesions and only 1 patient with invasive cancer among 77 women with no history of breast cancer (9).

In analyzing masses and considering an appropriate differential for possible malignant etiologies the age of the patient, any physical findings and the imaging features of the lesion are helpful. Many of our patients presenting with a round high-density mass (expansile margins, or “blow up” lesions) on the mammogram, and marked hypoechogenicity, cystic spaces (see Fig. 4.37), and posterior acoustic enhancement on ultrasound, are diagnosed with poorly differentiated, rapidly growing invasive ductal carcinomas, NOS (see Table 7.8 for differential considerations). In the younger patients (pre-menopausal), these lesions may represent interval cancers (cancers presenting between screening...
FIG. 8.11  ● Palpable asymmetry, invasive ductal carcinoma, NOS intermediate nuclear grade. CC (A) and MLO (B) views in a 47-year-old patient. Parenchymal asymmetry is imaged in the upper outer quadrant of the left breast corresponding to a “lump” (metallic BB) described by the patient; at least on the CC, the area of asymmetry is the densest portion of the mammogram. Note morphologically normal-appearing lymph nodes in the axillae. Palpable parenchymal asymmetry requires evaluation with spot compression view (not shown), correlative physical examination, and ultrasound. The tumor in this patient is estrogen and progesterone receptor-positive, HER2/neu-negative. The sentinel lymph node (LN) biopsy is negative (0/2 LNs).

FIG. 8.10  ● Invasive ductal carcinoma NOS, high nuclear grade. A: Spot compression view, left breast MLO projection in a 65-year-old patient. Oval, high-density mass with indistinct margins is confirmed in the left breast. B: Ultrasound. An oval hypoechoic, horizontally oriented mass (arrow) is imaged in the left breast correlating to the mass identified mammographically. At the time of the ultrasound, this mass could not be palpated. Given the patient’s age and the mammographic features of this lesion, biopsy is done. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. An invasive ductal carcinoma high nuclear grade is reported on the cores. The tumor is estrogen and progesterone receptor-negative, HER2/neu-positive. C: MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. An oval mass with irregular and spiculated margins and heterogeneous enhancement is imaged corresponding to the site of the patient’s known malignancy. No other lesions are identified in either breast. The histology is confirmed at the time of lumpectomy. The sentinel LN biopsy is negative (0/3 LNs).
studies) and are often triple-negative lesions (estrogen and progesterone receptor-negative, HER2/neu-negative) (Fig. 8.19). The triple-negative cancers are also reportedly more common in African American patients (10,11). On physical examination, these lesions are often seemingly larger than the lesion seen on mammography or ultrasound (Leborgne law). If there is associated intraductal disease, it is usually characterized by central necrosis such that linear calcifications may be seen mammographically. In patients with an “expansile” mass, it is appropriate to consider some of the more common invasive ductal subtypes including medullary, mucinous, papillary, and metaplastic carcinomas. Medullary carcinomas are more common in younger premenopausal patients and may present as interval cancers. Mucinous and papillary carcinomas are slower growing (less likely to be interval cancers) and more common in post-menopausal women. On ultrasound, mucinous carcinoma may be difficult to identify because it is often iso to slightly hyperechoic, and papillary carcinomas are usually a complex cystic mass in the subareolar area. Except for the pleomorphic variant (rare), invasive lobular carcinoma rarely presents as a round mass and as such it is usually not included in the differential for round masses.

In considering the differential for malignancies presenting with masses that have spiculated margins (see Table 7.9 for differential considerations), invasive ductal carcinoma NOS is the most likely, and many of these are low to intermediate grade. If associated intraductal disease (DCIS) is present, it is not typically characterized by central necrosis; it is often low to intermediate grade such that, if there are calcifications, they are likely to be predominantly fine pleomorphic including round, punctate, and amorphous forms. Of the

FIG. 8.12 • Invasive ductal carcinoma NOS, intermediate grade. CC view photographically coned to the lateral aspect of the left breast, screening study in a 52-year-old woman. Distortion (arrow) is noted laterally in the left breast. Confirmed on orthogonal spot compression views (not shown). The only thing that might prevent a biopsy with this type of finding (e.g., distortion, spiculation) is a history of prior surgery localized to this site. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. Diagnosis of invasive ductal carcinoma intermediate nuclear grade is established on an ultrasound-guided core biopsy. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

FIG. 8.13 • Multifocal and multicentric invasive ductal carcinoma, NOS intermediate nuclear grade with micropapillary features. A: MLO views in a 72-year-old patient presenting with a “lump” anteriorly (radiopaque triangular marker). As compared to her prior studies (not shown), the right breast is now smaller with diffuse prominence of the trabecular markings and multiple masses (arrows). BI-RADS 4C: Suspicious abnormality; biopsy is indicated. In this patient, the two masses furthest apart are biopsied to establish the extent the disease. B: MRI, T1-weighted sagittal reconstruction of the right breast post-contrast. Multiple masses with spiculated margins and heterogeneous enhancement, are imaged encompassing multiple quadrants in the breast (not all the masses are included at this scan plane). Nipple retraction is also noted on the MRI. The lesions are estrogen and progesterone receptor-positive, HER2/neu-negative. Signal flaring is noted in the area of the inframammary fold.
**FIG. 8.14** • Invasive ductal carcinoma, low nuclear grade with associated DCIS. Spot compression view, MLO projection in 63-year-old patient. An iso dense mass (long arrows) with spiculated margins is present. Fine pleomorphic (round and punctate) calcifications (short arrows) are noted extending away from the mass with some of the calcifications demonstrating a linear distribution. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. In taking care of this patient, biopsies are done of the mass and the anterior-most extent of the calcifications, thereby establishing the extent of the disease. If the patient wants conservative therapy, bracketing the mass and calcifications with two wires is important preoperatively. Likewise, alerting the pathologist to the location of the calcifications away from the primary finding on the specimen radiograph is critical in establishing an accurate diagnosis and extent of disease. In this patient, synchronous DCIS is diagnosed on MRI (not shown) in the contralateral breast.

**FIG. 8.15** • Invasive ductal carcinoma, NOS. **A:** MLO views in a 37-year-old patient who presents describing a “lump” in her left breast. The metallic BB marks the site of the palpable finding. Dense tissue is imaged at the site of concern on all images (CC and spot tangential views not shown). **B:** Ultrasound. An irregular, vertically oriented, markedly hypoechoic mass (arrows) with angular margins and a thickened and irregular echogenic rim is imaged in the lower outer quadrant of the left breast corresponding to a discrete, fixed hard mass (PALP). BI-RADS 4C: Suspicious finding; biopsy is indicated. This BI-RADS is based on the clinical and ultrasound findings, not the mammogram (which in this patient is normal). The evaluation of a patient with dense tissue mammographically corresponding to a site of concern is incomplete without correlative physical examination and an ultrasound. The diagnosis in this patient is established after an ultrasound-guided biopsy. **C:** MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. A homogeneously enhancing irregular mass (long arrow) with smooth margins is imaged in the lower outer quadrant of the left breast zone B. Clumped and linear enhancement (short arrow) is identified extending anteriorly from the mass for approximately 2 cm consistent with associated DCIS. **D:** CC view of the right breast photographically coned to medial quadrants in a different patient. An oval dense mass (arrow) with indistinct margins is identified in the right breast. The features of this mass are confirmed on spot compression views (not shown). Seemingly normal tissue is seen on ultrasound at the expected location for this mass. Since no cyst is imaged, it is presumed that the mass seen mammographically is solid and isoechoic with surrounding tissue. Given the mammographic features (new, medial location, margins), a stereotactically guided biopsy is done to establish the diagnosis of invasive ductal carcinoma, poorly differentiated. BI-RADS 4C: Suspicious finding; biopsy is indicated.
FIG. 8.16 Multifocal, invasive ductal carcinoma NOS, intermediate grade. A: Spot compression view, right breast MLO projection done to further evaluate possible distortion noted on the screening mammogram in a 76-year-old woman. A dense irregular mass (arrow) with spiculated margins and associated distortion is confirmed on orthogonal spot compression views (only one projection is shown). BI-RADS 4C: Suspicious abnormality; biopsy is indicated. Ultrasound-guided biopsy (not shown) is done to establish the suspected diagnosis. B: MRI, T1-weighted coronal reconstruction, right breast pre-contrast. An oval mass with high T1 signal (arrow) is seen superiorly in the right breast prior to the contrast bolus consistent with a biopsy-related hematoma. C: MRI, T1-weighted coronal reconstruction, right breast post-contrast. Three enhancing masses are identified on the MRI. The largest of these (long arrow) demonstrates spiculated margins and heterogeneous enhancement and corresponds to the mass identified mammographically and the site of the patient’s known invasive ductal carcinoma. Two smaller (“satellites”) more homogeneously enhancing masses (short arrows) are seen in close proximity to the primary lesion. Three foci of invasive ductal carcinoma are confirmed at the time of the patient’s lumpectomy. In comparison with the pre-contrast image shown in part B, the hematoma shows no enhancement.
more common invasive ductal subtypes, tubular carcinoma is the only one that typically presents as one or several small masses with spiculated margins and is more common in pre-menopausal women. Invasive lobular carcinoma is also included in this differential since a mass with spiculated margins is the most common presentation for this type of tumor; patients with invasive lobular are often older post-menopausal women.

In patients with known invasive breast primaries, we routinely scan the ipsilateral axilla (see discussion at the end of this chapter). Ultrasound evaluation of the ipsilateral axilla in patients with a probable malignancy can be useful because it provides access to an area that may be difficult to evaluate on the mammogram. If a suspicious lymph node is identified, a core biopsy or fine needle aspiration is done at the time of biopsy of the primary breast lesion. Patients identified with metastatic disease bypass sentinel lymph node biopsy and go on to have full axillary dissections at the time of the lumpectomy. Alternatively, depending on the size of the primary, patients with positive axillary lymph nodes at the time of presentation may be treated with neo-adjuvant therapy prior to any surgery.

Histologically, invasive ductal carcinomas NOS demonstrate variable growth patterns (infiltrative, expansile), cellular morphology, and no special features. Several grading systems are available based on tubule formation, nuclear morphology, and mitotic activity. Estrogen receptors are reportedly positive in 55% to 72% of lesions; however, poorly differentiated lesions are less likely to have estrogen receptors. Progesterone receptors occur in 33% to 70% of lesions, and approximately 15% of lesions are estrogen receptor-positive and progesterone receptor-negative (1,2,7). HER2/neu (ERBB2) is an epidermal growth factor receptor (type 2) that may be present in some breast cancers. The ERBB2 gene is amplified in approximately 25% of all breast cancers as well as some ovarian cancers and amplification is almost always associated with overexpression. The amplification of this gene in breast cancers is associated with a bad prognosis such that patients have an increased rate of metastasis as well as decreases in time to recurrence and overall survival. Trastuzumab (Herceptin) is used in the treatment of patients with HER2/neu-positive tumors (1).

**Fig. 8.16** (continued)

**Fig. 8.17** Synchronous lesions, invasive ductal carcinoma NOS intermediate grade in the right breast and DCIS (extensive), intermediate grade in the left breast. A: CC views in a 72-year-old woman. Dense breast parenchyma is present with arterial calcification and dystrophic-type calcifications scattered bilaterally (left more than right). A dense, round mass with indistinct and spiculated margins is present at the glandular tissue-retroglandular fat interface in the right breast. Note also that this is the densest area in this patient’s mammogram. A hypoechoic mass with internal echoes consistent with calcifications, indistinct, spiculated and angular margins, and shadowing is imaged on ultrasound (not shown) corresponding to the mass seen mammographically in the right breast. Although this is a screen-detected abnormality, a hard immobile mass is palpated at the time of the ultrasound. B: MRI, axial T1-weighted image post-contrast. A mass (long arrow) with thickened, irregular rim enhancement and spiculated margins is imaged in the right breast at the site of patient’s known cancer. Focal non-mass-like linear enhancement (short arrow) is noted in the left breast laterally in zone B. DCIS intermediate grade is diagnosed on an MRI-guided biopsy. The findings are confirmed at the time of bilateral lumpectomies. The DCIS in the left breast is described as extensive; however, no invasion is identified.

**EXTENSIVE INTRADUCTAL COMPONENT**

Patients with invasive ductal carcinomas and extensive areas of associated intraductal carcinoma were initially thought to have a worse...
FIG. 8.19 • Invasive ductal carcinoma NOS, high nuclear grade.

Dense, round, mass with microlobulated, indistinct margins corresponding to a “lump” described by the patient in her left breast (triangular opacity used to denote the palpable finding). This is a rapidly developing expansile (“blow up”) lesion in a 48-year-old pre-menopausal woman. Not surprisingly, it is a triple-negative (estrogen and progesterone receptor, HER2/neu-negative), poorly differentiated invasive ductal carcinoma.
prognosis, and were described as having a higher incidence of local recurrence following conservative treatment. This is probably related to incomplete resection of the lesion and residual disease in the breast (12). When patients with lesions having EIC are adequately resected, prognosis is not significantly different from that of women with lesions lacking EIC (13,14). When malignant-type calcifications, or clumped and linear enhancement on MRI, are seen extending for a distance away from a clinically or mammographically detected mass (Fig. 8.14; also see Figs. 7.2B, 7.3, and 3.16), it is important to alert the surgeon and pathologist with respect to the extent of disease and adequately bracket the area at the time of surgery so that the intraductal disease is resected with the invasive component. MRI is the best modality available in detecting and characterizing the extent of EIC (e.g., DCIS is underdiagnosed and the extent underestimated on mammography). Definitions of EIC have varied. Currently, EIC is diagnosed when DCIS constitutes 25% or more of the invasive tumor, or when DCIS is present within and extends beyond (Fig. 8.9C and 8.14) the invasive component (1,2,7,15).

DUCTAL CARCINOMA IN SITU
As discussed in Chapter 6, DCIS is now most commonly diagnosed in asymptomatic women following the detection of calcifications on screening mammograms or the identification of clumped and linear enhancement following MRI. Prior to the widespread use of screening mammography, however, DCIS was uncommon and constituted less than 5% of all breast cancers; patients presented with a palpable mass, spontaneous nipple discharge, or Paget disease of the nipple (16). Although uncommon (so much so that DCIS is rarely included in the differential of an uncalcified, mammographically detected mass), DCIS can be detected as an uncalcified, round, oval, irregular or microlobulated, mass with partially circumscribed (Fig. 8.20) or spiculated margins (Fig. 8.21), distortion (Fig. 8.22), developing ductal distension (see Figs. 5.38, 9.35, and 9.36), parenchymal asymmetry (see Figs. 9.27 and 9.28), or diffuse change (see Figs. 9.20 and 9.21 and Table 6.6 for DCIS presentations). These findings are attributable to the presence of distended, cancer-containing ducts, in aggregate, and an associated periductal inflammatory process. Histologically, central necrosis may be present.

TUBULAR CARCINOMA
Tubular carcinomas are uncommon lesions representing less than 2% of all breast cancers and commonly diagnosed in women in their late 40s. These are a subtype of invasive ductal carcinoma with well-differentiated features. The pure form of tubular carcinoma is almost always ER/PR-positive, HER2/neu-negative, and associated with an excellent prognosis, and yet approximately 10% of patients are found to have axillary metastasis at the time of diagnosis (1).

Mammographically, tubular carcinomas are commonly diagnosed as one or more small (<1 cm), iso- to low-density masses with spiculated margins (Fig. 8.23) or distortion in asymptomatic women (17–22). Rarely, these lesions are palpable and may be mammographically occult. Associated fine pleomorphic calcifications including amorphous, round, and punctate forms (Fig. 8.24) may be present since low nuclear grade DCIS lacking central necrosis is reported in as many as 65% of patients with tubular carcinomas. An irregular hypoechoic mass with spiculated, angular margins and shadowing is the most common presentation for tubular carcinomas on ultrasound. Rarely, these tumors may be more round in appearance (Fig. 8.25). On MRI, tubular carcinomas can demonstrate rapid wash-in and wash-out kinetics; however, rarely these lesions may demonstrate little if any
FIG. 8.21 • DCIS, high nuclear grade with central necrosis. A: Spot compression view, right MLO projection in a 63-year-old patient confirms the presence of an irregular iso dense mass (arrow) with spiculated margins and associated distortion. Screen-detected abnormality. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. Because no abnormality is identified on ultrasound at the expected location for this finding, a stereotactically guided biopsy is done. “Scant breast parenchyma with fibrocystic changes” is reported on the cores. What do you think? These results are not congruent with the imaging findings. B: MRI, sagittal maximum intensity projection of the right breast. An irregular mass (short arrow) with spiculated margins, heterogeneous enhancement, and associated distortion is imaged corresponding to the mammographic finding. DCIS, high nuclear grade is diagnosed on an MRI-guided core biopsy (see Fig. 12.37G for biopsy image). Morphologically normal-appearing lymph nodes are noted in the right axilla (long arrows). The diagnosis of DCIS with no associated invasive disease is confirmed on excision. Although this patient was diagnosed accurately following the MRI biopsy, it is important to emphasize that, if the MRI had been normal at the site of the mammographic finding, a repeat stereotactically guided biopsy or an excisional biopsy would be indicated for the mammographic finding.

FIG. 8.22 • Distortion, extensive DCIS, intermediate nuclear grade, cribriform and solid patterns. A: CC view right breast photographically coned to the anterior aspect of the breast. Distortion (within oval) of the tissue is identified involving the subareolar area of the right breast. B: MRI, axial T1-weighted image of the right breast post-contrast. Non-mass-like (arrows) heterogeneous enhancement is present along the anterior edge of the glandular tissue corresponding to the area of distortion identified mammographically. DCIS is confirmed at the time of definitive surgery. Given the extent of disease noted on the imaging studies, a sentinel lymph node (LN) biopsy is done and reported as negative (0/2 LNs).
these lesions need to be distinguished from sclerosing adenosis and complex sclerosing lesions, both of which demonstrate myoepithelial cells. Mitoses are uncommon (1,2).

**MUCINOUS CARCINOMA**

Mucinous carcinomas are a subtype of invasive ductal carcinoma, and can be further subdivided into pure and mixed forms (mucinous and invasive ductal NOS components) (23,24). In the pure form, mucinous carcinomas represent approximately 2% of all breast cancers and, although they can present at any age, at least the pure forms, are reportedly more common in older post-menopausal women. Estrogen and progesterone receptors have been reported to be positive in 91% to 94% and 79% to 81% of patients with pure mucinous carcinomas, respectively (25). The reported incidence of axillary metastases ranges from 2% to 14% in pure mucinous carcinomas and enhancement (e.g., false-negative MRI). As with mammography and ultrasound, tubular carcinomas are typically small irregular masses with spiculated margins having heterogeneous less commonly homogenous enhancement; rarely, they may be more round and oval with circumscribed margins (Fig. 8.25A).

Histologically, there is proliferation of angulated, oval, and elongated tubules lined with a single epithelial cell layer. The proliferating tubules are distinguished from normal ducts by the absence of myoepithelial cells. Pathologists may use special stains (e.g., p63) to establish the absence of myoepithelial cells and confirm the diagnosis (see additional discussion in papillary carcinoma section). Histologically,
The influence of size on the likelihood of metastatic disease is controversial; some reports describe a direct correlation between tumor size and positive lymph nodes, others do not (25).

Patients can present with a palpable mass (Fig. 8.26) or, if asymptomatic, a round (Fig. 8.27) or oval mass with circumscribed to indistinct margins (Fig. 8.28); the mixed forms are more likely to be irregular in shape (24,27–30). Many of these lesions are slow-growing and as such may be seen on prior studies. Minimal increases in size and loss of marginal definition in a small round mass in an older patient should suggest the diagnosis of mucinous carcinoma. The diagnosis is further suggested if on ultrasound, an iso- to slightly hyperechoic mass with defined margins and variable amounts of posterior enhancement is imaged correlating to the mass seen mammographically. Their tendency to be iso- to slightly hyperechoic (Figs. 8.26B, 8.27B and 8.28C) makes detection on ultrasound challenging such that meticulous ultrasound technique is often required. Less commonly, mucinous carcinomas are hypoechoic or have a heterogeneous echotexture (Fig. 8.29) that may demonstrate variable amounts or shadowing. Rarely, a complex cystic mass is seen (Fig. 8.30).

On MRI, pure mucinous carcinomas are characterized by a high T2 signal (close to that of water), a reflection of the mucinous component of these lesions (Figs. 8.26D, 8.27C, 8.28C; also see Fig. 5.16); degeneration, necrosis, fibrosis, hemorrhage, or calcification may alter the T2-signal intensity (24,30). The T1 signal of these lesions is variable pre-contrast. Gradual enhancement (persistent-type kinetic curve) is typical; however, it appears that with increases in the cellularity of the described cell aggregates (see below), heterogeneous and intense rim enhancement is seen on early phase images (Figs. 8.26D, 8.27D and 8.28D). Some of the larger lesions may demonstrate non-enhancing septations (Fig. 8.26D) that are dark on T2 (similar to findings sometimes seen in patients with fibroadenomas and phyllodes) (24,30).

Grossly, core samples and the cut surface of these lesions are distinctly gelatinous and glistening in appearance (Fig. 8.31A, B). Histologically, mucinous carcinomas are characterized by cancer cell aggregates floating in extracellular pools of mucin (Fig. 8.31C). The aggregates vary from dense to sparse cellularity, and fibrous septae may be seen separating the pools of mucin. Some mucinous carcinomas have associated low- to intermediate-grade DCIS lacking central necrosis; however, associated DCIS is not usually a prominent feature. Necrosis is uncommon (1,2).

**MEDULLARY CARCINOMA**

Medullary carcinomas are a subtype of invasive ductal carcinoma. The reported incidence is variable secondary to an overdiagnosis of this tumor type (31). When strict histological criteria are followed, these tumors represent less than 2% of breast cancers. Medullary carcinomas present as round or oval masses with circumscribed to indistinct margins (Fig. 8.32A). On ultrasound they are moderately to distinctly gelatinous and glistening in appearance (Figs. 8.26D, 8.27D and 8.28D). Some of the larger lesions may demonstrate non-enhancing septations (Fig. 8.26D) that are dark on T2 (similar to findings sometimes seen in patients with fibroadenomas and phyllodes) (24,30).

Histologically, nests of large, high-grade epithelial cells with scant surrounding stroma form a syncytial pattern. Nuclei are pleomorphic and there is a high mitotic rate. A significant lymphocytic and plasma cell infiltrate is present surrounding the lesions. Associated DCIS may be seen at the periphery of these lesions. Areas of necrosis may be present as the rapid growth of the tumor outstrips the vascular supply. Most of medullary carcinomas are triple-negative tumors (estrogen and progesterone receptor-negative, HER2/neu-negative) (1,2).
FIG. 8.26 Mucinous carcinoma. A: MLO view of the left breast photographically coned to the anterior aspect of the breast in a 70-year-old patient presenting with a “lump.” An irregular dense mass (arrow) is imaged superficially in the subareolar area of the left breast corresponding to the palpable finding. B: Ultrasound. An iso to hyperechoic round mass (calipers) with posterior acoustic enhancement causing a slight contour (bulge) abnormality is imaged at the site of the palpable and mammographic finding. Ill-defined, irregular thin linear bands of relative hypoechogenicity are noted coursing through the mass. The deep dermal layer (arrows) appears disrupted such that skin involvement may be present. Although not pathognomonic, the echogenicity of this mass should raise the possibility of a mucinous carcinoma. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. C: MRI, sagittal T2-weighted fat suppressed image of the left breast. A mass with circumscribed margins and predominantly high but heterogeneous T2 signal is imaged in the left subareolar area. D: MRI, T1-weighted sagittal reconstruction of the left breast, post-contrast. Heterogeneously enhancing mass with non-enhancing internal septations is imaged in the left subareolar area. Although a homogeneously high T2 signal is usually considered a feature of benign lesions (cysts, young fibroadenomas, lymph nodes), areas of intermediate-to-high (heterogeneous) T2 signal can be seen in mucinous, papillary, and metaplastic carcinomas, necrotic areas in high-grade invasive ductal carcinomas NOS, and phyllodes tumors. This patient’s tumor is estrogen receptor-positive, progesterone receptor-negative, and HER2/neu-negative.
**FIG. 8.27**  ● Mucinous carcinoma. **A:** Spot compression view, MLO projection done to evaluate a screen-detected mass in a 64-year-old patient. An iso dense round mass with indistinct margins is present in the left breast. Incidentally noted is a biopsy clip in close proximity to the mass. **B:** Ultrasound. A horizontally oriented, iso-to-slightly hyperechoic mass with an echogenic rim is imaged in the left breast correlating to the mass seen mammographically. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. **C:** MRI, sagittal T2-weighted fat-suppressed image of the left breast. A mass (arrow) with high (heterogeneous) T2 signal is imaged in the left breast posteriorly corresponding to the site of the patient’s known mucinous carcinoma (e.g., mass detected mammographically). Two oval masses with intermediate T2 signal superior to the mass are lymph nodes. Coil-related artifact (signal flaring) is noted primarily in the area of the inframammary fold. **D:** MRI, T1-weighted axial image post-contrast. A rim-enhancing mass (short arrow) is imaged in the central to slightly lateral aspect of the left breast posteriorly correlating to the mass with high T2 signal shown in part C. The mammography, ultrasound, and MRI findings in a 64-year-old patient are highly suggestive of mucinous carcinoma. Note several homogeneously enhancing lymph nodes (long arrows) posterolaterally in the right breast; these are morphologically normal when viewed in sagittal and coronal reconstructions (not shown). This patient’s mucinous carcinoma is estrogen and progesterone receptor-positive, HER2/neu-negative, and the sentinel lymph node (LN) biopsy is negative (0/5 LNs).
**FIG. 8.28** Mucinous carcinoma. **A:** Spot compression view done to evaluate a screen-detected mass in a 69-year-old patient. A low-density oval mass with indistinct and spiculated margins is confirmed in the right breast on the spot compression views (only one is shown). **B:** Ultrasound. A horizontally oriented oval hyperechoic mass (arrow) with gentle macrolobulation is imaged on ultrasound corresponding to the mammographic finding. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. The mammography and ultrasound features of this mass in a 69-year-old patient are highly suggestive of mucinous carcinoma. **C:** MRI, sagittal T2-weighted fat-suppressed image of the right breast. A mass with high T2 signal is imaged in the inferior aspect of the right breast. **D:** MRI, T1-weighted sagittal reconstruction of the right breast, post-contrast. A mass with rim enhancement is imaged corresponding to mass with high T2 signal shown in part C. Kinetic curves demonstrate rapid wash-in with rapid wash-out of contrast. This patient’s tumor is estrogen and progesterone receptor-positive, HER2/neu-negative, and the sentinel lymph node (LN) biopsy is negative (0/1 LN).
FIG. 8.29  *Mixed mucinous and invasive ductal carcinoma.*

A: Ultrasound. Round mass with heterogeneous echotexture and posterior acoustic enhancement is imaged corresponding to a palpable mass in a 56-year-old patient.  
B: CC views. A dense mass with circumscribed macrolobulated margins is present medially in the left breast corresponding to the mass shown in part A.  
C: MRI, sagittal T2-weighted fat-suppressed image of the left breast. A round mass with areas of intermediate and high T2 signal is imaged in the left breast corresponding to the mass shown in parts A and B. Internal low T2 signal septations are also noted. D: MRI, sagittal T1-weighted reconstruction of the left breast post-contrast. The mass demonstrates heterogeneous internal enhancement with predominantly rapid wash-in and wash-out kinetic curves and circumscribed lobulated margins. The tumor is estrogen receptor-positive, progesterone receptor-negative, and HER2/neu-negative.
FIG. 8.30  Mucinous carcinoma. A: An iso dense round mass with circumscribed margins is imaged in the sub-areolar area of the left breast in a 78-year-old woman presenting with a “lump”; in retrospect, this can be seen on a study done 2 years previously (now larger). B: Ultrasound. A round complex cystic (arrows) and solid mass with posterior acoustic enhancement is imaged corresponding to the palpable finding and the mass seen mammographically. Imaging-guided core biopsy is done to establish the diagnosis.

FIG. 8.31  Mucinous carcinoma. A: The cores obtained from mucinous carcinomas are distinctive in appearance with a glistening gelatinous appearance. B: Grossly on cross-section, a microlobulated mass (arrow) with a gelatinous consistency is seen. A 0.2-cm focus of hemorrhage in the upper aspect of the mass reflects a core biopsy site. The surface of the specimen is black because it has been immersed in India ink; this is used to establish the proximity of the tumor to the margins. C: Histologically, mucinous carcinomas are characterized by nests of malignant cells (short arrows) floating in pools of mucin separated by thin fibrovascular septae (long arrows). The cellularity of the nests is variable in a given lesion and between lesions; some have used this variability in cellularity and amount of extracellular mucin to explain the various imaging characteristics of mucinous carcinomas.
FIG. 8.32  ●  Medullary carcinoma with adjacent DCIS. A: CC view photographically coned to the inner aspect of the left breast in a 40-year-old patient presenting with a "lump." The metallic BB marks area of concern to the patient. A round iso dense mass (short arrow) with indistinct margins is imaged corresponding to the area of clinical concern. Associated punctate calcifications are noted (long arrow). B: Ultrasound. Round, markedly hypoechoic mass with indistinct, angular margins and minimal posterior acoustic enhancement is imaged corresponding to the clinically and mammographically apparent mass. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. (From Cardeñoso G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

PAPILLARY CARCINOMA

These lesions represent approximately 1% to 2% of all breast cancers and are more common in older post-menopausal women who present describing a palpable mass or nipple discharge. Like papillomas, these lesions can be solitary, usually central in location, or multifocal and peripheral in location. In women with solitary papillary carcinomas, the mass is often subareolar in location and may cause nipple displacement and skin stretching. Patients may have associated nipple discharge. Mammographically, one of two presentation patterns may be seen. Solitary papillary carcinomas are common in the subareolar area presenting as a dense round, oval or macrolobulated mass with circumscribed (expansile) margins (Figs. 8.33A and 8.34A). A complex cystic and solid mass (Fig. 8.33B) is the most common ultrasound feature in patients presenting with a subareolar mass (35,36). Alternatively, multiple peripheral papillary carcinomas present as multiple round, oval, or macrolobulated masses of varying sizes and densities with circumscribed to indistinct margins (Fig. 8.35). On ultrasound, the peripheral lesions are often solid (Fig. 8.36) and indistinguishable from any other solid mass; however, complex cystic and solid masses may also be seen (Fig. 8.37). The appearance of these lesions on MRI is also variable. An enhancing mass with margins that range from circumscribed to spiculated, a high T2 signal component, or an association with a dilated duct may all be seen (Figs. 8.34B–D, 8.36B–D, and 8.37D, E). Rapid to medium wash-in and wash-out or plateau-type kinetic curves are seen commonly with these lesions (37–39).

Malignant papillary tumors are a complex group of lesions, variably defined by pathologists and characterized by confusing terminology. Included are DCIS arising in a papilloma, papillary DCIS (Fig. 8.34), intraductal papillary carcinoma (CA) (e.g., intracyctic or encapsulated papillary CA), solid papillary CA, invasive carcinoma arising in an intracyctic papillary CA (Figs. 8.36 and 8.37), and invasive papillary...
FIG. 8.33 • Papillary carcinoma. A: MLO view in a patient presenting with a palpable mass that is smoothly protuberant; overlying skin thinning and stretching with a fading ecchymosis are noted on physical examination. No nipple discharge is elicited. An oval, high-density mass with circumscribed margins is imaged in the right breast. In an attempt to adequately penetrate (expose) the mass, the remainder of the breast parenchyma is “burned” out. B: A complex cystic and solid mass with posterior acoustic enhancement is imaged corresponding to the palpable mass. Given the size of the lesion, it is not possible to include all of it in one image. Hemorrhagic fluid is often obtained when the cystic component is aspirated; however, in approximately 50% of patients, the diagnosis is not established on the fluid aspirate alone; core biopsy through the solid component is needed to reliably establish a diagnosis. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

FIG. 8.34 • Papillary DCIS, intermediate grade forming a mass. A: CC views in a 62-year-old patient. A dense, round mass (long arrow) with circumscribed margins and an associated ductal structure (short arrows) confirmed on spot compression views (not shown) is identified in the right subareolar area. B: MRI, axial T1-weighted image post-contrast. A heterogeneously enhancing mass (short arrow) with circumscribed margins and an associated non-enhancing dilated duct (long arrow) extending posteromedially from the mass are imaged in the right subareolar area corresponding to the mass seen mammographically. C: MRI, sagittal T2-weighted fat-suppressed image of the right breast. Mass (arrow) with heterogeneous but predominantly high T2 signal is imaged corresponding to the enhancing mass seen on the image shown in part B. Associated dilated duct is not seen on this scan plane. D: MRI, sagittal T2-weighted fat-suppressed image of the right breast. Dilated fluid-filled (high T2 signal) ductal structure (arrows) extending posterior from the mass (mass on a different scan plane is shown in part C).
Multiple peripheral papillary carcinomas in two different patients. A: CC projection of the right breast photographically coned to the lateral aspect of the breast. Multiple iso- to high-density round masses with indistinct margins are identified in a 69-year-old patient presenting with a palpable mass in the right breast. The metallic BB marks the site of the palpable finding. Solid masses are imaged on ultrasound (not shown) corresponding to the clinical and mammographically apparent masses. B: Left CC view of the left breast photographically coned to the lateral aspect of the breast in a 74-year-old patient presenting with a palpable mass in the left breast. The metallic BB marks the site of the palpable finding. The palpable mass is round and high in density with indistinct margins. Four low-density masses with indistinct margins are noted in the surrounding tissue. Solid masses are imaged on ultrasound (not shown) corresponding to the clinically and mammographically apparent masses. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
FIG. 8.36 • Intracystic papillary carcinoma with invasive ductal carcinoma. **A:** Spot compression view in the MLO projection done for evaluation of a screen-detected mass in the upper outer quadrant of the right breast posteriorly in a 59-year-old patient. The mass is high in density, lobulated with circumscribed margins. **B:** Ultrasound. A hypoechoic oval mass with gentle lobulations, mostly circumscribed margins, and posterior acoustic enhancement is imaged in the right breast corresponding to the mass described mammographically. **C:** MRI, T1-weighted axial image post-contrast and **D:** MRI, sagittal T2-weighted fat suppressed image of the right breast. A lobulated mass (arrows) with circumscribed margins, heterogeneous enhancement, and non-enhancing internal septations is imaged in the upper outer quadrant of the right breast posteriorly. MRI, sagittal T2-weighted fat suppressed image of the right breast. This mass (arrow) demonstrates an intermediate T2 signal with minimal surrounding edema. The lesion is estrogen receptor/progesterone receptor-positive, HER2/neu-negative, and the sentinel lymph node (LN) biopsy is negative (0/2 LNs).
Synchronous cancers. Papillary carcinoma predominantly in situ with foci of invasive disease in the left breast and DCIS solid and cribriform types with central necrosis in the right breast. A: CC views in a 62-year-old patient presenting with a “lump” in the left breast for 3 months. A dense, oval mass with indistinct and lobulated margins is imaged corresponding to the palpable finding. When your brain is focused on a clinically and mammographically apparent mass, it is imperative that you force yourself to evaluate the remainder of the tissue in the left breast as well as the contralateral side. In this patient, a cluster of calcifications (arrow) is present in the retroareolar aspect of the right breast in zone B. B: Ultrasound. A complex cystic mass that is predominantly solid with cystic components and posterior acoustic enhancement is imaged corresponding to the clinically and mammographically apparent mass in the left breast. C: Spot compression magnification view, right breast. Fine pleomorphic calcifications including round, punctate, amorphous, and linear forms (arrows) in a segmental distribution are imaged in the right breast. DCIS is diagnosed on a stereotactically guided biopsy of the calcifications. D: MRI, sagittal T1-weighted reconstruction of the left breast, post-contrast. A mass with lobulated, circumscribed margins and heterogeneous internal enhancement is imaged corresponding to the mass in the left breast. E: MRI, sagittal T2-weighted fat-suppressed image of the left breast. The T2 signal of the mass is variable with portions demonstrating intermediate and others, high T2 signal. Coil artifact (signal flaring) is noted inferiorly.
carcinoma. Accurate classification of these lesions and the determination of invasion in intraductal papillary carcinomas pose a challenge for the pathologist (40–45).

Histologically, encapsulated papillary CAs demonstrate an arborescent, frond-like proliferation of low-grade epithelial elements with a central fibrovascular core completely contained in a dilated duct. The absence of myoepithelial cells in the papillary lesion indicates malignancy (Fig. 8.38), however, the presence of these cells does not completely exclude an intraductal papillary carcinoma since myoepithelial cells may be seen sporadically in the fronds of intraductal papillary carcinomas. Also considered by some authors in the classification of these lesions is the absence of myoepithelial cells in the wall of the cystically dilated duct surrounding the encysted papillary proliferation (40–45).

Solid papillary carcinomas are characterized by circumscribed nodules of proliferating low-grade homogenous cells packing a dilated duct that lacks myoepithelial cells commonly in the central aspect of the breast. Many are further characterized by the presence of neuroendocrine features as well as extra- and intracellular mucin such that some authors have suggested these lesions may represent precursors of mucinous carcinoma (46).

Although “malignant” papillary lesions are considered to be non-invasive, some have postulated that these are “pushing border” or “expansile” indolent variants of invasive ductal carcinoma. Some actually do demonstrate stromal invasion. The invasive component is usually indistinguishable from invasive ductal carcinoma NOS; less commonly, it may demonstrate a papillary growth pattern.

Papillary lesions are characteristically friable and as such the seeding of epithelial cells into the surrounding stroma, adjacent lymphatic channels (47), and subsequent transport of displaced epithelium into the axillary lymph nodes (48) following needle biopsies is a recognized phenomenon (40–42). This can compound the challenge of accurately characterizing these lesions histologically. The history of recent needle instrumentation, altered red blood cells, inflammatory changes, and a lack of a desmoplastic reaction surrounding the displaced cells can be used to recognize displacement from invasion. Evaluating the edge of the lesion away from areas of recent instrumentation is also recommended (41).

**FIG. 8.38** Pathology, papillary carcinoma. A: Low power (4×) of a core biopsy. Frond-like proliferation of epithelial elements with central fibrovascular cores (arrows) is apparent on this core. Even at higher power (not shown), no myoepithelial cells could be identified. B: Special stain (p63) (20×) confirming the absence of myoepithelial cells. C: For comparison, section (20×) through normal breast tissue demonstrating ducts with a contiguous epithelial cell lining and discontinuous intensely staining (brown with p63) myoepithelial cells at the base of the ducts. Absence of the myoepithelial cells is what distinguishes papillary carcinomas from papillomas (and tubular carcinomas from normal ductal structures and benign lesions such as sclerosing adenosis).
Papillary carcinomas should not be confused with invasive micropapillary carcinomas. Clinically and histologically distinct, micropapillary carcinomas are characterized by an aggressive behavior, propensity for lymphovascular space involvement, and positive lymph nodes at the time of diagnosis. Proliferating pseudopapillary structures with no fibrovascular cores are identified histologically in clear empty spaces (41,42,49).

**METAPLASTIC CARCINOMA**

This invasive ductal subtype represents less than 5% of all breast cancers and is characterized by rapid growth and a poorer prognosis. The patients may present describing a rapidly growing mass or the mass may be detected on screening mammography. Metaplastic carcinomas are typically estrogen and progesterone receptor and HER2/neu-negative (e.g., triple-negative), and although lymphatic metastases are reported in 8% to 40% of patients at the time of presentation, they can also metastasize hematogenously to lung and bone (1,2,50–52).

These tumors are characterized by variable features on mammography including high density, round, oval, or irregular masses with circumscribed (Fig. 8.39A), obscured, indistinct (Fig. 8.40A), or spiculated margins. Calcifications are not a prominent feature, but when present, are typically a mixture of amorphous, round, and punctate forms. Rarely, when there is osseous differentiation, a dense osseous structure (trabecula) may be apparent in the mass. The ultrasound features of metaplastic carcinomas are also variable. These lesions can present as heterogeneous, hypoechoic (Figs. 8.39B and 8.40B), or complex cystic and solid masses with posterior acoustic enhancement. On MRI, an intermediate to increased T2 signal and iso intense to hypointense T1 signal are common. Heterogeneous and rim-enhancement patterns are the two most common appearances on the dynamic sequences. Kinetic curves may be variable; however, rapid wash-in with plateau or wash-out delayed curves predominate (50–52).

Histologically, metaplastic carcinomas are heterogeneous and include glandular (epithelial) elements and non-glandular mesenchymal components that are possibly a reflection of metaplasia involving the myoepithelial cells. Focal squamous metaplasia in an invasive ductal carcinoma is one of the more common features of these lesions. Other tumors demonstrate cohesive sheets of spindle cells such that differentiation from fibromatosis or fibrosarcoma may be difficult. An associated inflammatory reaction is almost always present leading some to mistake the diagnosis. In some patients, metaplastic carcinomas are characterized by matrix formation, cartilaginous or osseous being the more common components described. Carcinosarcoma and osteoclastic giant cells are much less common. In some patients, the tumor demonstrates a mixture of these components (1). The prognosis for these lesions is likely related to the stage at the time of diagnosis and not necessarily to the histologic features of the metaplastic component(s).

**INVASIVE LOBULAR CARCINOMA**

Invasive lobular carcinoma represents approximately 10% of all breast cancers; it constitutes less than 2% of all breast cancers in women under the age of 35 and 11% in women over the age of 75 (1). The prognosis for these cancers should not be confused with invasive micropapillary carcinomas. Clinically and histologically distinct, micropapillary carcinomas are characterized by an aggressive behavior, propensity for lymphovascular space involvement, and positive lymph nodes at the time of diagnosis. Proliferating pseudopapillary structures with no fibrovascular cores are identified histologically in clear empty spaces (41,42,49).
that the incidence of invasive lobular carcinomas in pre-menopausal women is increasing. The sensitivity of detecting invasive lobular carcinomas using mammography and ultrasound is lower than that for invasive ductal carcinomas; reported false-negative rates of interpretation range from 19% to 43% (53–55). In our experience, 66% of patients with invasive lobular carcinoma are symptomatic at the time of presentation and 41% have positive axillary lymph nodes. Bilateral disease is seen in as many as 28% of patients. Many of these tumors (up to 92%) are estrogen receptor-positive (1,2), with more variability in the progesterone receptor status.

The diagnosis of invasive lobular carcinoma may be elusive at every step: clinically, mammographically, and histologically. The tissue may be thickened such that its consistency is different from that of surrounding tissue or the corresponding region in the contralateral breast. In some patients, the size of the breasts may be asymmetric.

In our experience, the mammographic presentation of invasive lobular carcinoma is variable and parallels what has been described in the literature (54–60). One or multiple masses with spiculated margins (Figs. 8.41 and 8.42) is seen in 40% of our patients, asymmetric densities (Fig. 8.43) in 16%, architectural distortion (Figs. 8.44 and 8.45) in 15%, and diffuse trabecular abnormalities leading to either a shrinking (see Figs. 9.18 and 9.19) or an enlarging breast in 11% of patients. Since these lesions appear to be planar, invasive lobular carcinoma may be more apparent in one projection, often the CC view, and subtle or difficult to see on the orthogonal view (Fig. 8.45); this observation also applies to the conspicuity of the lesion in ultrasound and MRI. A round mass is seen in less than 5% of patients with invasive lobular carcinoma. Although some authors have reported that some invasive lobular carcinomas present with calcifications, in our experience, calcifications do not occur in invasive lobular carcinomas. The malignant cells do not usually form any nests or spaces within which calcifications can develop. The malignant cells invade individually rather than as nests of cells. When biopsies are done for calcifications, the invasive lobular carcinoma is an incidental unsuspected finding and the calcifications are found in benign processes including sclerosing adenosis, fibrocystic changes, and fibroadenomas. In approximately 3% of patients with invasive lobular carcinoma, the mammogram is reportedly normal, and even when present, the mammographic findings often underestimate the extent of disease (Fig. 8.46). MRI may more accurately predict the size and extent of disease in women with invasive lobular carcinoma. On ultrasound, significant shadowing may be associated with invasive lobular carcinomas (Figs. 8.41B and 8.43C). Alternatively, a vertically oriented hypoechoic mass with angular, spiculated, indistinct margins and shadowing (Figs. 8.42B, C, 8.44C, and 8.46C) or a hypoechoic, lobulated mass may be seen (60,61). Commonly, the lesion seen on ultrasound appears smaller than what is palpated. Most invasive lobular carcinomas demonstrate enhancement on MRI with rapid wash-in and wash-out or persistent-type delayed kinetic curves (Figs. 8.45 and 8.46). The extent of disease is often better delineated on MRI and the presence of multifocal (Fig. 8.42D), multicentric (Fig. 8.46), bilateral (synchronous) disease can be established on MRI (Fig. 8.45). (60,62,63).

Although there are variants, most lobular carcinomas are characterized by the migration of individual, small cells (Fig. 8.47) through the stroma, with little associated reaction or scirrhous change histologically. The cells can simulate lymphocytes, thereby making the pathological diagnosis difficult in some patients. Lobular neoplasia (a.k.a. lobular carcinoma in situ = LCIS) is found extensively involving the tissue in 41% of our post-menopausal patients with invasive lobular carcinoma. As discussed in Chapter 9, LCIS may represent more of a precursor lesion in some patients rather than just a marker lesion with no malignant potential.
FIG. 8.41 • Invasive lobular carcinoma. A: Spot compression view demonstrates an irregular, low-to-isodense mass (arrow) with spiculated margins corresponding to a “lump” described by a 42-year-old patient in her right breast. B: Ultrasound. Irregular, vertically oriented mass (arrow) with indistinct and angular margins as well as intense shadowing is imaged corresponding to the clinically and mammographically apparent mass. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

FIG. 8.42 • Multifocal, invasive lobular carcinoma with DCIS and LCIS. A: Spot compression view in a 48-year-old patient presenting with a “lump” in her right breast. Two irregular iso dense masses with spiculated margins are imaged, the largest correlating with the triangular marker used to denote a palpable finding. B: Ultrasound. Round, hypoechoic mass (arrows) with spiculated and angular margins, an echogenic rim, and shadowing is imaged in the right breast. This correlates to the palpable (PALP) mass. C: Ultrasound. A vertically oriented, irregular, hypoechoic mass (arrows) with spiculated and angular margins and shadowing is imaged corresponding to the second mass seen mammographically. This is not palpable. D: MRI, T1-weighted sagittal reconstruction of the right breast post-contrast. The masses (short arrows) demonstrate heterogeneous enhancement with spiculated margins; non-mass-like linear enhancement (long arrow) is noted extending anteriorly from the superior mass. Histologically, the smaller of the two masses is an invasive lobular carcinoma. The clinically apparent and larger of the two masses is predominantly invasive lobular carcinoma; however, there are areas where the lesion is mixed (e.g., invasive lobular and ductal). DCIS is also described and LCIS is noted throughout the surrounding tissue. Both lesions are estrogen/progesterone-positive, HER2/neu-negative. The sentinel lymph node is positive and as such a full axillary dissection is done yielding 2 lymph nodes with metastatic disease out of the 22 sampled. Extracapsular extension is noted affecting one of the positive lymph nodes. (continued)
Invasive lobular carcinoma. CC (A) and MLO (B) views in a 45-year-old patient. Focal parenchymal asymmetry (arrows) is present in the lower central aspect of the right breast anteriorly. C: Ultrasound. On physical examination, a hard mass is palpated inferiorly in the right breast corresponding to the site of the parenchymal asymmetry. An irregular mass (arrows) with angular margins and intense shadowing is imaged at the palpable site corresponding to the asymmetry seen on the mammogram. An abnormal lymph node (not shown) is also identified in the right axilla with metastatic disease diagnosed on core biopsy. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. In addition to the invasive lobular carcinoma, extensive LCIS is reported in the mastectomy specimen and metastatic disease is diagnosed in six of nine axillary lymph nodes. The tumor is estrogen and progesterone-positive, HER2/neu-negative.
**FIG. 8.44** Invasive lobular carcinoma. CC (A) and MLO (B) views photographically coned to a screen-detected abnormality in a 54-year-old patient. A low-density area of distortion and spiculation (arrow) is noted in the CC projection anterolaterally in the left breast. This area is more mass-like (arrow) on the oblique view. A vertically oriented markedly hypoechoic mass with angular margins and some shadowing is imaged on ultrasound (not shown) in the left breast corresponding to the mammographic finding. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. C: MRI, T1-weighted axial image of the left breast post-contrast. D: MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. The mass demonstrates heterogeneous internal enhancement and spiculated margins. The observation made mammographically is also apparent on MRI; the mass (arrow) is best seen and appears more mass-like in the sagittal projection in part D. The mass (arrow) is subtle and more difficult to characterize on the axial images (e.g., equivalent to the CC projection). It is thought that invasive lobular carcinoma demonstrates a planar growth pattern; consequently, it is common for it to be more conspicuous in one of the two orthogonal projections. This lesion is estrogen receptor-positive, progesterone receptor weakly positive, and HER2/neu-negative. The sentinel lymph node (LN) biopsy is negative (0/1 LN).
FIG. 8.45 • Synchronous lesions: invasive lobular carcinoma right breast, invasive ductal carcinoma left breast. CC (A) and MLO (B) views in a 63-year-old patient. Your eye is likely drawn to the dense mass (long arrow) in the left breast best seen on the CC view. Remember, when faced with an obvious finding, force yourself to evaluate the remaining tissue in that breast as well as the contralateral side, and specifically look for some of the more subtle presentations of cancer including distortion. In evaluating the images of the right breast carefully, you should note distortion anteriorly on the CC view (short arrows) and an area of “rigid” tissue with increased density (short arrows) on the MLO view. C: MRI, T1-weighted axial image post-contrast. Non-mass–like enhancement (arrows) of the tissue in the right breast anteriorly matches the area of distortion noted on the CC views. D: MRI, T1-weighted sagittal reconstruction of the right breast, post-contrast. Non-mass–like enhancement (arrows) is noted superiorly in the right breast comparable to what is seen on the MLO view. This plaque-like (planar) growth appearance is one of the characteristics of invasive lobular carcinoma. The finding is often better seen and more prominent in one projection compared with the other. E: MRI, T1-weighted axial image post-contrast at a different scan plan than that shown in part C demonstrates the mass (arrow) in the left breast. The mass is characterized by lobulated, irregular margins and heterogeneous enhancement. Histologically, an invasive lobular carcinoma is described in the right breast and invasive ductal carcinoma, high grade, is diagnosed in the left breast. Two lymph nodes in the right axilla are positive for metastatic disease; the sentinel lymph node biopsy on the left is negative. The invasive ductal carcinoma is triple-negative. This patient illustrates nicely some of the differences in the imaging presentations between invasive ductal and lobular carcinomas.
The metastatic pattern for invasive lobular carcinomas may be distinctive in some patients. Unlike invasive ductal carcinomas that tend to metastasize to solid organs including liver, lungs, bones, and brain, invasive lobular carcinomas may simulate ovarian carcinomas in their behavior. Studding of peritoneal and pleural surfaces is seen with the development of ascites and pleural effusions; involvement of the leptomeninges, uterus, ovaries, and stomach can also occur (64).

**LYMPHOMA**

Primary breast lymphoma represents approximately 0.04% to 0.5% of all breast malignancies. Lymphoma is considered primary to the breast when the breast is the first or major site of involvement and, exclusive of ipsilateral axillary lymph node involvement, there is no lymphoma elsewhere. Ipsilateral axillary lymph node involvement is acceptable, provided the breast and axillary lymph node lesions are diagnosed simultaneously (65). More commonly, lymphomas involve the breast secondarily. Patients may present with a palpable finding. Alternatively, one (Fig. 8.48) or more masses with circumscribed to indistinct margins are detected mammographically, or rarely, as discussed in Chapter 9, parenchymal asymmetry (see Fig. 9.29) or diffuse changes (see Fig. 9.22). Calcifications are

**FIG. 8.46** *Multicentric invasive lobular carcinoma.* CC (A) and MLO (B) views in a 62-year-old patient. A mass (arrow) with spiculated margins is present in the left subareolar area best on the CC view. Nipple thickening and retraction is apparent in both projections and a new finding compared with prior studies (not shown). A vertically oriented hypoechoic mass with an echogenic rim is imaged on ultrasound (not shown) corresponding to the mass seen mammographically. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. An invasive lobular carcinoma is diagnosed on the ultrasound-guided core biopsy. **C:** MRI, maximum-intensity projection image. Multiple masses with homogeneous enhancement and spiculated margins are noted predominantly involving the upper central and lateral aspects of the left breast. Multicentric invasive lobular carcinoma with extensive LCIS is reported on the mastectomy specimen; estrogen and progesterone receptor-positive, HER2/neu-negative with one of four lymph nodes positive for micrometastatic disease. Multifocality, multicentricity, and bilateral disease are relatively common in patients with invasive lobular carcinoma.

**FIG. 8.47** *Pathology.* Histologically, individual, small relatively monomorphic cells invading the stroma in a single file (arrows) characterize invasive lobular carcinoma. In contrast, nests of cells invading and disrupting surrounding tissue and normal structures characterize invasive ductal carcinoma.
FIG. 8.48 • Primary breast lymphoma. A: MLO view in an 80-year-old patient photographically coned to upper aspect of the breast. A low-density oval mass (arrow) with indistinct margins is detected mammographically in the upper inner quadrant of the left breast. Arterial calcification is present. Low-grade lymphoma is diagnosed on an excisional biopsy of the mass. Patient has no history of lymphoma and all staging studies done at this time are normal. B: CT scan, 2 years following the diagnosis shows a small pleural effusion on the right and anterior mediastinal adenopathy (arrow). C: MRI demonstrates a scalp mass (thin arrows) and adenopathy (thick arrow) adjacent to left jugular vein. D: Additionally, a soft tissue mass (arrow) is present lateral to the left orbit. Biopsy of the scalp mass is reported as consistent with recurrent lymphoma. A diffuse, large, B-cell-type lymphoma is described. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
uncommon. At the time of presentation, axillary nodes are involved in 30% to 40% of patients (1,2). Bilateral disease is uncommon. Night sweats, fever, and weight loss have been reported in 6% to 20% of patients (1).

Two different patient populations have been described with primary breast lymphomas. In the first group, patients present during pregnancy or lactation with rapid, bilateral breast enlargement. In this group of patients, it is usually a Burkitt-type lymphoma with ovarian and CNS involvement and a poor prognosis. The second group of patients presents over a wider age spectrum with unilateral breast involvement, and an underlying histology of a diffuse large cell lymphoma of the B-cell type. Primary breast lymphoma is treated like other extranodal lymphomas. After a histological diagnosis, patients are staged and radiation and chemotherapy are used (65).

SARCOMAS
Malignancies involving the stromal tissues of the breast represent a heterogeneous group of lesions that are rare. Included in this group of lesions are malignant phyllodes tumor (see Figs. 7.66 through 7.69), stromal sarcoma, fibrosarcoma, malignant fibrous histiocytoma, carcinosarcoma, granulocytic sarcoma (chloroma), leiomyosarcoma (Fig. 8.49), liposarcoma (Fig. 8.50), and angiosarcomas (Fig. 8.51). Patients commonly present with a mass that may have circumscribed (Fig. 8.52) margins. On ultrasound, a solid mass with a heterogeneous echotexture and enhancement or shadowing may be seen. Alternatively, a complex cystic and solid mass may be imaged. Axillary lymph nodes are usually not involved since these lesion spread hematogenously (66–68). The MRI features of these lesions are not well-described.

A separate and rare group of patients to consider with sarcomatous lesions are those who present following radiation therapy (see Figs. 11.21 and 11.22). In these patients, the sarcomas are likely radiation-induced and can develop in the skin (e.g., cutaneous angiosarcomas), breast parenchyma, or the soft tissues surrounding the breast (e.g., chest wall, upper abdomen) that were included in the radiation field or exposed to scattered radiation (69,70).

METASTATIC DISEASE TO THE BREASTS
The most common metastatic lesion to the breast is from the contralateral breast through lymphatic channels on the anterior chest wall. Patients present with erythema involving the medial quadrants of the breast; some have nodules that may be ulcerative, associated with the erythema (Fig. 8.6A). There may be relative sparing of the skin overlying the sternum (Fig. 8.53).

Extramammary metastases are usually hematogenous and represent 1% to 3% of all breast lesions (71). Hematopoietic and lymphoreticular lesions such as leukemia and lymphoma (Fig. 8.54), melanoma, lung, ovary (Figs. 8.55 and 8.56), renal, bladder, colon, stomach, and cervix have been reported. Single or multiple masses may be palpated. Very rarely, lung carcinomas can extend through the chest wall to involve the breast secondarily (Fig. 8.57).

Mammographically, single (Figs. 8.56A) or multiple (Fig. 8.55A) uni- or bilateral masses (Fig. 8.54A) are identified. The masses are usually round or oval with circumscribed, less commonly, indistinct margins. Solid hypoechoic masses with variable echotextures are seen on ultrasound. Since some of these lesions grow fairly rapidly, posterior acoustic enhancement may be apparent, as can cystic spaces reflecting areas of necrosis.

**FIG. 8.49** **Leiomyosarcoma.** A: MLO views in a 54-year-old patient with a “lump.” The metallic BB marks the location of the palpable finding. A dense mass (arrow) is imaged in the upper central aspect of the right breast posteriorly. B: Ultrasound. A complex cystic and solid mass with posterior acoustic enhancement is imaged in the right breast corresponding to the palpable finding. BI-RADS 4C: Suspicious abnormality; biopsy is indicated.
**FIG. 8.51 • Angiosarcoma.** Spot tangential view. A macrolobulated mass with variable density, indistinct margins, and "cloud-like" appearance sometimes seen with vascular lesions is imaged at the site of a palpable finding. Associated coarse calcifications. Some patients with angiosarcomas will have a bruit and a bluish discoloration overlying lesion. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

**FIG. 8.50 • Liposarcoma.** A: Left MLO view. A predominantly fatty mass is present extending into the axilla and displacing breast parenchyma anteriorly; the transition between tumor and normal breast tissue is apparent (arrows). Efforts to position the breast to include more pectoral muscle proved unsuccessful. B: Ultrasound. A predominantly hyperechoic but heterogeneous mass (arrows) is imaged throughout the upper aspect of the left breast extending into the axilla and superiorly to the subclavicular area. Given the size and the infiltrative pattern of the mass it is not possible to image the lesion completely on any one image. C: CT scan. The lesion is predominantly fatty with internal septations, expands the left breast and extends into the axilla.
FIG. 8.52  Dermatofibrosarcoma protuberans with eventual fibrosarcomatous transformation. A: Left CC view in a 31-year-old patient with multiple “lumps.” Low- to iso-dense mass (thin arrow) with circumscribed margins corresponding to one of the palpable areas. Fibroadenoma diagnosed following excisional biopsy of this lesion. No definite mass noted at second palpable site (thick arrow). B: Ultrasound using standoff pad to evaluate inner quadrant lesions. Two oval masses (arrows) with circumscribed margins causing a bulge in the contour of the breast. It is not possible to determine if these lesions are arising in the breast or the skin. Dermatofibrosarcoma protuberans is diagnosed on the excisional biopsy. Although wider excision was strongly recommended, patient declined further evaluation. C: Lateral view of the patient 21 months after image in part A. A mass is visible in the upper inner quadrant of the left breast (at the site of the prior biopsy). The patient presents because of significant tenderness associated with the mass. D: Left CC view. An oval iso dense mass with circumscribed margins is imaged mammographically corresponding to area of clinical concern. E: Ultrasound. An oval mass with heterogeneous echotexture and posterior acoustic enhancement is imaged corresponding to the clinically and mammographically apparent mass. Biopsy at this time shows sarcoma (fibrosarcomatous variant) arising in a dermatofibrosarcoma protuberans. (From Cardeñoso G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
(continued)
METASTATIC DISEASE TO INTRAMAMMARY AND AXILLARY LYMPH NODES

Metastatic disease to intramammary and axillary lymph nodes is usually related to an underlying ipsilateral breast cancer or uncommonly contralateral breast cancer. Mammographically, detection of lymph nodes particularly in the axilla is variable and dependent on patient positioning (72). From one year to the next, more or less axillary tissue may be included on the oblique views and as such care must be exercised in considering what is perceived as a change. Provided axillary lymph nodes are included on the mammogram, and if comparison films are available, the affected intramammary or axillary node(s) is often enlarged, the fatty hilum is attenuated or absent, and the cortex is thickened and dense (Fig. 8.58). In most patients, the margins of the lymph node remain circumscribed less commonly indistinct or spiculated (72–75).

Ultrasound is a better tool to evaluate the axilla. As mentioned previously, depending on patient positioning, lymph nodes may not be imaged on the mammogram, and as such, the axilla of patients presenting with breast cancer, or those describing a palpable mass in the axilla, should be evaluated with ultrasound. With respect to axillary lymph nodes, we do not use size as a criterion for establishing the need for biopsy but rather rely on mammographic changes if these can be ascertained or their ultrasound features. If a mass with a hyperechoic fatty hilum is imaged in the axilla, we describe it as a lymph node and focus our attention on the relationship of the cortex to the fatty hilum: is there mass effect (Fig. 8.58C) or is the fatty hilum attenuated? With respect to the cortex, we specifically consider its width, contour, and echogenicity. A thickened, markedly hypoechoic cortex with bulging (Fig. 8.59) or mass effect on the fatty hilum (Fig. 8.58C) in a patient with breast cancer suggests the presence of metastatic disease (76,77). In our experience, the echogenicity of the cortex is particularly helpful. In patients in whom the cortex is thickened and bulging, as the echogenicity of the cortex increases, the likelihood of metastatic disease decreases. Hyperechoic cortices are more commonly seen in patients with inflammatory processes while the cortex of lymph nodes in patients with metastatic breast cancer or lymphoma is usually hypoechoic to almost anechoic.

In patients with complete replacement of the node with tumor, the fatty hilum may not be apparent and a markedly hypoechoic (nearly anechoic) mass with posterior acoustic enhancement is imaged in the axilla (Fig. 8.60). Keep in mind that cysts do not occur in the axilla and only rarely do patients with prior sentinel lymph node biopsy or a full axillary dissection present with a postoperative fluid collection in the axilla. Consequently, a non-vascular mass with marked hypoechoogenicity...

FIG. 8.52  (continued)

FIG. 8.53  Skin metastasis. Confluent erythematous changes involving the inner quadrants bilaterally with relative sparing of the skin overlying the sternum. At least one raised erythematous nodule (arrow) is noted in the lower inner quadrant on the right.
FIG. 8.55 Metastatic invasive carcinoma high grade with necrosis consistent with metastatic disease from ovarian primary (anaplastic ovarian CA). A: MLO views in a 42-year-old patient. A round, high density mass (long arrow) is imaged in the lower inner quadrant of the right breast posteriorly. A second oval iso dense mass (short arrow) is present anteriorly. B: Ultrasound. A complex cystic and solid mass (arrows) with posterior acoustic enhancement is imaged on ultrasound corresponding to the larger mass seen mammographically. The smaller mass has similar features on ultrasound (not shown). BI-RADS 4C: Suspicious abnormality; biopsy is indicated.

FIG. 8.54 Metastatic lymphoma, bilaterally. A: CC views. A dense, round mass with circumscribed macrolobulated margins (a “halo” is seen partially surrounding the mass) is imaged in the right breast, and an oval low-density mass with circumscribed margins is partially imaged posterolaterally in the left breast. The metallic BBs are used to denote the palpable findings in this 40-year-old patient. B: Ultrasound. A mass with a heterogeneous echotexture and posterior acoustic enhancement is partially imaged corresponding to the palpable mass in the right breast. C: Ultrasound. An oval mass with eccentric echogenicity and a markedly hypoechoic cortical region is imaged corresponding to the mass seen on the mammogram in the left breast. This represents an abnormal intramammary lymph node. Malignant large B-cell lymphoma metastatic to the breast is diagnosed following ultrasound-guided core biopsies.
FIG. 8.56  ●  Metastatic serous papillary carcinoma of the ovary.

A: MLO views in a 41-year-old patient presenting with a “lump” in the right breast. Dense, round mass with circumscribed margins. B: Spot tangential view. High-density mass with circumscribed margins and associated amorphous calcifications not readily apparent on the routine views because of the density of the mass. Metallic BB used to mark site of palpable finding. C: Ultrasound. Round, hyperechoic mass (arrows) with indistinct margins, posterior acoustic enhancement, and internal echogenic foci consistent with the calcifications seen on the mammogram. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. Ultrasound-guided biopsy is done to establish the diagnosis. D: Psammoma bodies (arrow) are described corresponding to the amorphous calcifications seen on the mammogram and ultrasound. E: Chest CT scan image at the level of the breast mass (short arrow) also demonstrates calcified mediastinal adenopathy (long arrow) and resulting collapse of the right middle lobe.
and posterior acoustic enhancement (simulating a cyst) imaged on ultrasound in the axilla is abnormal and may warrant biopsy. When no fatty hilum is identified on ultrasound, it may be unclear if the mass represents a replaced lymph node, or possibly a primary lesion, so we are dependent on the location of the mass: is the mass in the axilla or could it be in axillary tail breast tissue? Histologically, if no lymphoid elements or DCIS are identified on a core biopsy from a mass in the axilla, it is often impossible for the pathologist to differentiate metastatic disease from a primary lesion. If DCIS is seen, the sampled lesion is unlikely to represent metastatic disease and more likely to be a primary lesion. Conversely, if lymphoid elements are identified, metastatic disease is likely. The pathologist is dependent on an accurate description of the location of the lesion being sampled and the impression of the radiologist.

The anatomic variability in the location of lymph nodes can be appreciated on magnetic resonance. Depending on tissue mobility, lymph nodes are sometimes noted extending inferiorly from the axilla along the mid-axillary line (Fig. 8.61). As with mammography and ultrasound, the shape of normal lymph nodes is variable, the margins are often circumscribed, T2 signal is intermediate to high, and the enhancement is often homogeneous with rapid wash-in and washout kinetics. Abnormal lymph nodes may be enlarged with indistinct margins, variable T2 signal (often low), and a more heterogeneous, stippled enhancement pattern. MRI also readily enables identification of abnormal internal mammary lymph nodes (see Fig. 5.24).

As mentioned previously, patients with metastatic disease to intramammary or axillary lymph nodes at the time of presentation will bypass sentinel lymph node biopsy and have a full axillary dissection or, with increasing frequency, neo-adjuvant therapy prior to surgery. Also, when an abnormal intramammary lymph node is identified and found to be positive for metastatic disease, we wire localize the positive intramammary lymph node preoperatively since these are not routinely excised during sentinel lymph node biopsy or axillary dissections.
FIG. 8.58  Multifocal invasive ductal carcinoma with metastatic disease to an intramammary lymph node.  
A: CC views in a 68-year-old patient.  B: Comparison CC views 1 year earlier. The patient has developed two masses (long arrow) in the medial aspect of the left breast (spot compression views and ultrasound are not shown), diagnosed as invasive ductal carcinoma on needle biopsy. Also note the change in one of two pre-existing intramammary lymph nodes in the lateral aspect of the breast posteriorly. The node (arrow head) is now enlarged, is denser, and the fatty hilum is not readily apparent mammographically; the second slightly more posterior lymph node (short arrow in image A) is low in density and remains unchanged compared with the prior study. Intramammary lymph nodes postero-laterally in the right breast also remain unchanged.  
C: Ultrasound of the larger intramammary lymph node on the left demonstrates a lymph node with eccentric hyperechogenicity and a hypoechoic cortex that is thickened and exerts mass effect on the fatty hilum such that the fatty hilum is attenuated (arrows). Needle biopsy confirms metastatic disease.  
D: Ultrasound. In the tissue adjacent to the lymph node shown in part C, a morphologically normal-appearing lymph node is identified corresponding to the more posterior lymph node seen on the mammogram. This is a morphologically normal-appearing lymph node with a prominent fatty hilum (“plump”) and a thin surrounding cortex (arrow).  
E: MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. The lymph node demonstrates superior cortical bulging (arrow) and heterogeneous enhancement. Vascular structure is imaged entering the hilar region.
FIG. 8.59  ●  Invasive ductal carcinoma, metastatic to a right axillary lymph node. A: Ultrasound. An oval mass with an eccentric fatty hilum and surrounding hypoechoic (“plump”) cortex; at this scan plane, the fatty hilum appears normal. B: Ultrasound. As the lymph node is scanned away from the hilum, a cortical bulge is noted superiorly and laterally to the fatty hilum; also note marked hypoechogenicity of the cortex. Metastatic disease is confirmed on ultrasound-guided core biopsy. In these patients, the cortical bulge is targeted for the core biopsy.

FIG. 8.60  ●  Invasive ductal carcinoma, metastatic to a left axillary lymph node. A: Ultrasound. Oval markedly hypoechoic mass with circumscribed margins and posterior acoustic enhancement. Suspected metastatic disease is confirmed on an ultrasound-guided biopsy. B: MRI, T1-weighted sagittal reconstruction of the left breast post-contrast. Oval heterogeneously enhancing mass (short arrow) with circumscribed margins is imaged corresponding to the mass shown in A. Rim-enhancing mass (long arrow) is imaged inferiorly in the left breast corresponding to one of two sites of malignancy in this patient.

Lymphoproliferative disorders including lymphoma (Fig. 8.62) and leukemia can also involve intramammary or axillary lymph nodes. Likewise, metastasis from non-breast primaries including melanoma (see Fig. 3.2), lung, and ovarian cancer (Fig. 8.63) can involve axillary lymph nodes (41–45). Rarely, unsuspected malignancies are detected because of enlarged lymph nodes (Fig. 8.62; also see Fig. 5.27). Although pleomorphic calcifications related to metastatic breast cancer have been reported, this is unusual and may reflect the presence of tumor necrosis from a breast primary (Fig. 8.64) or calcifications related to psammoma bodies from ovarian (78) or thyroid primaries (Fig. 8.63).
FIG. 8.61 • Metastatic disease to lymph nodes detected along the mid-axillary line on MRI. A: MRI, T1-weighted sagittal reconstruction of the right breast, post-contrast. A mass with heterogeneous enhancement, circumscribed margins, and an associated vascular structure is imaged posterolaterally in the right breast. A second similar mass is imaged on a scan a few millimeters lateral to this scan plane. The patient’s primary tumor is seen inferiorly with rim and central enhancement, irregular margins, and non-mass-like enhancement extending anteriorly for approximately 2 cm (see Fig. 5.3 for a coronal reconstruction of this tumor). The MRI in this 51-year-old patient was done for staging purposes; an invasive ductal carcinoma was diagnosed in the right breast on an ultrasound-guided biopsy. Morphologically normal lymph nodes were imaged in the right axilla on the ultrasound done at the time of the original evaluation. B: Ultrasound. Using the MRI as a guide, the patient is re-scanned along the mid-axillary line. Two nearly anechoic masses with indistinct margins are imaged along the 9 o’clock axis, 15 cm from the right nipple. Ultrasound-guided biopsy confirms suspected metastatic disease. In evaluating for metastatic disease we are now routinely scanning the axilla and coming inferiorly along the mid-axillary line.

FIG. 8.62 • Follicular center cell lymphoma grade III (large cell). A: Spot compression view of the left axilla in a 74-year-old patient presenting with new enlarged lymph nodes in the left axilla. An oval iso dense mass with circumscribed margins is imaged in the left axilla. No fatty hilum is seen. B: A round markedly hypoechoic mass with posterior acoustic enhancement is imaged in the left axilla corresponding to a palpable finding. No fatty hilum is identified. Additional enlarged lymph nodes are palpated in left aspect of the neck and two masses are present in the scalp. BI-RADS 4C: Suspicious abnormality; biopsy is indicated. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
FIG. 8.63  ● Metastatic papillary carcinoma with psammoma bodies. A: Spot compression view of the left axilla. Enlarged axillary lymph nodes with calcifications are noted on the screening mammogram in a 71-year-old patient (screening images not shown). Three masses with circumscribed margins and fine pleomorphic (round, punctate, and amorphous) calcifications are present. B: A hypoechoic mass with foci of hyperechogenicity consistent with calcifications is imaged on ultrasound (arrow). Metastatic papillary carcinoma with psammoma bodies is reported on the ultrasound-guided core biopsy; features suggest gynecologic serous papillary carcinoma or primary serous carcinoma of the peritoneum. (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)

FIG. 8.64  ● Metastatic breast cancer from the contralateral breast. A: MLO view of the left axilla photographically coned to the upper portion of the image in a 50-year-old patient with a contralateral mastectomy (right breast) for inflammatory carcinoma 2 years previously. Round iso dense mass with circumscribed margins and pleomorphic calcifications. Differential considerations include metastasis from the contralateral cancer or a new primary in the left breast with associated DCIS. B: Ultrasound. Two masses are imaged in the left axilla. One of these has hyperechogenic foci consistent with the calcifications seen on the mammogram (black arrow). A second round hypoechoic mass with a nearly anechoic center (white arrow) and indistinct margins is imaged deeper in the axilla. An ultrasound-guided needle biopsy of the calcified mass is done. Metastatic breast cancer (similar features to contralateral inflammatory carcinoma) with calcifications in areas of necrosis is diagnosed histologically. No DCIS is seen. Also, note that the mass is arising high in the axillary tail of the breast with no surrounding tissue; this is consistent with metastatic disease (as opposed to a second primary). (From Cardeñosa G. Breast Imaging [The Core Curriculum Series]. Philadelphia, PA: Lippincott Williams & Wilkins; 2003.)
References


CHAPTER SELF-ASSESSMENT QUESTIONS

1. Representative spot compression view (left) and ultrasound image (right) in a 73-year-old woman called back for additional evaluation of a mass in the left breast. What is the most likely diagnosis?

A. Invasive ductal carcinoma, not otherwise specified
B. Mucinous carcinoma
C. Tubular carcinoma
D. Invasive lobular carcinoma
2. Mediolateral oblique views (top) and representative image from a right breast ultrasound (bottom). This tumor is likely to be:

A. Estrogen (ER) and progesterone (PR) receptor positive, Her2-neu positive
B. ER/PR negative, Her2-neu negative
C. ER/PR positive, Her2-neu negative
D. ER/PR negative, Her2-neu positive

Answers to Chapter Self-Assessment Questions

1. B Mucinous carcinoma is the leading consideration in a 73-year-old woman presenting with a round mass with circumscribed margins that is nearly iso to slightly hyperechoic on ultrasound. Invasive ductal carcinomas not otherwise specified are usually hypoechoic, with indistinct margins and overall more conspicuous on ultrasound. Tubular carcinomas are typically small (<1 cm) irregular masses with spiculated margins; on ultrasound these are often associated with distortion and shadowing. Tubular carcinomas are also reportedly more common in premenopausal patients. Invasive lobular carcinoma rarely presents as a round mass with circumscribed margins; a mass with spiculated margins, developing parenchymal asymmetry and distortion are the most common mammographic findings in women with invasive lobular carcinoma. On ultrasound, a mass with spiculated margins as well as associated distortion and intense shadowing are the common findings in patients with invasive lobular carcinoma.

2. B A dense round (expansile) mass with indistinct margins is seen mammographically. On ultrasound, the mass is characterized by a heterogeneous echotexture and posterior acoustic enhancement. An invasive ductal carcinoma, not otherwise specified should be suspected in patients presenting with rapidly developing expansile (“blow up”) masses, particularly if the patient is premenopausal. These tumors are often Her2-neu as well as estrogen and progesterone receptor negative (triple negative tumors).