Imaging of the Symptomatic Male Breast

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Introduction

While common in women, breast cancer is rare in men and accounts for less than 1% of all diagnosed breast cancer cases [1]. The American Cancer Society estimated that approximately 2620 new cases of invasive breast cancer will be diagnosed in males in the year 2020, compared to approximately 246,480 in women [2]. While male breast cancer continues to be rare, the Surveillance, Epidemiology and End Results (SEER) data reports an increased incidence by 40% from 1975 to 2015 [3].

Aside from breast cancer, men can experience a variety of clinical symptoms and pathologic processes similar to what is seen in the female breast. Therefore, a working knowledge of appropriate imaging indications and commonly encountered imaging findings in the male breast is essential for radiologists and other clinicians involved in male breast health. In this chapter, we provide an overview of the anatomy of the male breast, appropriate imaging indications, and commonly used imaging modalities in the symptomatic male breast as well as review a spectrum of benign and malignant disease processes encountered upon imaging male patients.

Embryology and Anatomy of the Male Breast

The development of the mammary bud begins early in utero in both male and female embryos around 4–6 weeks gestation [4]. At this time, mammary-specific epithelial cells can be seen in the epidermis of the thoracic region and extend in a paired line between the axillae and inguinal region bilaterally to form the mammary crests or milk lines [4]. The majority of the epithelial tissue in the milk lines will atrophy to leave only the primary mammary buds in the pectoral regions [5, 6]; however, if atrophy does not occur or is incomplete, supernumerary nipples can occur. Supernumerary nipples can be seen in 2–5% of humans and may have the appearance of a pigmented macule or a fully developed nipple-areolar complex [7–11]. At 6 months gestation, the rudimentary framework for the mammary gland is present [4]. By the end of third trimester, approximately 15–20 lobes of glandular tissue exist [4].

The mammary glands of males and females are nearly identical at birth consisting of subareolar lactiferous ducts [12]. During puberty, an increase in estrogen stimulates ductal proliferation and maturation of the terminal ductal-lobular units in the female breast, essential for milk production. In young men, the pubertal increases in testosterone results in involution and atrophy of the lactiferous ducts [13]. If exposed to increased levels of estrogen, male lactiferous ducts can proliferate and branch resulting in gynecomastia; however, a notable difference is the rarity of lobule formation in the male breast. For this reason, lobular proliferative processes seen in females, such as fibroepithelial lesions, cysts, radial scar, lobular carcinoma in situ (LCIS), and invasive lobular carcinoma (ILC), are very rare in men. Although atrophic, ductal epithelial tissue does persist in male breasts; therefore, invasive ductal carcinoma, ductal carcinoma in situ (DCIS), papillary lesions, as well as other proliferative processes related to ductal epithelium can be seen [12].

The normal adult male breast consists of a nipple, areola, and subcutaneous fat (Fig. 3.1). Typically, no glandular tissue is seen in the subareolar region of the male breast unless gynecomastia is present.

Imaging the Male Breast

The majority of male patients presenting for breast imaging are symptomatic, commonly with an area of palpable concern, breast enlargement, or pain, with gynecomastia being the most common cause of the symptoms [14–16]. If a patient has clinical exam findings classic for gynecomastia

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or pseudogynecomastia (breast enlargement due to the deposition of adipose tissue), imaging is not routinely indicated [17]. Gynecomastia typically presents as a rubbery, mobile mass located central to the nipple in the retroareolar breast and is more likely to be tender [14, 18]. In contrast, male breast cancer usually presents as a painless, firm or fixed mass central or eccentric to the nipple, sometimes with associated findings such as skin thickening, nipple discharge, nipple retraction, or axillary adenopathy [14]. If the clinical exam findings are indeterminate or concerning for malignancy, imaging should be performed. Because only 6% of male breast cancers occur in patients under 40 years of age and only 1% in those less than 30 years of age, age-based imaging protocols have been developed [14, 19] and are supported by the American College of Radiology (ACR) [17].

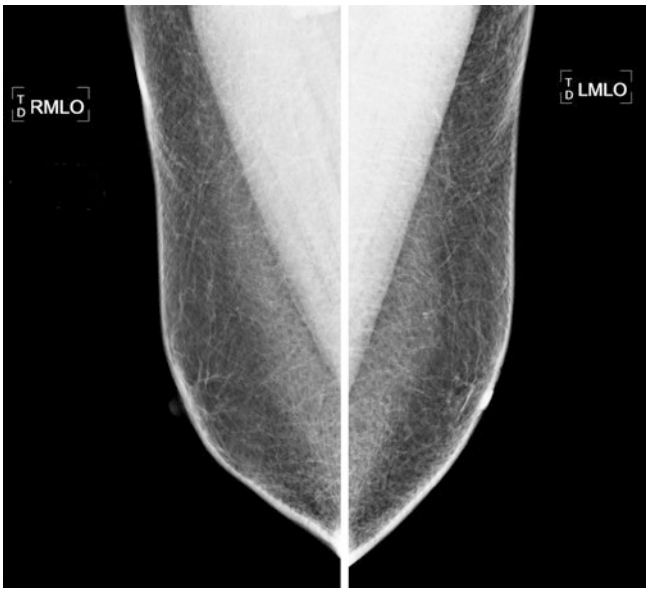

Fig. 3.1 Bilateral full-field digital mammography in the mediolateral oblique (MLO) projection of the normal male breast. The male breast consists of a nipple, areola, and subcutaneous fat. A well-developed triangular pectoralis muscle can be seen posteriorly

Mammography

Mammography is the mainstay modality in imaging the male breast in the diagnostic setting due to its high sensitivity (92–100%) and high specificity (90–96%) in the detection of breast cancer and has a negative predictive value of 99–100% [14, 20–22]. This level of accuracy keeps mammography at the forefront of the radiologist's toolkit in evaluating the male breast. In addition, mammography is most likely to show suspicious calcifications, commonly associated with in situ carcinoma, which can be difficult to appreciate on other imaging modalities. Mammography performs very well in distinguishing benign versus malignant pathology in the male breast and can obviate the need for further imaging workup with ultrasound or core biopsy in patients with classically benign mammographic findings.

Standard, full-field mammography can be performed on the male breast, with technique mirroring that used on the female breast (Fig. 3.2a, b). Mammography is often acquired bilaterally to assess symmetry and possible, albeit

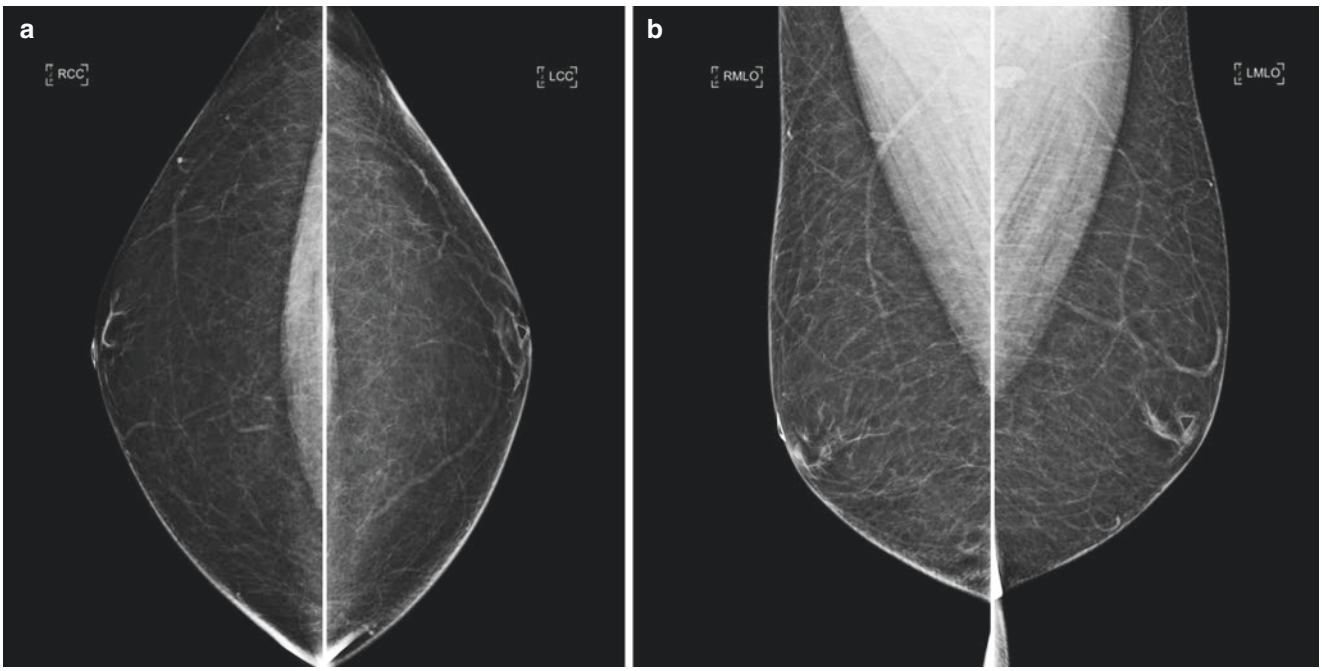

Fig. 3.2 (**a**, **b**) Bilateral standard full-field digital mammographic views in the craniocaudal (CC) (**a**) and mediolateral oblique (MLO) (**b**) projections. Triangle-shaped palpable skin markers were placed to indicate the areas of palpable complaint

rare, occult malignancy in the contralateral breast. Although there is no strong data to support imaging the asymptomatic breast, imaging both sides is common practice. Pectoralis-displaced mammographic views may be obtained if the breast tissue is obscured by robust pectoralis musculature [23]. The technique is similar to implant-displaced views in patients with breast implants. Spot compression or spot magnification mammographic views may be obtained to further characterize a mammographic mass, asymmetry, architectural distortion, or calcifications and may be especially useful if gynecomastia is present, which can mask the finding or obscure the margins of a mass (Figs. 3.3a, b and 3.4a–d). Digital breast tomosynthesis (DBT) is now in widespread use in many practices and can also be used to image the male breast. There is limited data available evaluating the incremental yield of DBT compared to mammography alone in male patients. In some studies, DBT has been found to show comparable imaging appearances for benign and malignant pathology as that of mammography [24–26]. DBT may be especially helpful in male patients with dense gynecomastia to reduce the masking effect of dense tissue and in characterizing mass margins (Figs. 3.5a, b and 3.6a, b).

In male patients 25 years of age and older with an indeterminate clinical exam finding such as a palpable mass, not consistent with gynecomastia, pain, nipple discharge, or axillary lymphadenopathy, mammography or DBT is the initial exam of choice according to the American College of Radiology (ACR) Appropriateness Criteria [17], which provides evidence-based imaging guidelines. In male patients less than 25 years of age, in which the likelihood of breast cancer is extremely low, ultrasound is recommended as the initial imaging exam [17]. If an

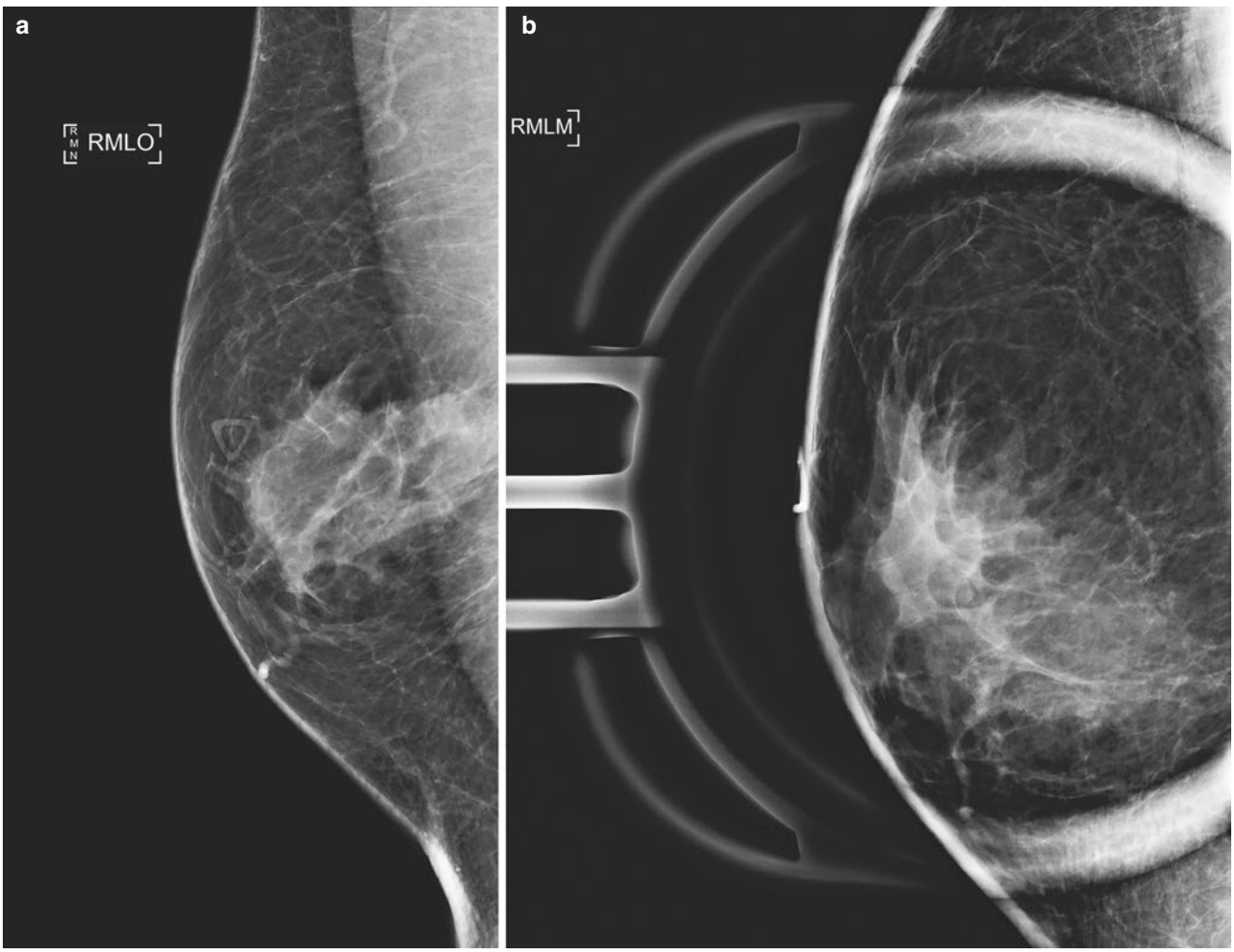

Fig. 3.3 (**a**, **b**) Right breast full-field digital mammographic views in the mediolateral oblique (MLO) projection (**a**) demonstrates dense gynecomastia in the retroareolar breast. The lateromedial (LM) spot magnification mammographic view (**b**) confirms glandular tissue without an underlying mass, consistent with gynecomastia

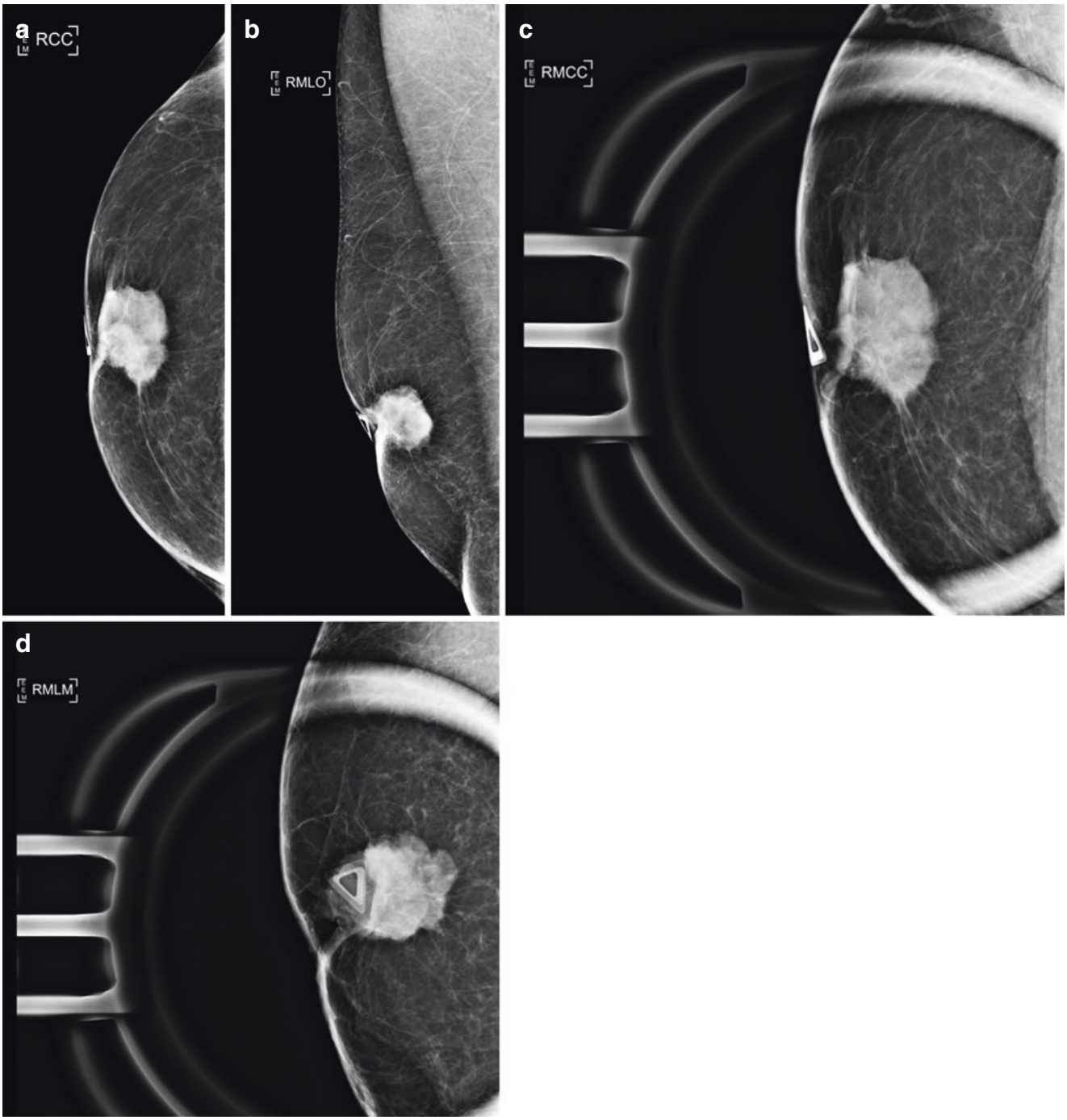

Fig. 3.4 (**a**–**d**) Right breast full-field digital mammographic views in the craniocaudal (CC) (**a**) and mediolateral oblique (MLO) (**b**) projections demonstrate a mass in the retroareolar right breast that correlates with the palpable complaint as indicated by the triangular marker. Digital spot magnification mammographic views in the craniocaudal (CC) (**c**) and lateromedial (LM) (**d**) projections demonstrate an irregular mass with microlobulated and spiculated margins and associated nipple retraction, which is highly suspicious for malignancy

indeterminate or concerning finding is seen on ultrasound, mammography or DBT should be performed to aid in the assessment of benign versus malignant pathology before core biopsy is recommended [17]. In men of any age with clinical exam findings suggestive of breast malignancy, mammography or DBT should be performed as the initial exam followed by ultrasound as an adjunct modality for further characterization and biopsy planning [17].

Screening mammography is not routinely recommended in male patients due to the very low prevalence of breast cancer in men. Although there is not robust data regarding screening men at elevated risk for developing breast cancer,

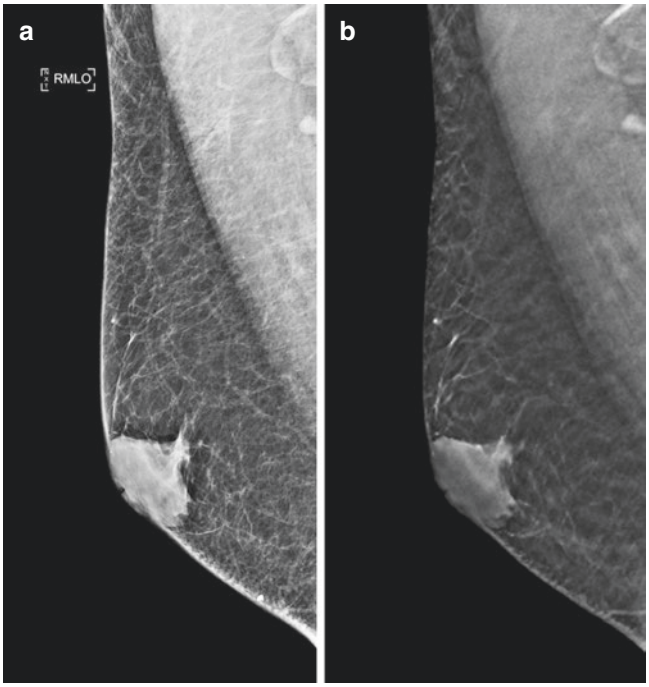

Fig. 3.5 (**a**, **b**) Right breast full-field digital mammographic views in the mediolateral oblique (MLO) projection (**a**) demonstrating dense gynecomastia in the retroareolar breast. Digital breast tomosynthesis image in the same projection (**b**) confirms superimposed dense glandular tissue with no underlying mass

some case reports and studies suggest men at elevated risk may benefit from screening mammography [27–30]. The current screening guidelines from the National Comprehensive Cancer Network (NCCN) for male BRCA mutation carriers recommend annual clinical breast exam starting at age 35 and the consideration of annual screening mammography in men with gynecomastia starting at age 50 or 10 years before the earliest known male cancer in the family [31]. As more data becomes available, the use of mammography as a screening modality in men at high-risk for developing breast cancer may become more prevalent.

Ultrasound

Ultrasound is most commonly used as an adjunct imaging modality with mammography. If an indeterminate or suspicious finding is seen on mammography, ultrasound should be performed to aid in lesion characterization and to guide core biopsy, if needed (Figs. 3.7a–c and 3.8a–c) [14]. In patients with imaging findings suggestive of breast malignancy, ultrasound is useful in evaluating the regional nodal basins for staging purposes. Studies have shown variable ultrasound performance in the evaluation of the male breast when used as a single modality. In a study of 638 patients, Munoz Carrasco et al. [14] demonstrated a sensitivity for the detection of breast cancer to be 88.9% compared to 99.5% for

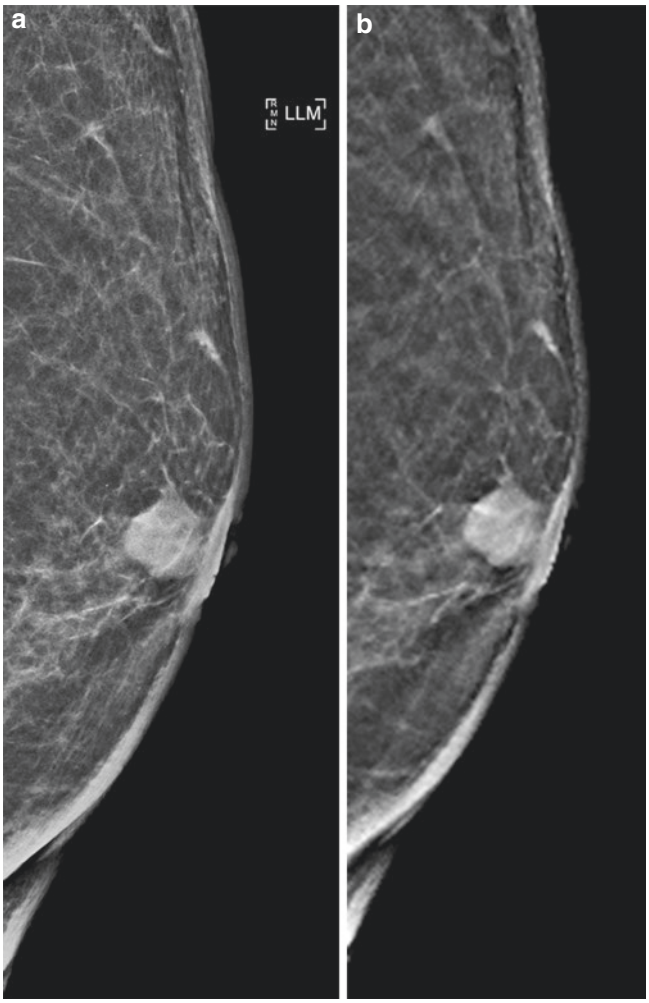

Fig. 3.6 (**a**, **b**) Left breast full-field digital mammographic view (**a**) and digital breast tomosynthesis image (**b**) in the lateromedial (LM) projection shows an irregular mass in the retroareolar breast with indistinct margins concerning for malignancy. This was found to be invasive ductal carcinoma upon subsequent workup and core biopsy

mammography with a comparable specificity of 95.3%. In a study of 166 patients, Patterson et al. [22] found ultrasound to have equivalent sensitivity to mammography of 100% and a lower specificity of 74%.

In male patients younger than age 25, ultrasound should be the initial imaging exam of choice given the extremely low prevalence of breast cancer in this age group as recommended by the ACR Appropriateness Criteria [17]. Ultrasound can be followed by mammography or DBT if an indeterminate or suspicious sonographic finding is identified [17].

Breast Magnetic Resonance Imaging

In the diagnostic setting, magnetic resonance imaging (MRI) of the breast is generally not indicated in male patients as most clinical questions and imaging findings can be resolved with a

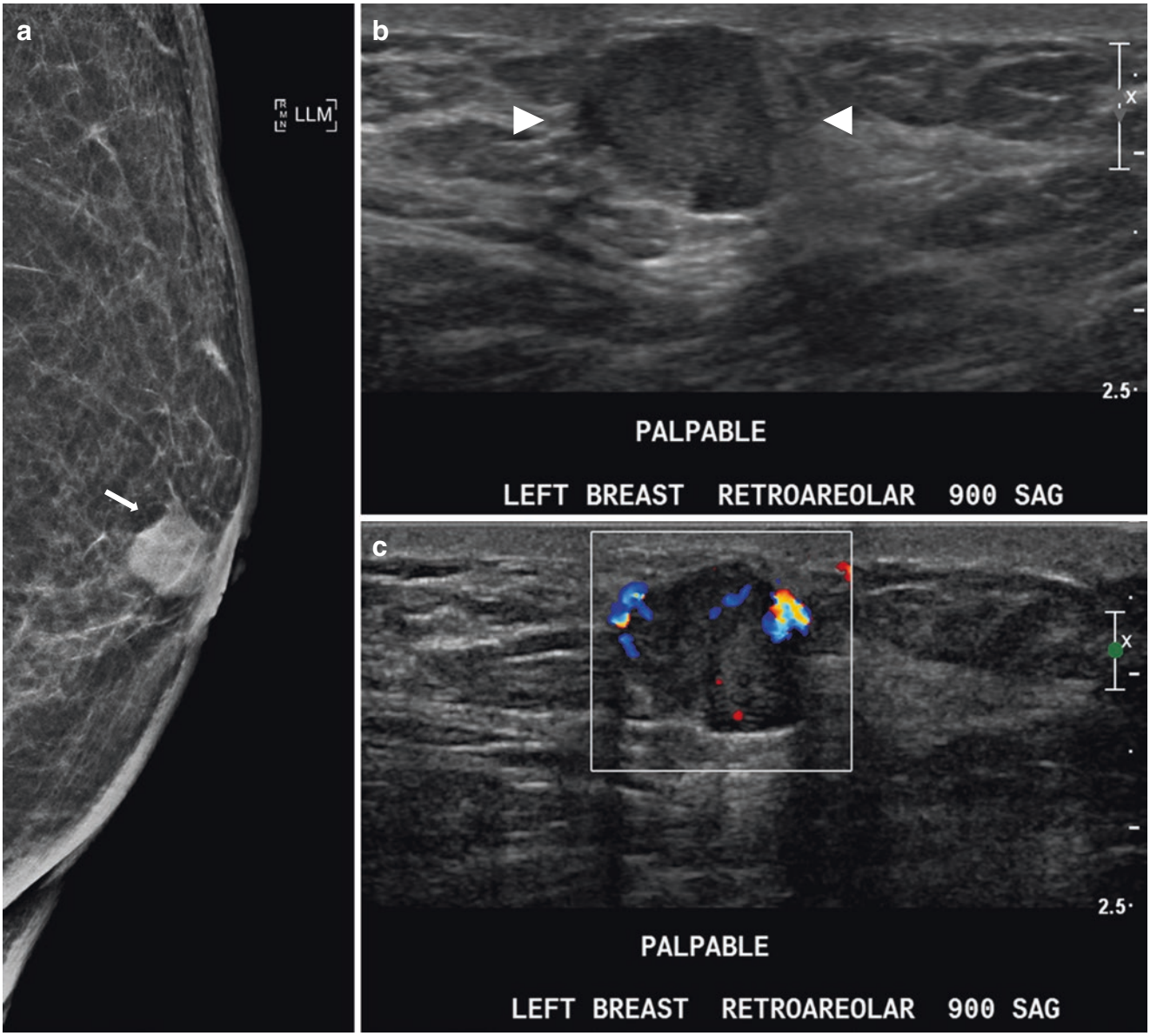

Fig. 3.7 (**a**–**c**) Left breast full-field digital mammographic view in the lateromedial (LM) projection (**a**) shows an irregular mass in the retroareolar breast (white arrow). Targeted ultrasound (**b**) with color doppler (**c**) reveals an irregular mass with indistinct margins (white arrowheads) with associated increased vascularity that is highly suspicious for malignancy

combination of mammography, ultrasound, and core biopsy [17]. Unlike the firm recommendations guiding the use of breast MRI in women, there is limited data regarding its clinical utility in male patients. In males with breast cancer, breast MRI may be helpful to define the extent of disease for staging and treatment planning, especially for patients with very posteriorly located tumors that are not fully delineated on mammography and ultrasound (Fig. 3.9a–g) [32]. As in female patients, breast MRI can demonstrate the tumor relationship to the underlying pectoralis musculature and chest wall to assess for involvement, evaluate for residual disease after surgery, assess for a primary breast malignancy in the setting of known axillary nodal metastases after negative mammography and ultrasound, as well as evaluating tumor response to neoadjuvant chemotherapy [32]. Breast MRI is also useful in the evaluation of regional nodal basins for breast cancer staging. It is important to note that breast MRI is not routinely indicated in all male patients with breast cancer but can be a helpful tool in select patients adding useful clinical information for treatment planning.

Breast Interventional Procedures

In male patients with imaging findings concerning for malignancy, a biopsy for tissue diagnosis is indicated. Tissue sampling can be performed by fine-needle aspiration or core

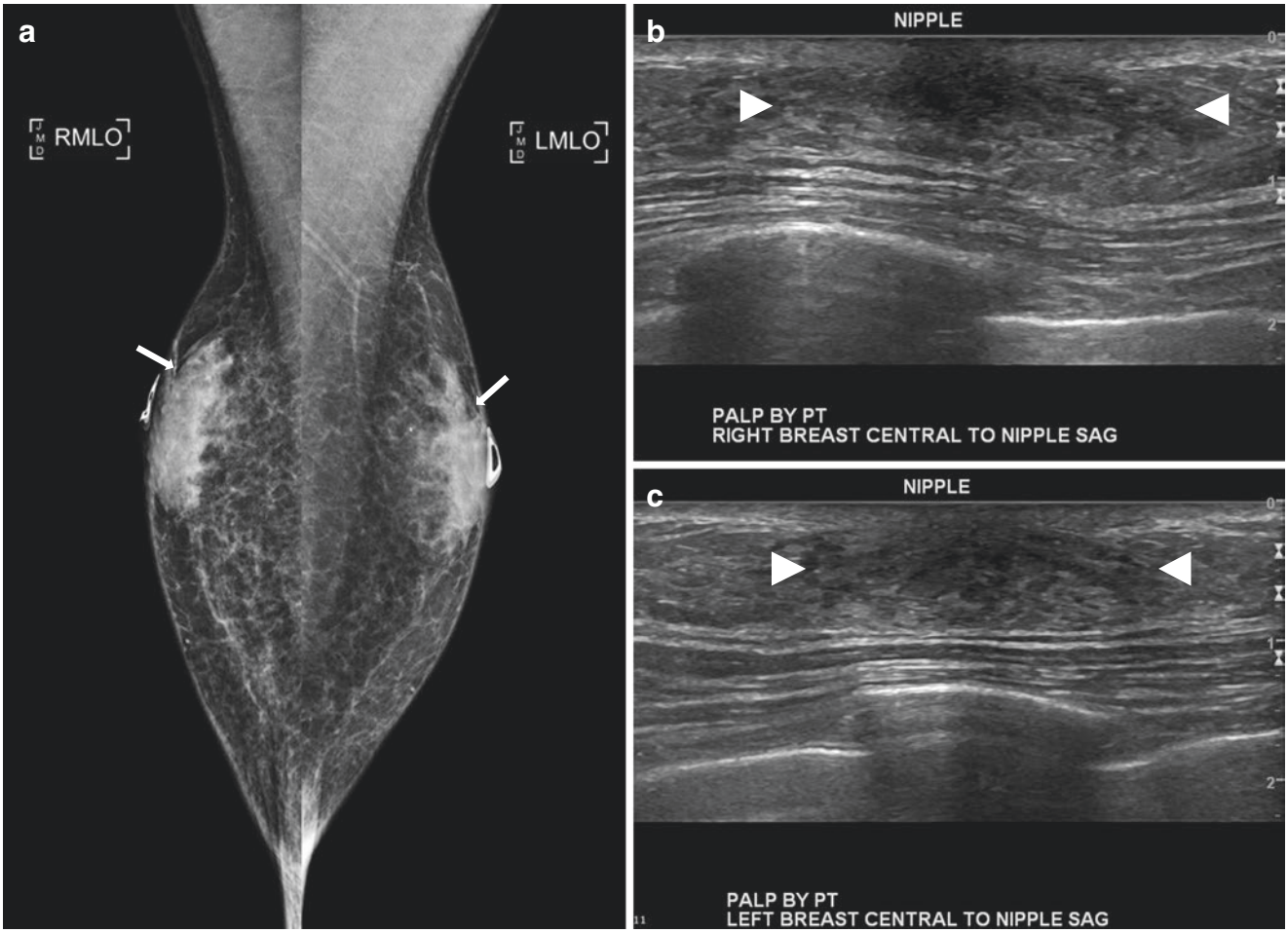

Fig. 3.8 (**a**–**c**) Bilateral full-field digital mammographic views in the mediolateral oblique (MLO) projection (**a**) demonstrates symmetric bilateral glandular tissue in the retroareolar breasts consistent with gynecomastia (white arrows). Targeted ultrasound (**b**, **c**) shows the typical sonographic appearance of gynecomastia (white arrowheads)

biopsy, most commonly under ultrasound guidance with or without vacuum assistance (Fig. 3.10a, b). Although much less common and more technically challenging, core biopsy of the male breast can also be performed using a vacuum-assisted device under stereotactic mammographic or tomographic guidance and, rarely, MR imaging guidance. These procedures are typically done using a local anesthetic and are generally well tolerated by patients.

Benign Diagnoses

Gynecomastia

Gynecomastia, the most common diagnosis encountered in the evaluation of the symptomatic male breast, is benign and characterized by proliferation of both the ductal and stromal elements. Gynecomastia can occur as a result of a hormonal imbalance between estradiol and testosterone levels, with some of the most common causes listed in Table 3.1 [33]. The most common presentation of gynecomastia is a painful lump located in the subareolar region, breast enlargement, or a burning sensation. These findings are most commonly unilateral, but can also be present in both breasts.

Unlike other male breast diseases (such as breast cancer or intraductal papilloma), associated findings like skin or nipple changes or pathologic nipple discharge are not identified on physical exam [18]. Another differentiating factor between gynecomastia and male breast cancer is the relationship of the findings with the nipple-areolar complex. Typically, gynecomastia is central to the nipple in location, whereas male breast cancer is usually eccentric to the nipple-areolar complex [33]. Despite the fact that gynecomastia has been reported in up to 40% of the male breast cancer cases, no causal relationship has been determined [34]. Through the combination of the patient's history (including a careful review of medical conditions and use of both pharmaceutical and recreational drugs), the findings on physical exam, and the imaging characteristics, it is usually possible to distinguish between a diagnosis of gynecomastia and breast

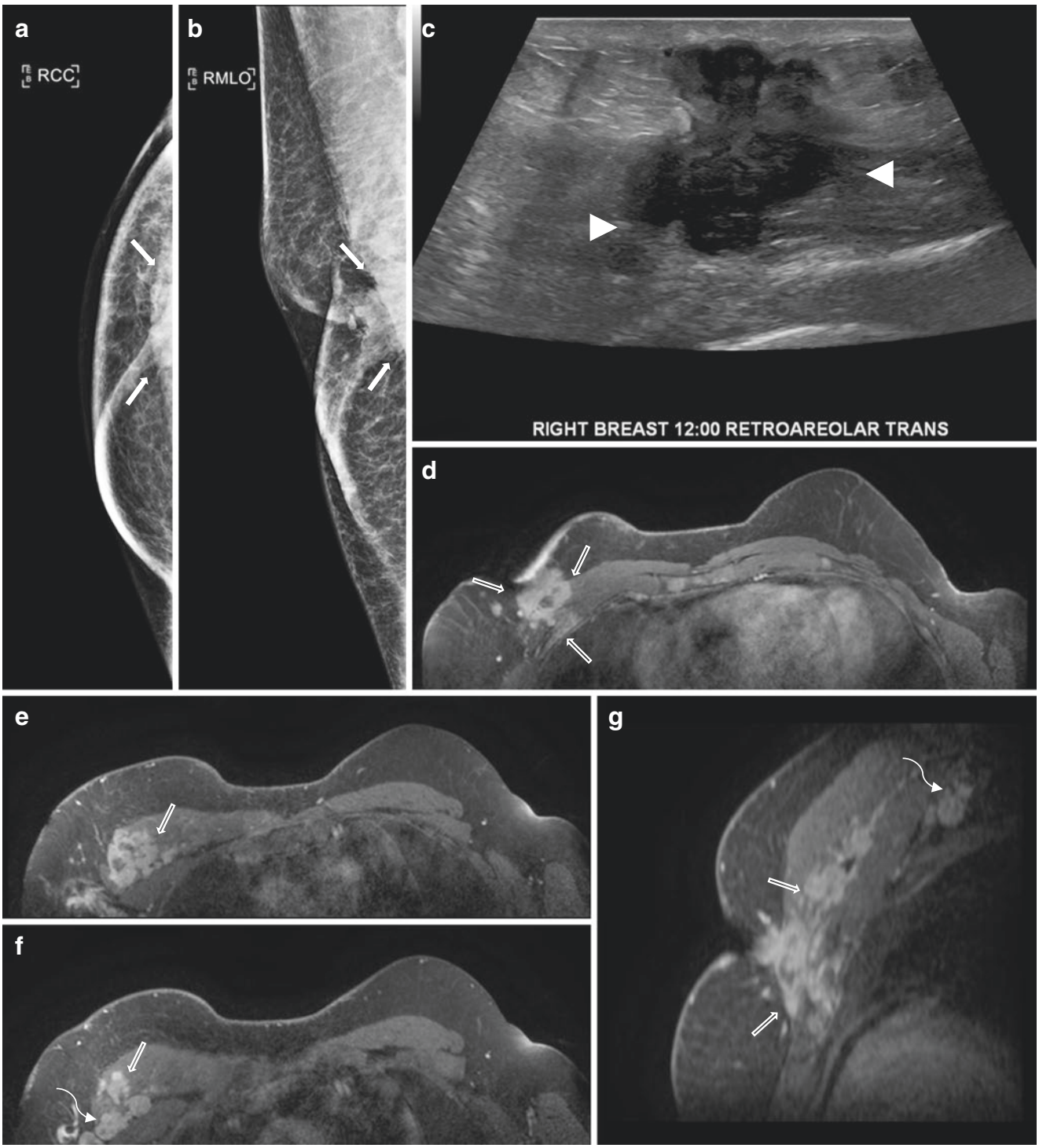

Fig. 3.9 (**a**–**g**) Right breast full-field digital mammographic views in the craniocaudal (CC) (**a**) and mediolateral oblique (MLO) (**b**) projections demonstrate a partially visualized mass in the retroareolar region with significant nipple retraction (white arrows). Targeted ultrasound of the retroareolar breast (**c**) shows an irregular mass that is inseparable from the underlying pectoralis major muscle (white arrowheads). Bilateral axial (**d**–**f**) and sagittal (**g**) contrast-enhanced breast MRI demonstrates a large irregular enhancing mass with significant involvement of the overlying skin and invasion of the pectoralis major muscle and chest wall (open white arrows) with metastatic axillary lymphadenopathy (white curved arrow)

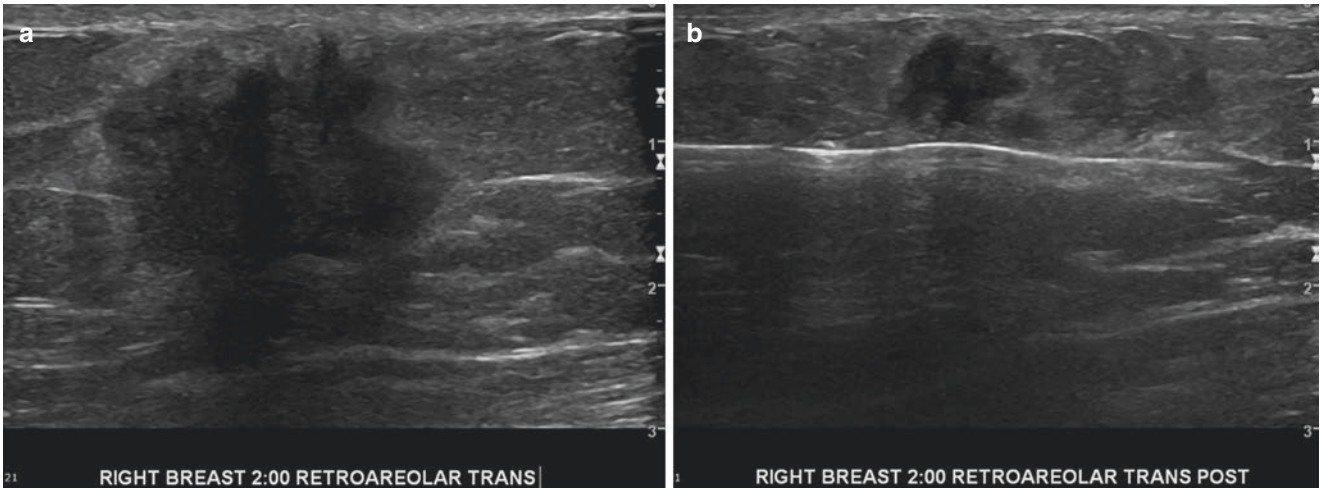

Fig. 3.10 (**a**, **b**) Ultrasound image of the right breast demonstrates an irregular mass with angular margins, highly suggestive of malignancy (**a**). A core biopsy was performed under ultrasound guidance with image demonstrating the biopsy needle going through the mass using proper technique with the needle parallel to the chest wall (**b**). Pathology yielded invasive ductal carcinoma

Table 3.1 Common causes of gynecomastia

Physiologic
Neonatal
Puberty
Senescence
Pharmaceutical and recreational drugs
Anabolic steroids
Cardiac (e.g., ACE-I, amiodarone, digoxin, spironolactone)
Cimetidine
Exogenous estrogen
Leuprolide acetate
Marijuana
Thiazide diuretics
Tricyclic antidepressants
Systemic
Chronic renal insufficiency
Cirrhosis
Hyperthyroidism
Neoplastic
Adrenal
Liver
Testicular
Idiopathic

cancer. In fact, mammography is able to distinguish between benign and malignant diagnoses with a high sensitivity (94%) and specificity (90%) based on a combination of the morphological appearance and the location of the imaging findings [20].

Three characteristic mammographic patterns of gynecomastia have been described: early nodular, late dendritic, and diffuse glandular. These mammographic patterns are the result of the underlying histologic changes that take place.

The nodular pattern is seen in cases in which the causative agent has been present for less than 1 year. Mammographically, it presents as a fan-shaped density that radiates from the nipple and progressively blends into the surrounding fat (Fig. 3.11a, b.) The ultrasound typically shows a subareolar hypoechoic mass (Fig. 3.11c) [35]. Microscopically, this pattern is characterized by hyperplasia of the intraductal epithelium associated with periductal inflammation and surrounding edema [36]. This early phase of gynecomastia is reversible if the precipitating factor is removed [34].

The dendritic pattern is considered a later, fibrotic phase of gynecomastia, seen in cases in which the causative agent has been present for more than 1 year. The classic mammographic appearance is a "flame-shaped" retroareolar density with concave margins and fingerlike projections that extend posteriorly, blending into the adipose tissue (Fig. 3.12a, b). On ultrasound, this pattern can appear as a triangular-shaped hypoechoic mass in the retroareolar region with the aforementioned fingerlike extension into the adjacent fatty tissue (Fig. 3.12c) [35]. Microscopically, this pattern is characterized by ductal proliferation with dense hyalinized, fibrotic stroma [36]. Resulting from the fibrosis, this later phase of gynecomastia is usually irreversible, both clinically and by imaging [18].

The diffuse glandular pattern is often seen in patients receiving exogenous high-dose estrogen. On both mammogram and ultrasound, this pattern is very similar in appearance to a heterogeneously dense female breast without an associated mass or adenopathy (Fig. 3.13a, b) [34, 35].

Treatment of gynecomastia usually includes an evaluation to determine the causative agent. In the majority of the cases that are physiologic, the majority undergo spontaneous regression. When a specific agent is identified (such as a medication or treatment for an underlying medical condition) and it is discontinued, the findings can regress as long as the exposure to the causative agent is not long-standing as previously described. Surgical options such as reduction mammoplasty and liposuction can be considered in symptomatic patients that have not responded to medical management [37].

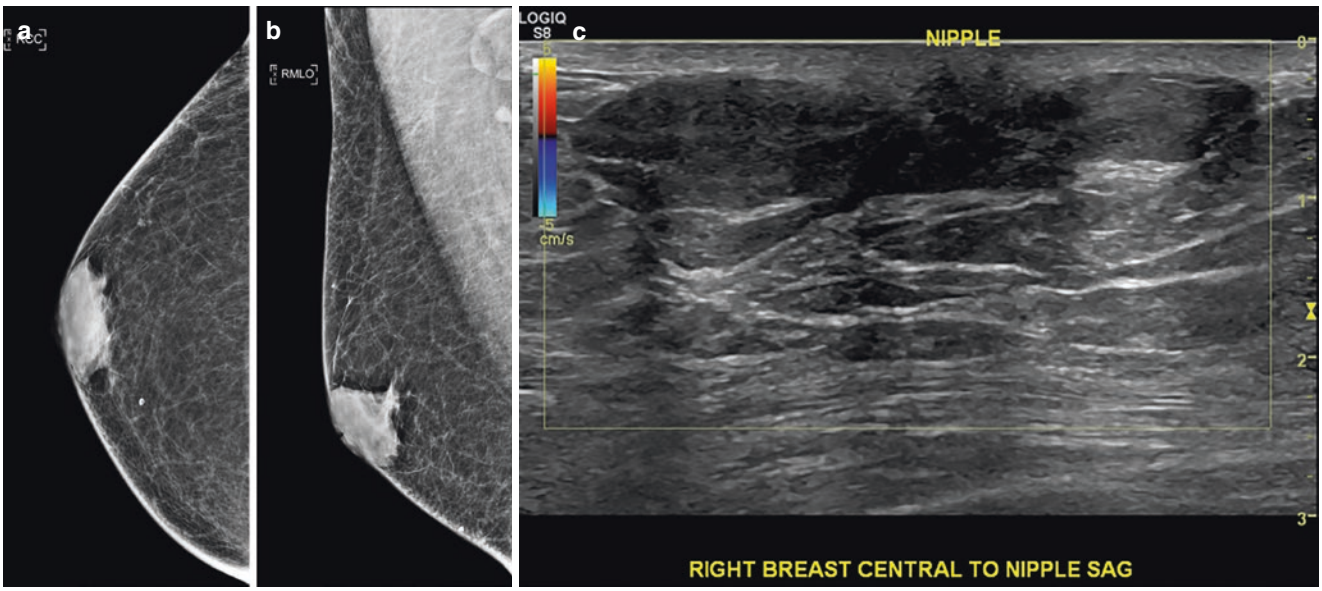

Fig. 3.11 (**a**–**c**) Nodular gynecomastia in a 38-year-old man with a tender, palpable mass in the retroareolar region of the right breast. Right breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections (**a**, **b**) as well as targeted ultrasound image (**c**) demonstrate the early nodular pattern of gynecomastia

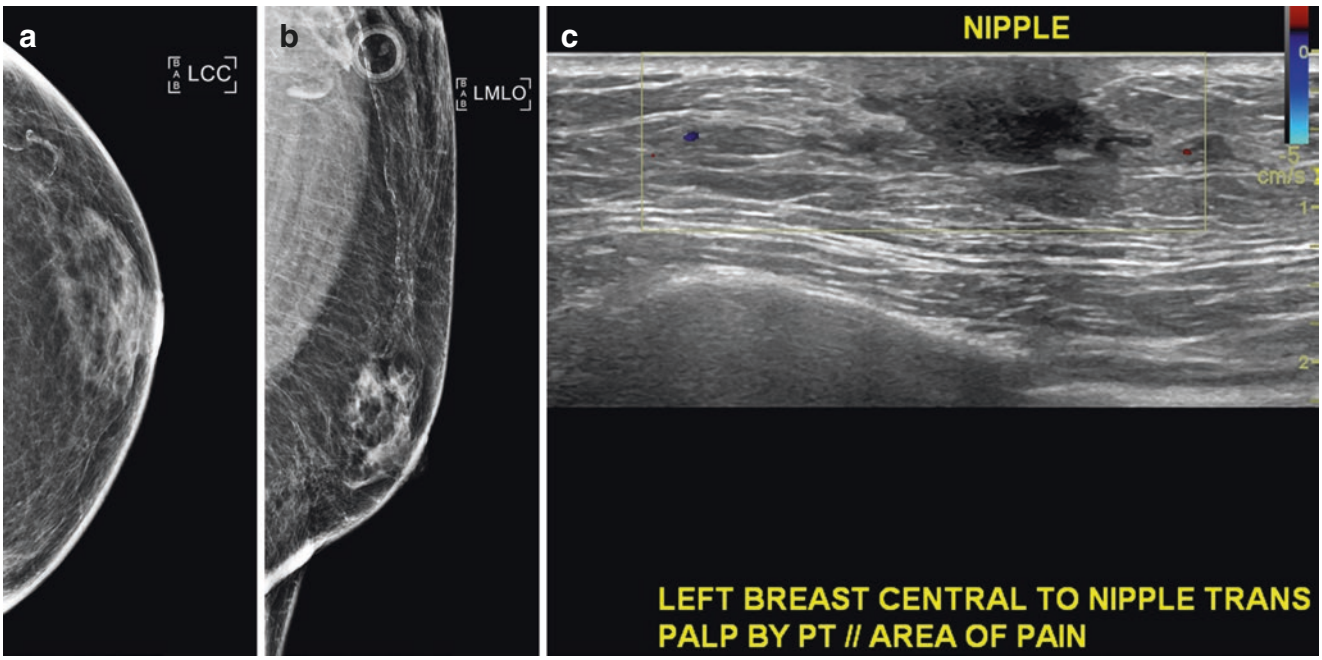

Fig. 3.12 (**a**–**c**) Dendritic gynecomastia in an 82-year-old man. Left breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections demonstrating the late dendritic pattern of gynecomastia (**a**, **b**). Ultrasound image of a different patient illustrating the late dendritic pattern of gynecomastia (**c**)

Pseudogynecomastia

Pseudogynecomastia is a benign condition in which the breast is enlarged as a result of the deposition of adipose tissue without stimulation of the ductal or stromal elements. The typical clinical presentation is unilateral or bilateral breast enlargement without a discrete palpable mass or associated findings such as skin or nipple changes or pathologic nipple discharge. Pseudogynecomastia is commonly seen in overweight or obese males [33]. The mammographic appearance is pathognomonic characterized by subcutaneous fatty tissue without an associated mass or glandular tissue (Fig. 3.14) [34]. No further imaging is necessary to establish the diagnosis.

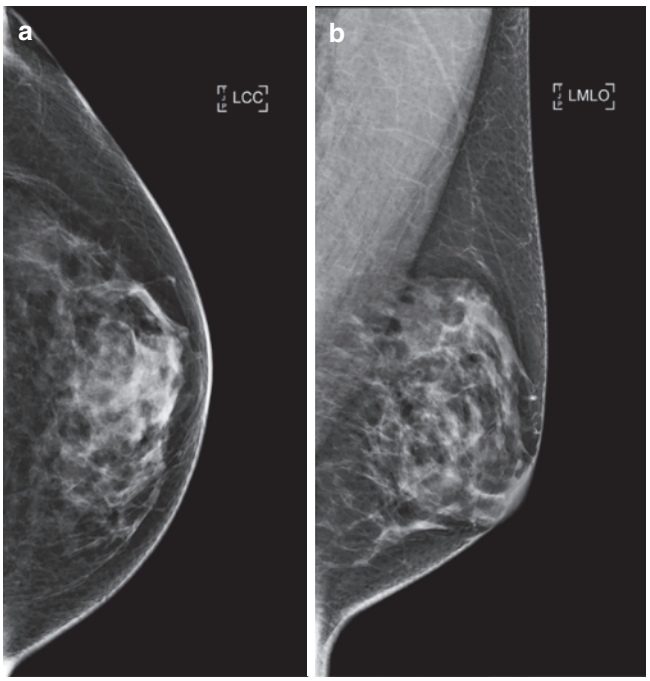

Fig. 3.13 (**a**, **b**) Diffuse gynecomastia in a 33-year-old transgender woman on hormone therapy for 6 years that presented for evaluation of breast pain. Left breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections demonstrating the diffuse glandular pattern of gynecomastia. (Images courtesy of Robert E. Lynch, MD)

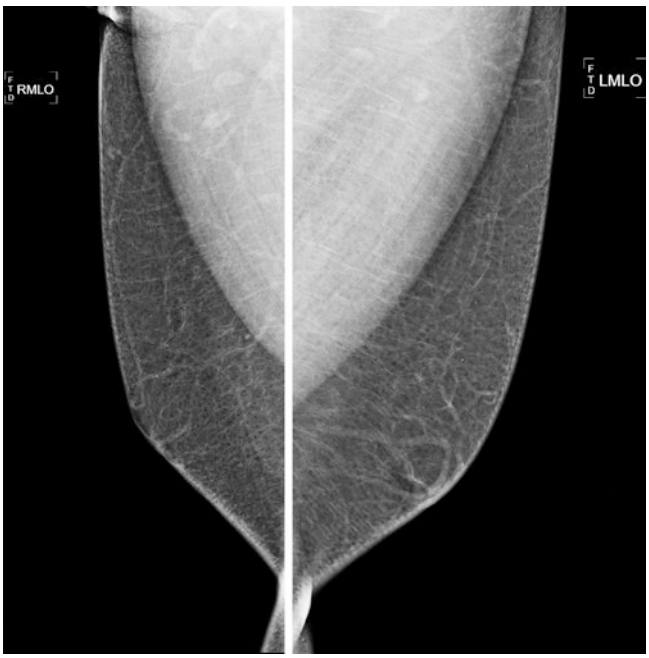

Fig. 3.14 Pseudogynecomastia in a 25-year-old man that presented with bilateral breast enlargement. Bilateral full-field digital mammographic views in the mediolateral oblique (MLO) projection demonstrating subcutaneous adipose tissue without an associated mass or glandular tissue

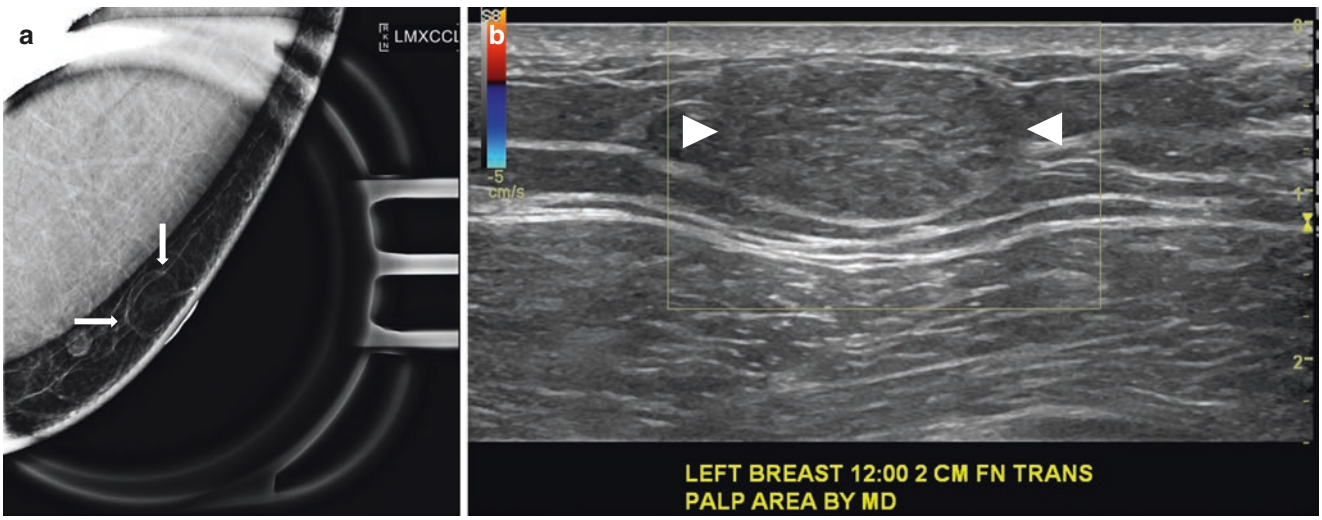

Fig. 3.15 (**a**, **b**) Lipoma in a 35-year-old man that presented for evaluation of a palpable complaint. Digital spot magnification mammographic view of the left breast in the exaggerated craniocaudal lateral (XCCL) projection (**a**) shows a circumscribed, oval, fat-containing mass with a thin pseudocapsule (white arrows) that corresponds to the palpable complaint as indicated by a triangular marker. Corresponding grayscale ultrasound image (**b**) shows a circumscribed, oval, slightly hyperechoic mass without associated vascularity (white arrowheads)

Lipoma

Lipomas are the second most common benign entity encountered in male patients [13]. This benign breast tumor is comprised of adipose cells. The typical clinical presentation is a palpable soft, mobile, painless mass located in the subcutaneous tissues and can be either single or multiple [37]. The typical mammographic appearance is an oval, fat-containing mass with a thin radiopaque capsule (Fig. 3.15a). However, it can be difficult to differentiate from the surrounding adi-

pose tissue if the pseudocapsule is not clearly visualized. On ultrasound, the typical appearance is a circumscribed, oval, isoechoic to slightly hyperechoic mass. This mass is homogeneous in echotexture, usually avascular, and has a parallel orientation to the skin (Fig. 3.15b) [13]. When these classic mammographic and sonographic features are present, no additional imaging is necessary to establish the diagnosis.

Intramammary Lymph Node

Intramammary lymph nodes (IMLNs) can be seen incidentally on imaging studies performed for evaluation of symptomatic male patients. Mammographically, these are circumscribed oval or reniform masses that contain a fatty hilum and are typically located in the upper outer breast in proximity to a feeding blood vessel [12]. These imaging characteristics are considered pathognomonic, and when all are present, no further imaging workup is necessary to establish the diagnosis (Fig. 3.16a). In cases in which either the mammographic features or the location (or both) are not characteristic of a benign IMLN, ultrasound is recommended for further evaluation. On ultrasound, benign IMLNs appear as a circumscribed, oval, or reniform mass with a uniform, thin hypoechoic cortex (up to 2–3 mm in thickness) and an echogenic fatty hilum with associated vascularity (Fig. 3.16b, c) [38]. When IMLNs have suspicious features on any of these imaging modalities, image-guided tissue sampling can be performed by either core biopsy or fine-needle aspiration (FNA) to determine the cause for these suspicious features (reactive changes, secondary to systemic processes, metastasis from primary breast, as well as non-breast malignancies) [39].

Pseudoangiomatous Stromal Hyperplasia

Pseudoangiomatous stromal hyperplasia (PASH) is a rare benign tumor characterized histologically by numerous slit-like spaces lined by spindle cells in a background of dense collagenous stroma [40, 41]. Although the precise cause for this proliferation of myofibroblasts is not known, it is thought to be the result of hormonal stimulation. It can present clinically as a palpable mass or it can be an incidental finding on breast biopsies [42]. When detected mammographically, PASH appears as a non-calcified, circumscribed or partially circumscribed mass (Fig. 3.17a) and if frequently coexists with benign gynecomastia. On ultrasound, it usually presents as a circumscribed hypoechoic mass and can sometimes have a cystic component (Fig. 3.17b).

Epidermal Inclusion Cyst

Epidermal inclusion cysts (EICs) are the third most common benign entity encountered in male patients and typically arise from obstructed or occluded hair follicles or at sites of prior trauma to the skin [13]. Mammographically, these typically present as a circumscribed oval or round mass that is superficial in location (Fig. 3.18a, b). The typical sonographic finding is a circumscribed, oval, or round hypoechoic

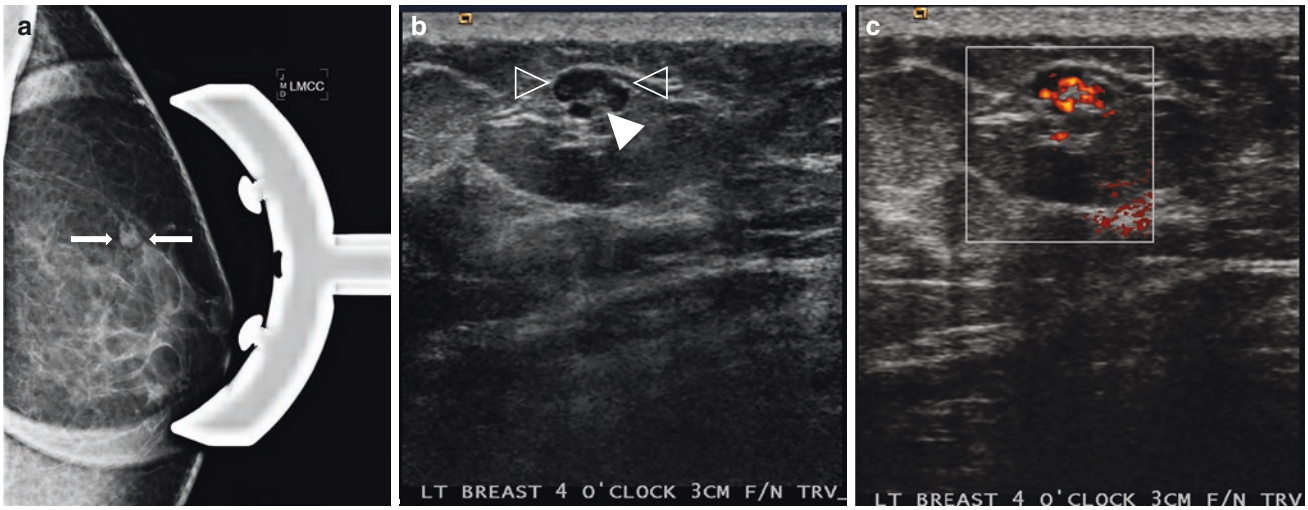

Fig. 3.16 (**a**–**c**) Benign intramammary lymph node (IMLN) in a 55-year-old man with tenderness and breast enlargement. Digital spot magnification mammographic view of the left breast in the exaggerated craniocaudal lateral (XCCL) projection incidentally shows a circumscribed oval mass with a discrete fatty hilum (white arrows), which is the pathognomonic appearance for a IMLN (**a**). Benign gynecomastia accounts for the presenting clinical symptoms. Targeted ultrasound shows a circumscribed, reniform mass with a hypoechoic cortex (open arrowheads) and echogenic fatty hilum (white arrowhead) (**b**) as well as normal vascularity on Doppler (**c**), which confirm the benign diagnosis

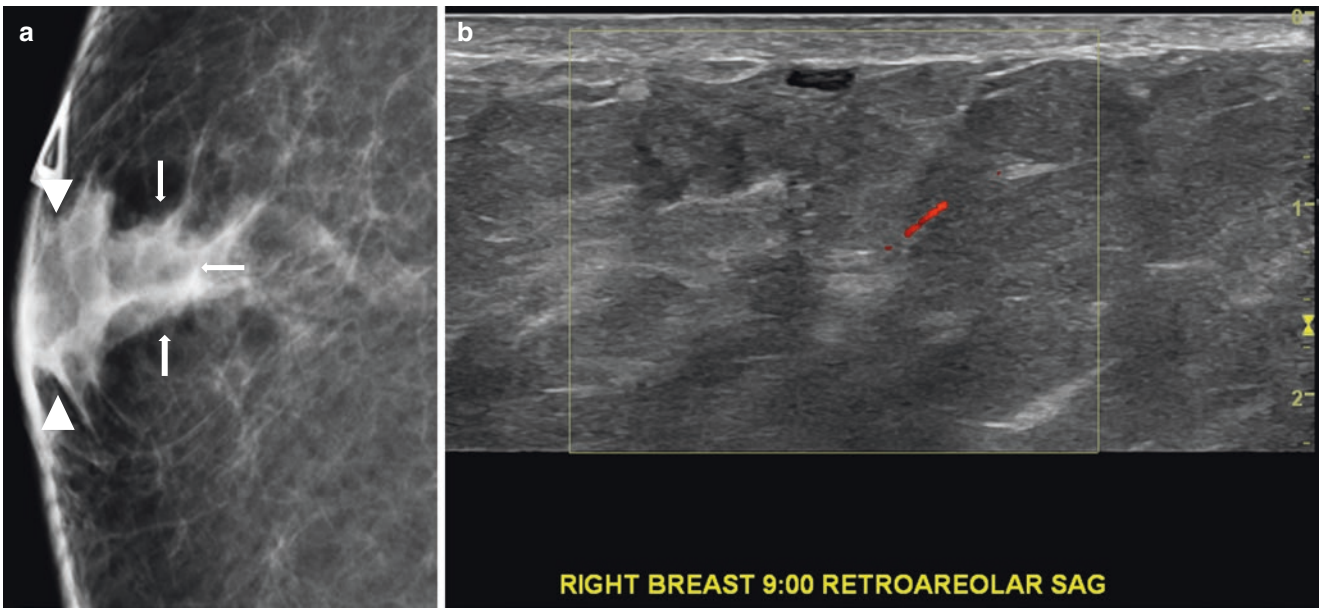

Fig. 3.17 (**a**, **b**) Pseudoangiomatous stromal hyperplasia (PASH) in a 54-year-old man that presented for evaluation of painful breast lump. Coned-down right breast digital mammogram shows an oval, partially circumscribed mass (**a**) (white arrows) in a background of gynecomastia (white arrowheads) that corresponds to the palpable complaint as indicated by the triangular marker. Corresponding targeted ultrasound image (**b**) shows a hypoechoic mass that contains a cystic component. Pathology from an ultrasound-guided biopsy yielded PASH

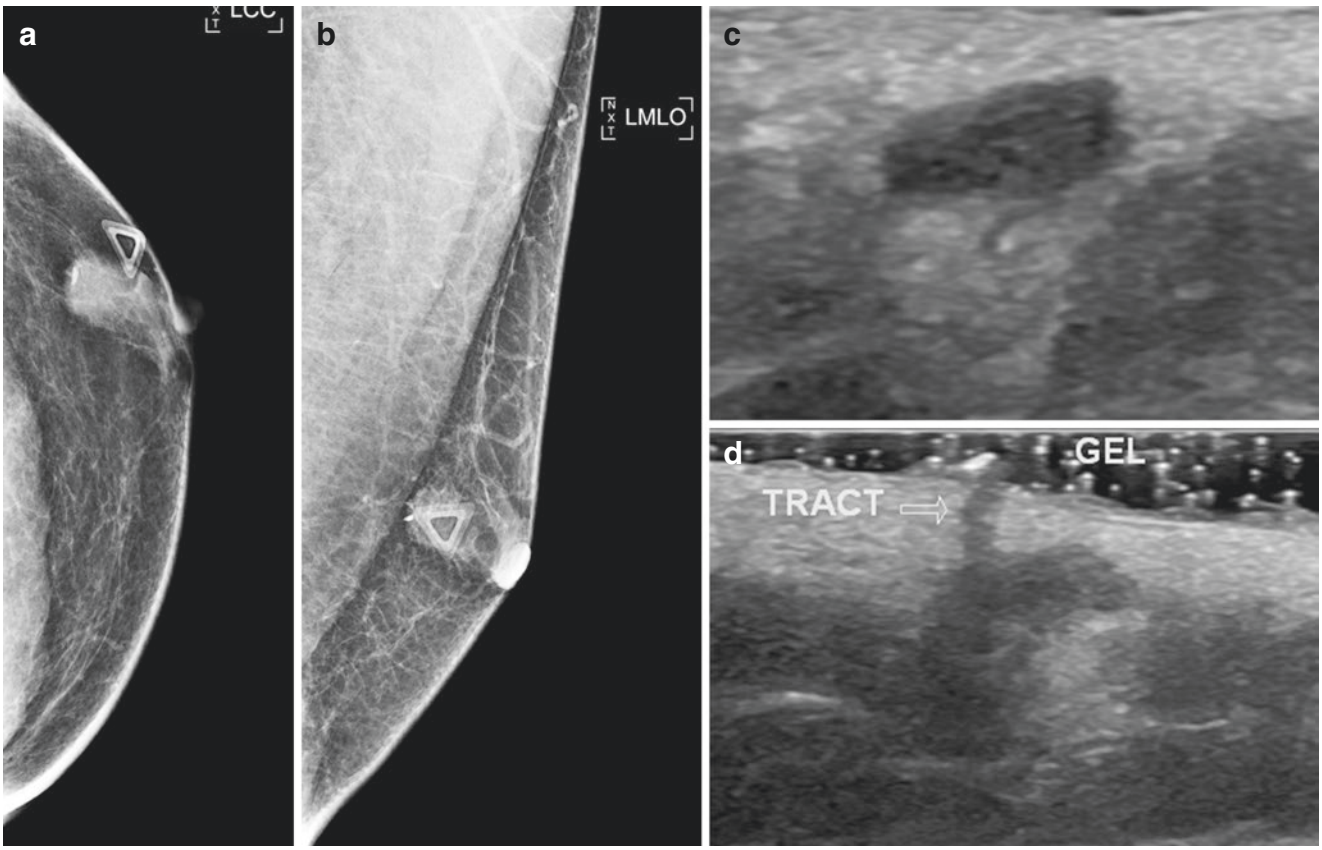

Fig. 3.18 (**a**–**d**) Epidermal inclusion cyst (EIC) in a man that presented for evaluation of a palpable breast mass. Right breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections demonstrate a circumscribed oval mass that corresponds to the palpable complaint as indicated by the triangular marker (**a**, **b**). Targeted ultrasound images from a different patient show a circumscribed, oval hypoechoic mass that is localized within the skin (**c**) and has a discrete tract that extends from the mass to the epidermis (**d**)

mass that is confined within the skin (Fig. 3.18c). A pathognomonic finding is a tract that extends from the mass to the epidermis (Fig. 3.18d).

Granulomatous Mastitis

Granulomatous mastitis (GM), also referred to as granulomatous lobular mastitis or granulomatous lobulitis, is a rare, chronic, benign inflammatory disease of the breast that was first described in 1972 by Kessler and Wolloch [43]. Known etiologies include infections and noninfectious causes that trigger the immune response system that lead to granuloma formation, such as tuberculosis, sarcoidosis, fungal infections and autoimmune diseases (e.g., giant cell arteritis (GCA), and granulomatosis with polyangiitis (GPA, formerly known as Wegener's granulomatosis) [44]. In other cases, the etiology is unknown and is classified as idiopathic granulomatous mastitis (IGM). Most of the cases of GM documented in the medical literature have been in women, although this rare inflammatory process can also be seen in male patients [44].

The common clinical presentation of GM is a unilateral, firm, or hard lump and may have associated overlying skin changes and/or ipsilateral axillary lymph node enlargement [45]. On mammography, GM can present as an irregular mass or masses with a non-circumscribed margin or as ill-defined asymmetries (areas of increased density) (Fig. 3.19a, b). Sonographically, these can correspond to irregular masses or ill-defined areas that are hypoechoic or heterogeneous in echotexture with indistinct margins and tubular extension(s) to the overlying skin with or without associated skin thickening (Fig. 3.19c). The role of magnetic resonance imaging (MRI) as part of the imaging workup has been discussed in very few studies, with MRI lacking sufficient specificity to be able to differentiate reliably between benign entities and malignancy [46]. Some of the common MRI findings documented are rim-enhancing masses and areas of segmental non-mass enhancement [46, 47]. Percutaneous sampling, most commonly performed under ultrasound guidance, is needed to establish the diagnosis. Treatment options are varied, ranging from observation, systemic treatment (oral antibiotics, oral steroids, methotrexate) to surgical intervention (limited or wide local excision and mastectomy) [45, 48].

Subareolar Abscess

A subareolar abscess results from a localized infection due to mammary duct ectasia, inflammation, and chronic obstruction. This is predominantly caused by bacteria that colonize the skin, with *Staphylococcus aureus* being the most common causative agent [49]. On physical exam, patients frequently present with pain, nipple swelling, and discharge. Signs can also include skin thickening and erythema.

Mammographically, a subareolar abscess can present as an irregular mass with an indistinct margin located in the subareolar region with thickening of the surrounding trabecular pattern (Fig. 3.20a–c). It can also present as increased

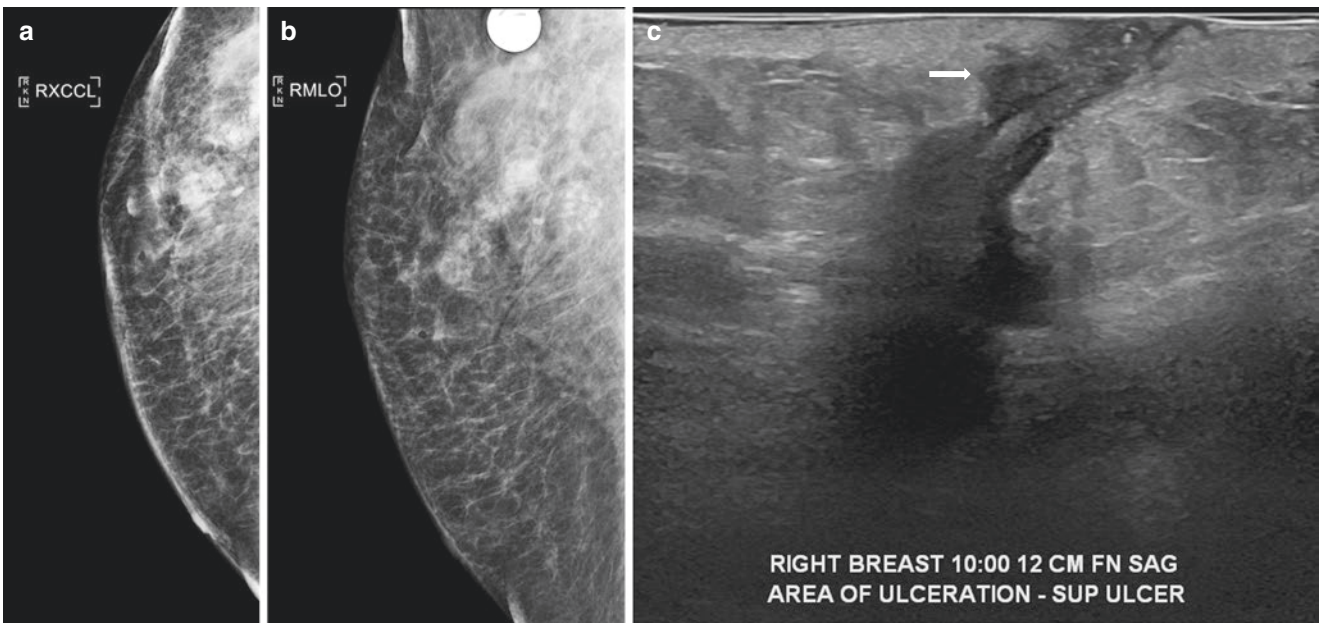

Fig. 3.19 (**a**–**c**) Granulomatous mastitis (GM) in a 48-year-old immunocompromised man who presented with increasing breast pain and swelling, refractory to several rounds of antibiotics. Right breast full-field digital mammographic views in the exaggerated craniocaudal lateral (XCCL) and mediolateral oblique (MLO) projections demonstrate multiple focal asymmetries in the upper outer right breast and associated skin thickening (**a**, **b**). Ultrasound shows an irregular hypoechoic mass with an indistinct margin and tubular extension to the overlying skin (white arrow) (**c**), for which ultrasound-guided biopsy was recommended. Pathology from the core biopsy yielded granulomatous mastitis

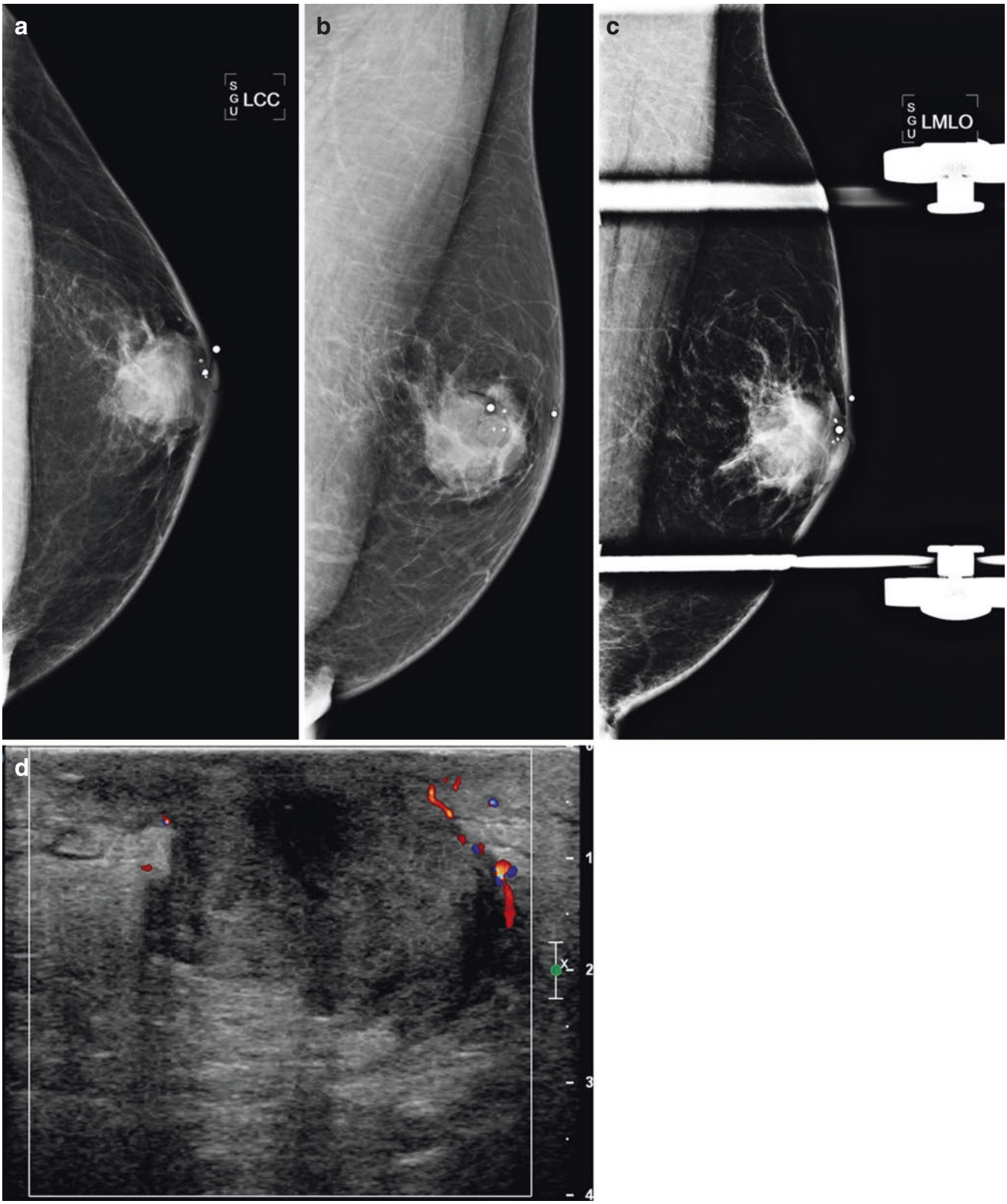

Fig. 3.20 (**a**–**d**) Subareolar abscess in a 27-year-old immunocompromised man that presented with a painful breast lump. Left breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections as well as a digital spot compression mammographic view of the left breast in the MLO projection show an indistinct subareolar mass with adjacent trabecular thickening that corresponds to the palpable complaint as indicated by the BB marker (**a**–**c**). On ultrasound, it corresponds to a complex fluid collection with hyperemia within the adjacent tissues (**d**). Combined with the clinical presentation, the constellation of imaging findings is consistent with abscess formation

density in the subareolar region and can mimic gynecomastia. In the latter scenario, it is important to correlate with the clinical history as well as recognize the presence of skin thickening on imaging to determine the correct diagnosis. On ultrasound, subareolar abscesses correspond to a complex fluid collection with no internal vascularity but with hyperemia and inflammatory changes within the adjacent tissues (Fig. 3.20d). Treatment includes antibiotic therapy and ultrasound-guided percutaneous drainage. In cases in which the fluid collection has internal flow suggesting the finding may be a complex cystic and solid mass rather than a simple fluid collection, core biopsy is necessary to exclude malignancy. When abscesses are recurrent, surgical excision of the abscess and the regional ducts may be necessary to prevent recurrence [50].

Myofibroblastoma

Myofibroblastomas are rare benign soft tissue tumors that arise from stromal elements in breast tissue. First reported by Wagortz et al. in 1987 [51], these tumors have been most commonly seen in men in the sixth to seventh decades of life [52]. The typical clinical presentation is a unilateral, painless, mobile mass that grows slowly and is long-standing. On mammography, these appear as circumscribed, oval, or round masses (Fig. 3.21a, b). On ultrasound, myofibroblastomas typically correspond to circumscribed, oval, or round masses that range from hypoechoic to heterogeneous echotexture, and variable internal vascularity on Doppler imaging (Fig. 3.21c, d). Less commonly, these may be ill-defined and can exhibit posterior acoustic shadowing. MRI typically shows a T1 hypo- to isointense, homogeneously enhancing mass with nonenhancing internal septations [52]. Definitive management is surgical excision with clear margins. To our knowledge, no cases of recurrence or malignant transformation have been reported [53, 54].

Nodular Fasciitis

Nodular fasciitis is a benign entity of unknown etiology characterized by reactive proliferation of fibroblasts in the subcutaneous soft tissues. First described by Konwaler et al. in 1955 [55], it typically has a predilection for upper extremities and head and neck areas [56]. It most commonly affects the forearm and involvement of the breast tissue is rare. The typical clinical presentation is a small, firm, and painless palpable mass that has a sudden onset and fast growth, and as result, it is frequently mistaken for malignancy [57]. Mammographically, it commonly appears as a high-density, irregular mass with an indistinct or spiculated margin (Fig. 3.22a, b). On ultrasound, it corresponds to an irregular mass that is hypoechoic or heterogeneous in echotexture with minimal or no associated vascularity (Fig. 3.22c). Because both the clinical and imaging findings can be similar to those of breast cancer, image-guided core biopsy is needed to establish the diagnosis [58]. Surgical excision is curative, and a few cases of spontaneous regression have been documented in the literature [57, 59, 60].

Granular Cell Tumor

Granular cell tumor (GCT) is a rare, usually benign soft tissue tumor that can present in the male breast [36]. On both physical exam and imaging studies, the findings often cannot be distinguished from breast cancer. The typical clinical presentation is a single, firm, or hard palpable mass and can have associated findings such as skin or nipple retraction, mimicking the appearance of breast cancer on imaging studies (Fig. 3.23a–c). Usually, a core biopsy followed by wide surgical excision is recommended to avoid local recurrence [61].

Hemangioma

Hemangiomas are benign vascular tumors of the breast, which were first described by Jozefczyk and Rosen in 1985 [62]. These can be further subdivided in two primary types depending on the size of the blood vessels: capillary and cavernous [36]. The reported incidence in postmortem studies on women is 11% [63, 64]. However, the exact incidence in men cannot be determined as not very few cases have been reported in the literature.

In men, hemangiomas most commonly present as a palpable breast mass, which makes it difficult to establish the diagnosis just based on the clinical presentation [65]. Mammographically, these appear as circumscribed, oval, or round masses that are superficial in location (either subdermal or in the subcutaneous soft tissues) and may or may not have associated calcifications (Fig. 3.24a, b) [63, 64]. On ultrasound, these typically present as a superficially located, circumscribed, oval mass of variable echotexture ranging hypoechoic to hyperechoic (Fig. 3.24c) [36, 63]. MRI features include a circumscribed oval mass that is T1 isointense, T2 hyperintense with possible peripheral arterial enhancement and delayed central enhancement on the post-contrast sequences [36, 63].

Tissue sampling with fine-needle aspiration or core needle biopsy is necessary to establish the diagnosis. Surgical excision may be necessary to exclude the possibility of angiosarcoma in cases where the clinical, imaging, and histological features are not characteristic [36, 64].

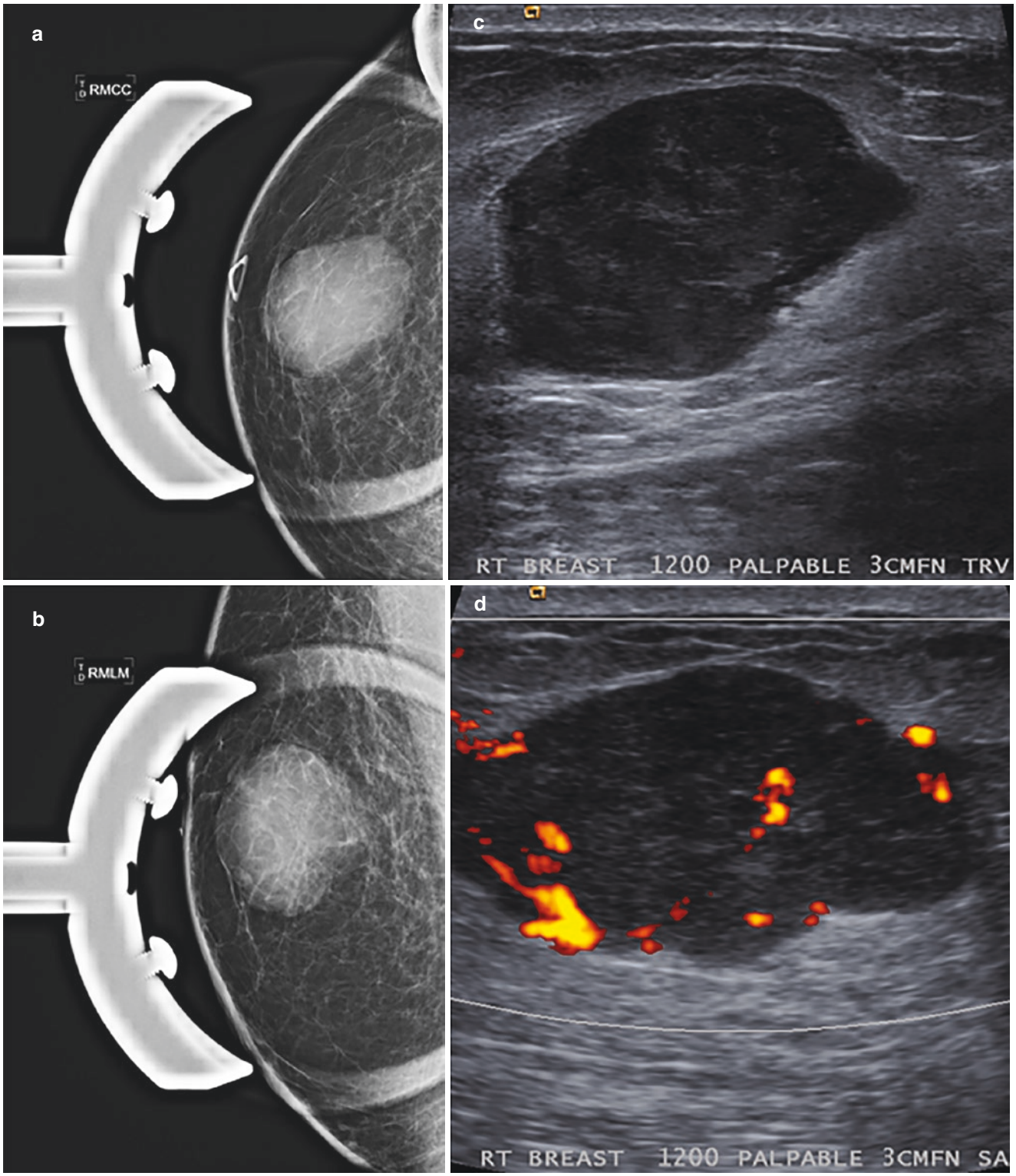

Fig. 3.21 (**a**–**d**) Myofibroblastoma in a 62-year-old man with a palpable, mobile, firm breast lump. Digital spot magnification mammographic views of the right breast in the craniocaudal (CC) and lateromedial (LM) projections reveal a circumscribed oval mass that correlates with the palpable complaint as indicated by the triangular marker (**a**, **b**). On ultrasound, this corresponds to a circumscribed hypoechoic mass (**c**) with increased internal vascularity (**d**). Pathology from ultrasound-guided biopsy and subsequent surgical excision yielded myofibroblastoma

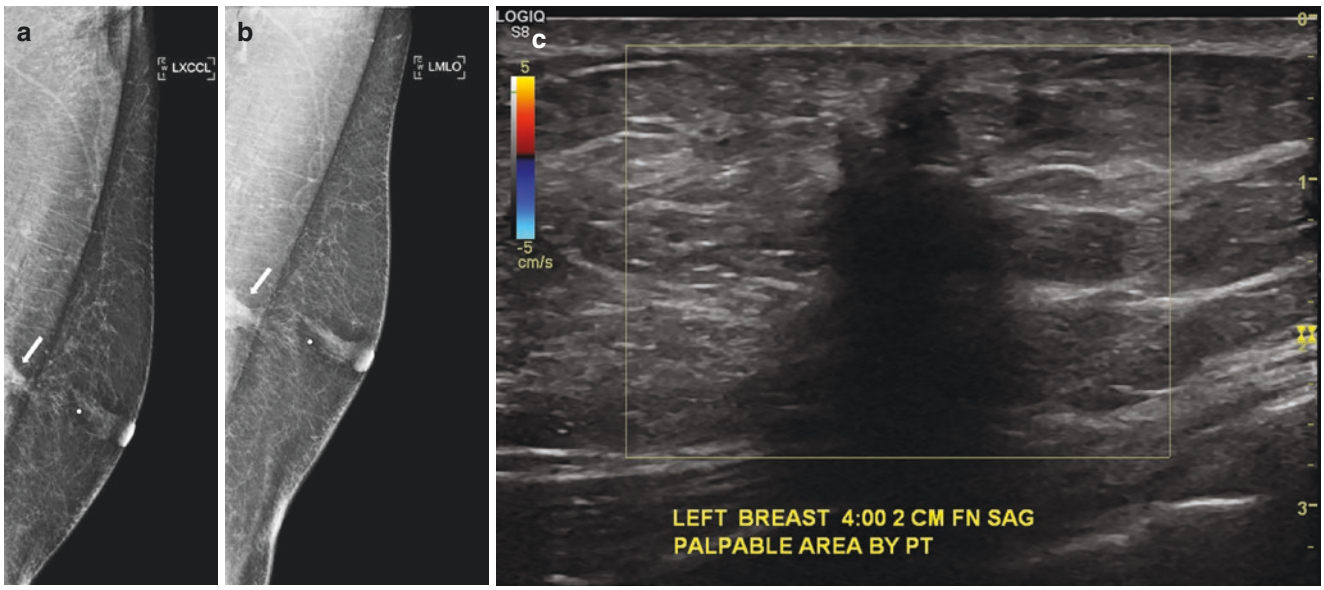

Fig. 3.22 (**a**–**c**) Nodular fasciitis in a 61-year-old man with a one-month history of a palpable breast lump. Left breast full-field digital mammographic views in the craniocaudal (CC) and mediolateral oblique (MLO) projections demonstrate a high-density, irregular mass with an indistinct margin (white arrows) that correlates with the palpable complaint as indicated by the BB marker (**a**, **b**). On ultrasound, this corresponds to an irregular, hypoechoic mass with indistinct and angular margins, posterior acoustic shadowing and no associated vascularity (**c**), for which ultrasound-guided biopsy was recommended. Pathology yielded nodular fasciitis

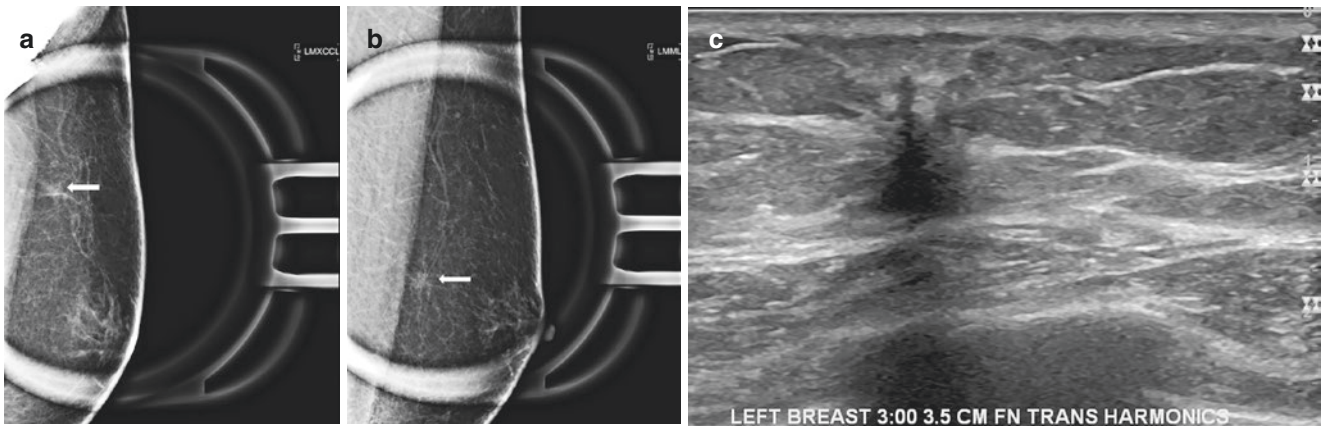

Fig. 3.23 (**a**–**c**) Granular cell tumor in a 71-year-old man that presented with left breast pain. Digital spot magnification mammographic views in the exaggerated craniocaudal lateral (XCCL) and mediolateral (ML) projections show an irregular spiculated mass (white arrows) in the posterior upper outer left breast (**a**, **b**). Benign gynecomastia accounts for the presenting clinical symptom. Corresponding grayscale ultrasound image shows an irregular, hypoechoic mass with a spiculated and indistinct margin and posterior acoustic shadowing (**c**), for which ultrasound-guided biopsy was recommended. Pathology yielded granular cell tumor

Male Breast Cancer

Male breast cancer is very uncommon, as it accounts for only 0.7% of all the patients diagnosed with breast cancer [66]. The mean age at diagnoses for men with breast cancer is 67 years, whereas for women is 62 years [67]. Similar to women, the incidence of breast cancer in men increases with increasing patient age. In 2020, an estimated 2620 new cases of breast cancer will be diagnosed in the USA and 520 men will die as a result of breast cancer [2]. Although the etiology of male breast cancer remains unclear, several risk factors have been identified and are listed in Table 3.2. Although gynecomastia has been reported in up to 40% of male breast cancer patients, no causal relationship has been established [68].

On physical exam, male breast cancer typically presents as a palpable, painless, firm, subareolar mass [33, 37]. Male breast cancer patients commonly presents at a more

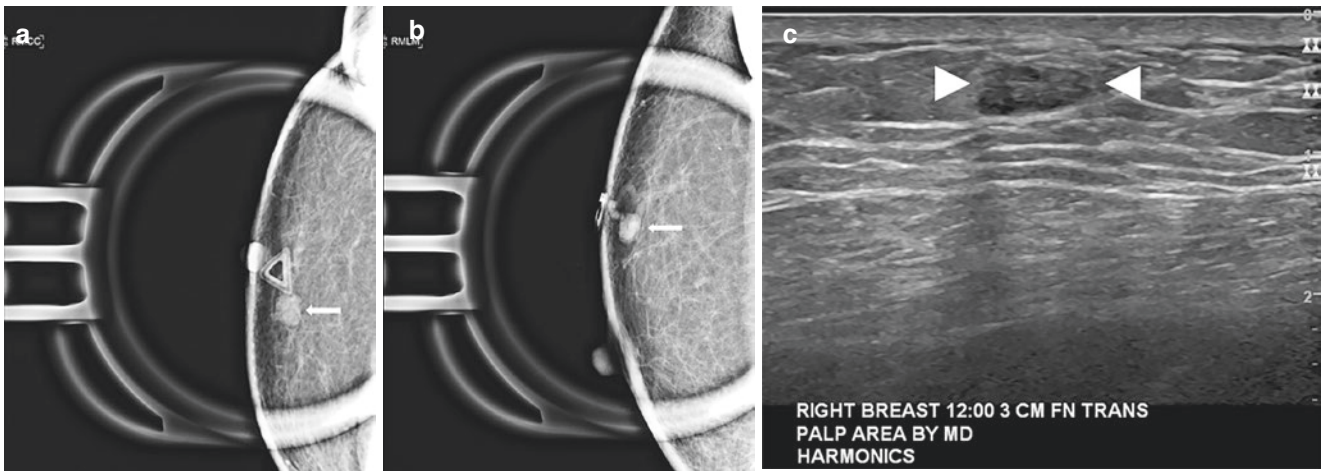

Fig. 3.24 (**a**–**c**) Capillary hemangioma in a 61-year-old man with family history of breast cancer that presented for evaluation of a palpable breast lump for the last month. Digital spot magnification mammographic views of the right breast in the craniocaudal (CC) and lateromedial (LM) projections show a circumscribed oval mass that correlates with the palpable complaint as indicated by the triangular skin marker (white arrows) (**a**, **b**). Corresponding grayscale ultrasound image shows a circumscribed, oval, hypoechoic mass located in the subcutaneous soft tissues (white arrowheads) (**c**). Pathology from an ultrasound-guided biopsy yielded capillary hemangioma

Table 3.2 Risk factors for the development of male breast cancer

Advanced age
Exogenous estrogen exposure Prostate cancer treatment Gender reassignment procedures
Genetic predisposition BRCA mutations (BRCA2 > BRCA1) Klinefelter syndrome
Personal history of chest irradiation
Family history of breast cancer in a first-degree relative
Androgen deficiency Testicular dysfunction Liver disease

advanced stage when compared to female patients as a result of delay in diagnosis and overall have a worse prognosis [69]. Associated signs and symptoms such as skin or nipple changes, nipple discharge, and palpable axillary adenopathy are common at the time of presentation. The treatment of male breast cancer is similar for men and women and will depend on the stage of the disease at the time of diagnosis and the tumor histology [66]. The imaging features of male breast cancer will depend on the histological subtype. Below is a discussion of the three most common histologies of male breast cancer and their corresponding imaging findings.

Invasive Ductal Carcinoma

Just like in women, invasive ductal carcinoma (IDC) is the most common type of breast cancer in men, comprising up to 85% of the cases [69]. The typical mammographic presentation is an irregular, spiculated, high-density mass that is eccentric in location and may or may not have associated suspicious microcalcifications corresponding to ductal carcinoma in situ (DCIS) (Fig. 3.25a, b). This is similar to the mammographic presentation of IDC in women. Approximately 35–50% of male breast cancers will also have associated DCIS. Pure DCIS without an associated invasive component accounts for approximately 5% of all breast cancers in men [68]. Associated signs and symptoms related to malignancy like skin or nipple changes, nipple discharge, and palpable axillary adenopathy are common. The typical sonographic appearance of breast cancer is an irregular, hypoechoic mass with a non-circumscribed margin that is eccentric to the nipple-areolar complex (Fig. 3.25c) [70]. As previously mentioned, more advanced presentations are common in men and include associated clinical findings such as skin or nipple changes, nipple discharge, and palpable axillary adenopathy (Fig. 3.26a–f).

Papillary Carcinoma

Papillary carcinoma is the second most common subtype of breast cancer in male patients and has a higher incidence in men (2.6%) when compared to women (0.6%) with breast cancer [37, 71]. Clinically, it commonly presents as a painless, subareolar mass and may be accompanied by pathologic nipple discharge. Mammographically, it usually presents as a subareolar mass that may be

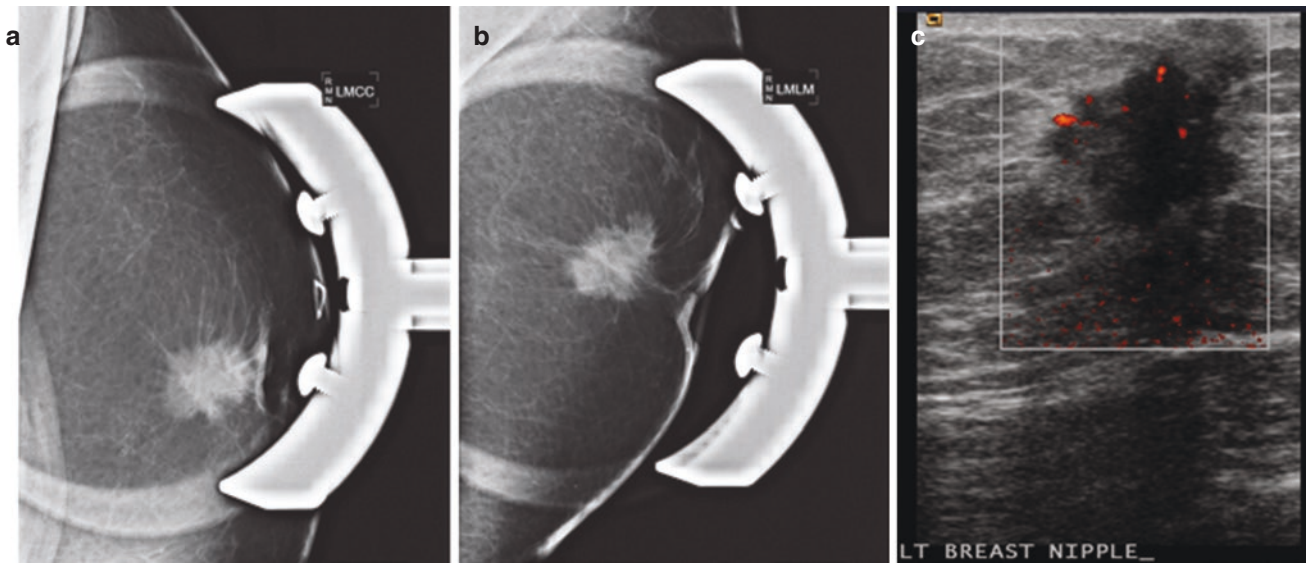

Fig. 3.25 (**a**–**c**) A 66-year-old man with new left nipple inversion. Digital spot magnification mammographic views of the left breast in the craniocaudal (CC) and lateromedial (LM) projections reveal an irregular, high-density mass with a spiculated margin that corresponds to the palpable complaint as indicated by the triangular marker (**a**, **b**). On ultrasound, this corresponds to an irregular, hypoechoic mass with an angular margin, associated vascularity and mild posterior acoustic shadowing (**c**). Pathology from an ultrasound-guided biopsy yielded invasive ductal carcinoma

irregular and can have either a circumscribed or spiculated margin. It is not commonly associated with microcalcifications (Fig. 3.27a, b). On ultrasound, papillary carcinoma is often associated with a cyst or dilated duct and can present as a complex cystic and solid mass (Fig. 3.27c) [36]. There is a paucity of information in the radiology literature regarding the imaging features of papillary carcinoma on MRI. It has been reported that although these can present as irregular enhancing masses or complex cystic and solid masses, there is a lot of variability in terms of their morphology and kinetics, which results in difficulty in distinguishing them from benign papillomas [72].

Invasive Lobular Carcinoma

Invasive lobular carcinoma (ILC) is rare and accounts for approximately 1.5% of all cases of breast cancer in male patients [67]. This is due to the very rare finding of lobules within the male breast. The majority of cases present as a spiculated mass or an area of architectural distortion on mammography (Fig. 3.28a–c), with a smaller subset presenting as a mammographic asymmetry or with a normal mammogram. On ultrasound, ILC most commonly presents as an irregular mass that is hypoechoic or heterogeneous in echotexture (Fig. 3.28d, e) and may be less distinct than the typical appearance of IDC [36].

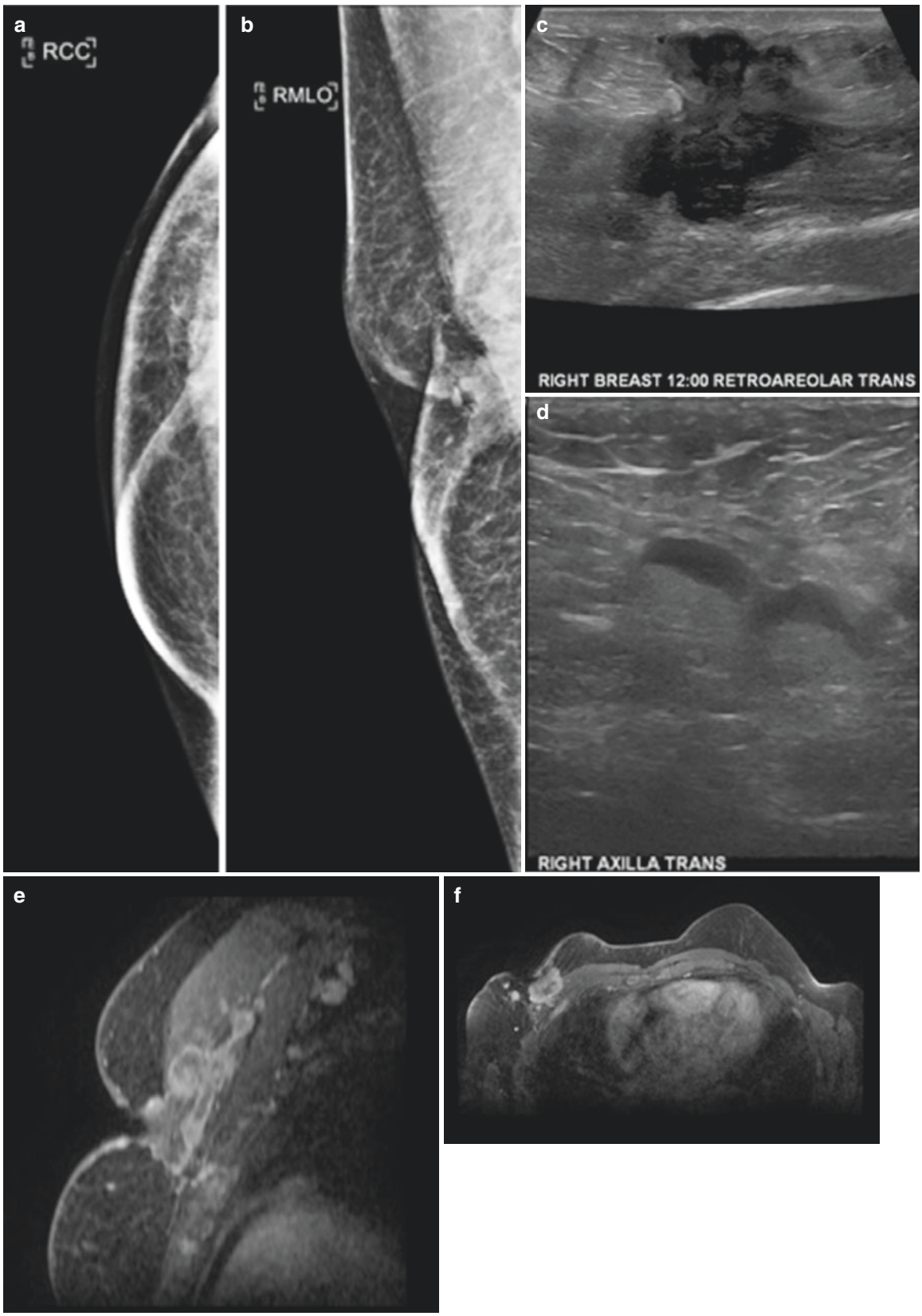

Fig. 3.26 (**a**–**f**) A 50-year-old man that presented for evaluation of a necrotic breast mass. Right breast full-field digital mammographic images in the craniocaudal (CC) and mediolateral oblique (MLO) projections show an irregular, high-density mass with an indistinct margin with associated skin thickening, nipple retraction, and partially imaged axillary adenopathy (**a**, **b**), corresponding ultrasound images of the right breast and axilla (**c**, **d**) and early-phase post-contrast sagittal and axial magnetic resonance (MR) images that demonstrate the typical findings of male breast cancer at an advanced stage of presentation (**e**, **f**). Ultrasound-guided biopsies yielded invasive ductal carcinoma (IDC) with ipsilateral metastatic axillary adenopathy

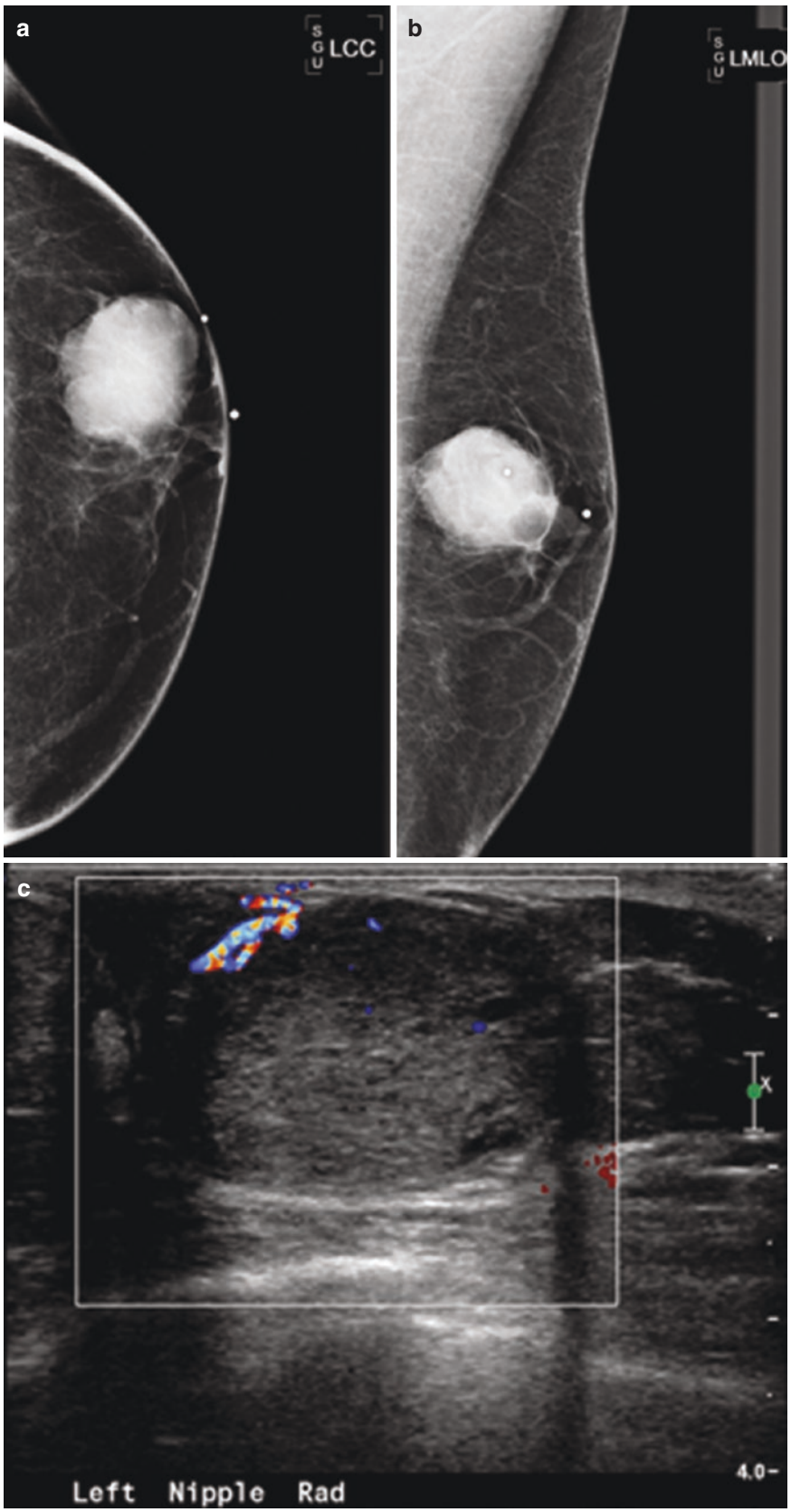

Fig. 3.27 (**a**–**c**) A 63-year-old man that presented for evaluation of a palpable breast mass. Left breast full-field digital mammography in the craniocaudal (CC) and mediolateral oblique (MLO) projections demonstrate a circumscribed oval high-density mass that is eccentric to the nipple, which corresponds with the palpable complaint as indicated by the BB marker (**a**, **b**). On ultrasound, this corresponds to a solid mass arising within a dilated duct (**c**). Pathology from an ultrasound-guided biopsy yielded papillary carcinoma

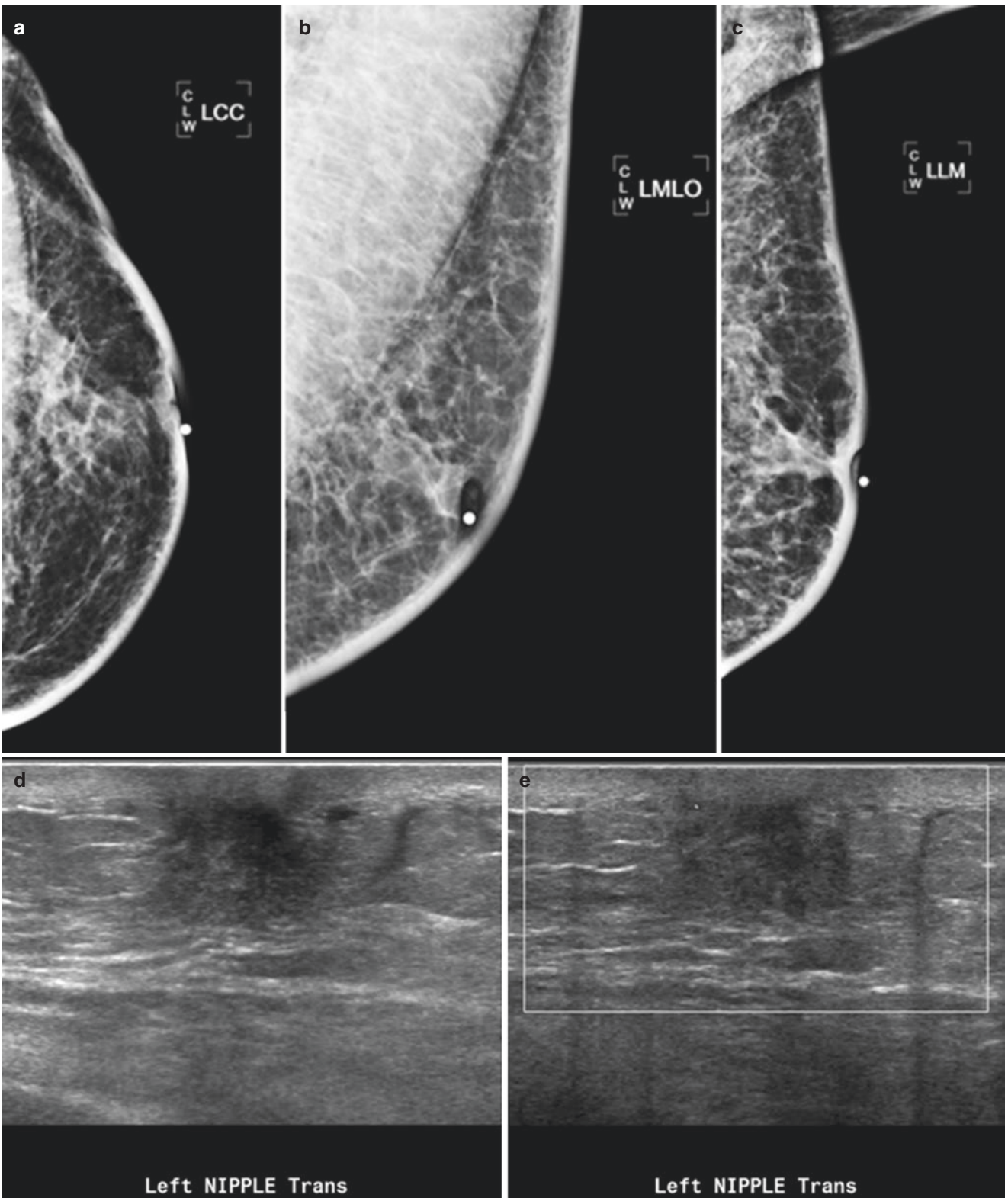

Fig. 3.28 (**a**–**e**) A 63-year-old man that presented for evaluation of left breast induration. Left breast full-field digital mammography in the craniocaudal (CC), mediolateral oblique (MLO), and lateromedial (LM) projections demonstrate a focal asymmetry in the central breast with associated nipple retraction (nipple position marked with a BB) (**a**–**c**). On ultrasound, this corresponds to an irregular hypoechoic mass with an indistinct margin and minimal internal vascularity (**d**, **e**). Pathology from an ultrasound-guided biopsy yielded invasive lobular carcinoma (ILC). (Case courtesy of Karan Saluja, MBBS, MD)

Summary

The majority of the breast conditions encountered in male patients are benign entities. Breast cancer is rare in men and accounts for less than 1% of all diagnosed breast cancer cases [1]. Imaging of the symptomatic male breast (mammography, ultrasound, and, if indicated, breast MRI) is extremely valuable to differentiate between the more common benign etiologies and those that need additional workup and possible core biopsy to establish a diagnosis.

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