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BREAST IMAGING
PICTORIAL ESSAY

Papillary lesions of the breast: imaging findings and diagnostic challenges

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ABSTRACT
Papillary breast lesions encompass a wide spectrum of pathologies ranging from benign lesions, such as solitary intraductal papilloma, to the uncommon papillary carcinoma. These lesions have various clinical presentations and diverse radiological features. Differentiating benign and malignant papillary lesions based on imaging features may often be difficult. Other benign and malignant pathologies can also mimic papillary lesions on imaging, and tissue diagnosis is essential. Imaging plays an important role in lesion identification, assessment of extent, tissue sampling, and follow-up. Surgical excision has been recommended for all papillary lesions due to an increased incidence of high-risk lesions and neoplasia even with percutaneous, biopsy-proven benign papillomas. This review looks at papillary breast lesions from the radiologists' standpoint and discusses the clinical, imaging, and pathological features of these lesions, as well as the role of imaging in their evaluation.

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Papillary lesions in the breast are uncommon but arise from a wide range of pathologies and have diverse clinical and imaging features. A papillary lesion is characterized by an arborescent structure composed of fibrovascular stalks covered by a layer of epithelial cells with or without an intervening myoepithelial cell layer (1). Overlapping features make differentiation of benign and malignant papillary lesions difficult on imaging, and a tissue diagnosis is essential. Definitive histopathologic diagnosis on core biopsy can occasionally be difficult. Additionally, even those lesions shown by percutaneous biopsy to be benign papillomas are associated with an increased likelihood of high-risk lesions and neoplasia. Due to nonspecific findings on imaging and histopathology, as well as varying malignant potential, papillary lesions present significant diagnostic and management challenges for the radiologists, pathologists, and surgeons. We briefly review the types of papillary lesions, multimodality imaging findings, and the radiologist's role in their evaluation.

The types and clinical features of papillary lesions

Papillary lesions can be broadly categorized as benign or malignant. Benign papillary lesions include a solitary intraductal papilloma, multiple intraductal papillomas, and atypical ductal hyperplasia (ADH) within a papilloma. Malignant papillary lesions include ductal carcinoma *in situ* (DCIS) arising in a papilloma, papillary DCIS, intracystic or encapsulated papillary carcinoma, solid papillary carcinoma, invasive papillary carcinoma arising in an intracystic papillary carcinoma, and invasive papillary carcinoma (1).

Intraductal papilloma

Solitary papillomas arise from a large central duct, are more common in perimenopausal women, and present with nipple discharge. Multiple papillomas are peripheral lesions arising from the terminal duct lobular unit. These are less common, usually affect a younger age group, and present as a palpable mass. Both can be associated with proliferative and high-risk lesions, such as radial scars, and with an increased risk of cancer. Patients with a solitary papilloma without atypia have a two-fold greater risk of cancer, whereas those with multiple papillomas have a relative risk of three (2).

ADH and DCIS both describe a neoplastic population of cells within a papilloma. They are more common with multiple papillomas. The atypical component is defined in various ways. Some authors define ADH as a population of such cells measuring ≤3 mm and DCIS as a population of such cells measuring >3 mm (3). Others consider these lesions to be *in situ* papillary carcinoma (4). Patients with solitary and multiple papillomas with atypia have five- and seven-fold increased risks of cancer, respectively (2).

Papillary DCIS

As a variant of DCIS, this lesion is characterized by neoplastic cells that grow around the internal lining of a duct with papillary projections. Extensive ductal spread and underestimation of the noncalcified part of the DCIS may make it difficult to obtain clear margins on excision. These lesions are associated with higher rates of multicentricity and microinvasion than other DCIS variants.

Papillary carcinoma

Papillary carcinomas are rare, comprising 1%–2% of all breast malignancies (1). They are more common in the postmenopausal age group and present with a palpable mass and nipple discharge. The absence of an intact myoepithelial cell layer within the papillary structures is an important marker for malignant lesions.

Intracystic or encapsulated papillary carcinoma is defined by the presence of papillary carcinoma within a cystically dilated duct. Intracystic papillary carcinomas that are associated with an invasive component are staged according to the size of the invasive component (1). A solid papillary carcinoma is an indolent tumor composed of circumscribed nodules of ovoid or spindle-shaped epithelial cells with a low nuclear grade. Intracystic and solid papillary carcinomas rarely metastasize and are associated with an excellent prognosis. Invasive papillary carcinoma is described as an infiltrating breast carcinoma exhibiting an exclusively papillary morphology. It is associated with a better prognosis compared with other forms of invasive carcinoma.

Imaging findings

Like their pathology, the imaging features of papillary lesions are diverse.

Papilloma

A solitary intraductal papilloma is usually observed on mammography as a rounded or ovoid, well-circumscribed retroareolar mass (Figs. 1, 2) that may be associated with ductal dilatation (Fig. 3). Smaller lesions may be occult on mammography. Multiple papillomas are usually peripheral in location and can be bilateral. Calcifications are uncommon and include both coarse dense calcifications and microcalcifications (Figs. 2, 4) (5).

The characteristic ultrasonography (US) finding of a papilloma is a solid mural nodule within a dilated duct (Fig. 5). Other features include an intracystic mass or a well-circumscribed hypoechoic solid mass (Figs. 1, 2, 6). Ductal dilatation may be the only finding in a small papilloma. Color Doppler imaging can depict a vascular pedicle within the mural nodule (Figs. 1, 2) (6, 7). Ductography may show an intraluminal filling defect, ductal dilatation, ductal wall irregularity, and distortion. Atypical papillomas may have imaging features similar to benign papillomas, and the diagnosis is usually based on histopathology (Figs. 7, 8). Magnetic resonance imaging (MRI) ductography using a microscopic coil has been proposed as a noninvasive alternative for the detection of intraductal papillomas (8).

The current role of MRI for evaluation of papillomas is unclear, and most papillomas are detected as incidental masses. There may be a role for MRI in the preoperative work-up of multiple nodular lesions to assess the extent of disease prior to surgical excision. MRI may also be useful in the follow-up of recurrent lesions. Most papillomas are observed as round, ovoid, or lobulated well-circumscribed masses with or without ductal dilatation

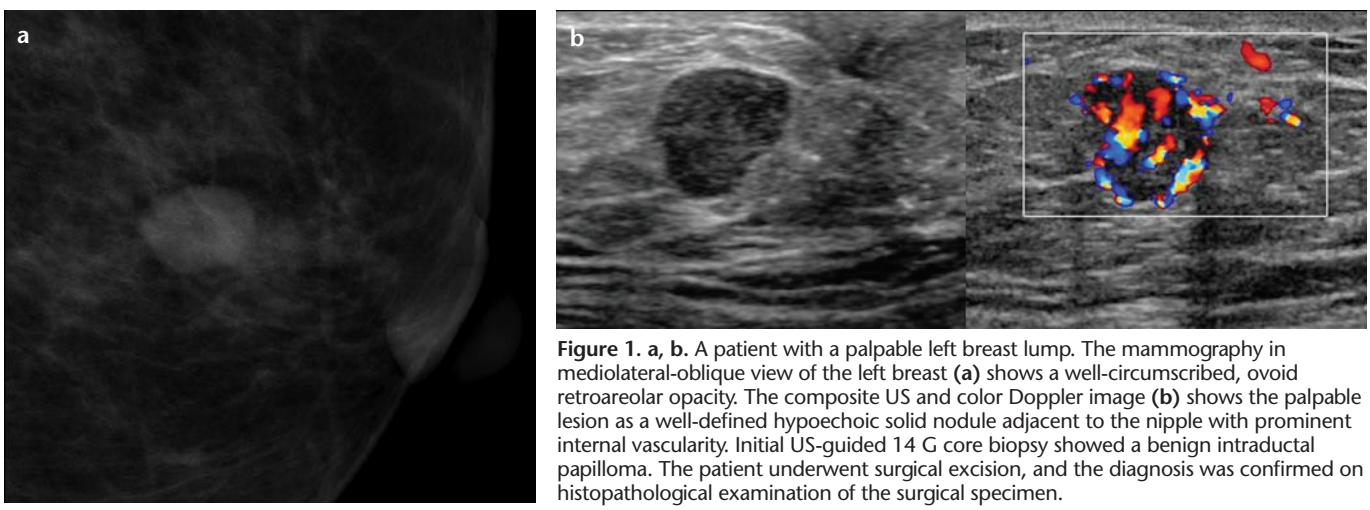

Figure 1. a, b. A patient with a palpable left breast lump. The mammography in mediolateral-oblique view of the left breast **(a)** shows a well-circumscribed, ovoid retroareolar opacity. The composite US and color Doppler image **(b)** shows the palpable lesion as a well-defined hypoechoic solid nodule adjacent to the nipple with prominent internal vascularity. Initial US-guided 14 G core biopsy showed a benign intraductal papilloma. The patient underwent surgical excision, and the diagnosis was confirmed on histopathological examination of the surgical specimen.

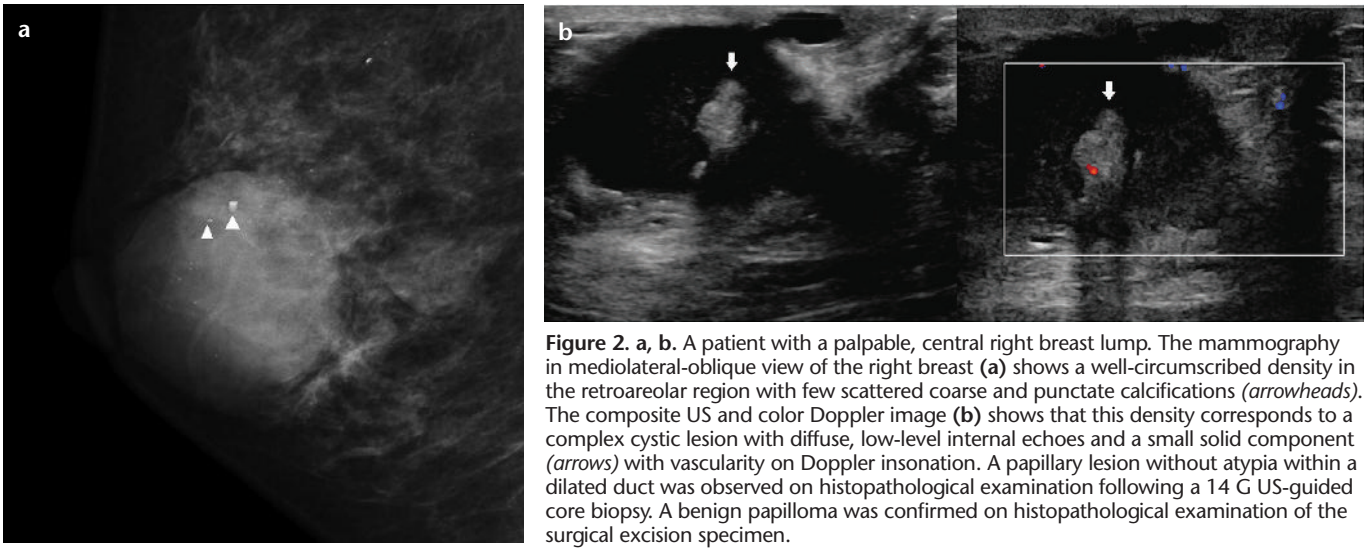

Figure 2. a, b. A patient with a palpable, central right breast lump. The mammography in mediolateral-oblique view of the right breast **(a)** shows a well-circumscribed density in the retroareolar region with few scattered coarse and punctate calcifications *(arrowheads)*. The composite US and color Doppler image **(b)** shows that this density corresponds to a complex cystic lesion with diffuse, low-level internal echoes and a small solid component *(arrows)* with vascularity on Doppler insonation. A papillary lesion without atypia within a dilated duct was observed on histopathological examination following a 14 G US-guided core biopsy. A benign papilloma was confirmed on histopathological examination of the surgical excision specimen.

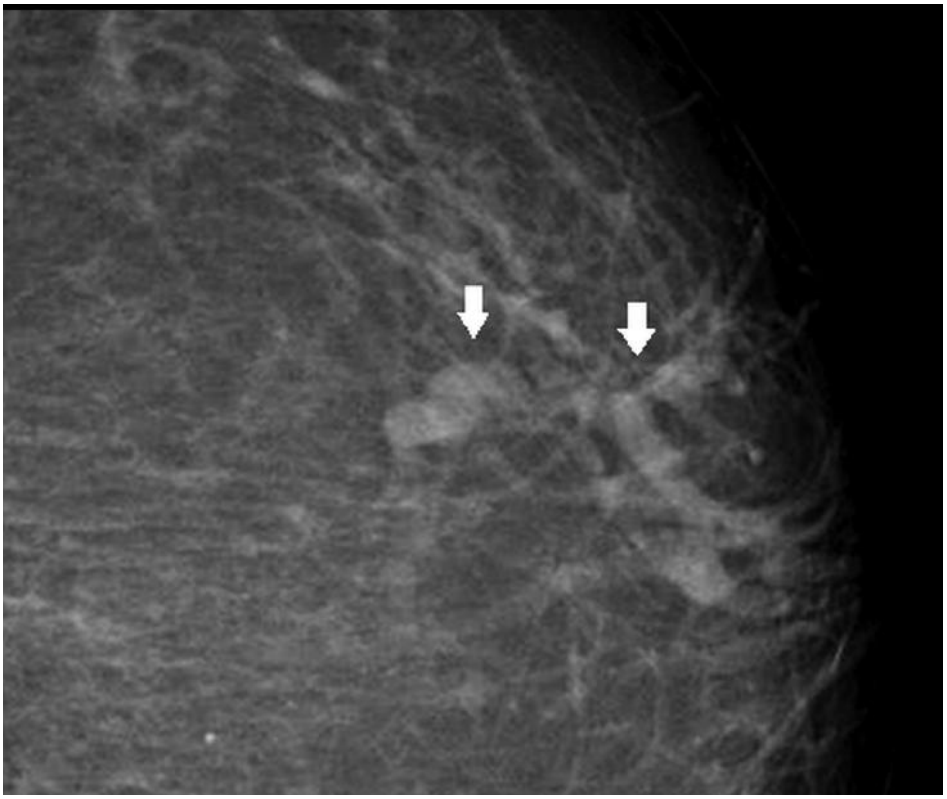

Figure 3. A patient with a screen-detected abnormality in the left breast. The mammography in cranio-caudal view shows a tubular branching structure *(arrows)* in the left outer breast. On US (not shown), this structure corresponded to a dilated duct with an intraductal nodule. A 14 G core biopsy for this lesion was reported as an intraductal papilloma. Subsequent 11 G vacuum-assisted excision biopsy confirmed this lesion to be a benign intraductal papilloma.

(Figs. 4, 9). Occasionally, a benign papilloma can have spiculated margins on mammography, US, and MRI and can thus mimic malignant disease. Variable enhancement patterns have been described, making differentiation from malignancies difficult (7, 8). In atypical papillomas with DCIS, MRI may play a role in evaluating the extent of DCIS.

Papillary DCIS

Papillary DCIS can be occult on imaging. When present, findings include pleomorphic calcifications and architectural distortion on mammography (Fig. 10), ill-defined hypoechoic mass or calcifications on US, and non-mass-like enhancement on MRI (7).

Papillary carcinoma

Mammographic findings of papillary carcinomas include round or

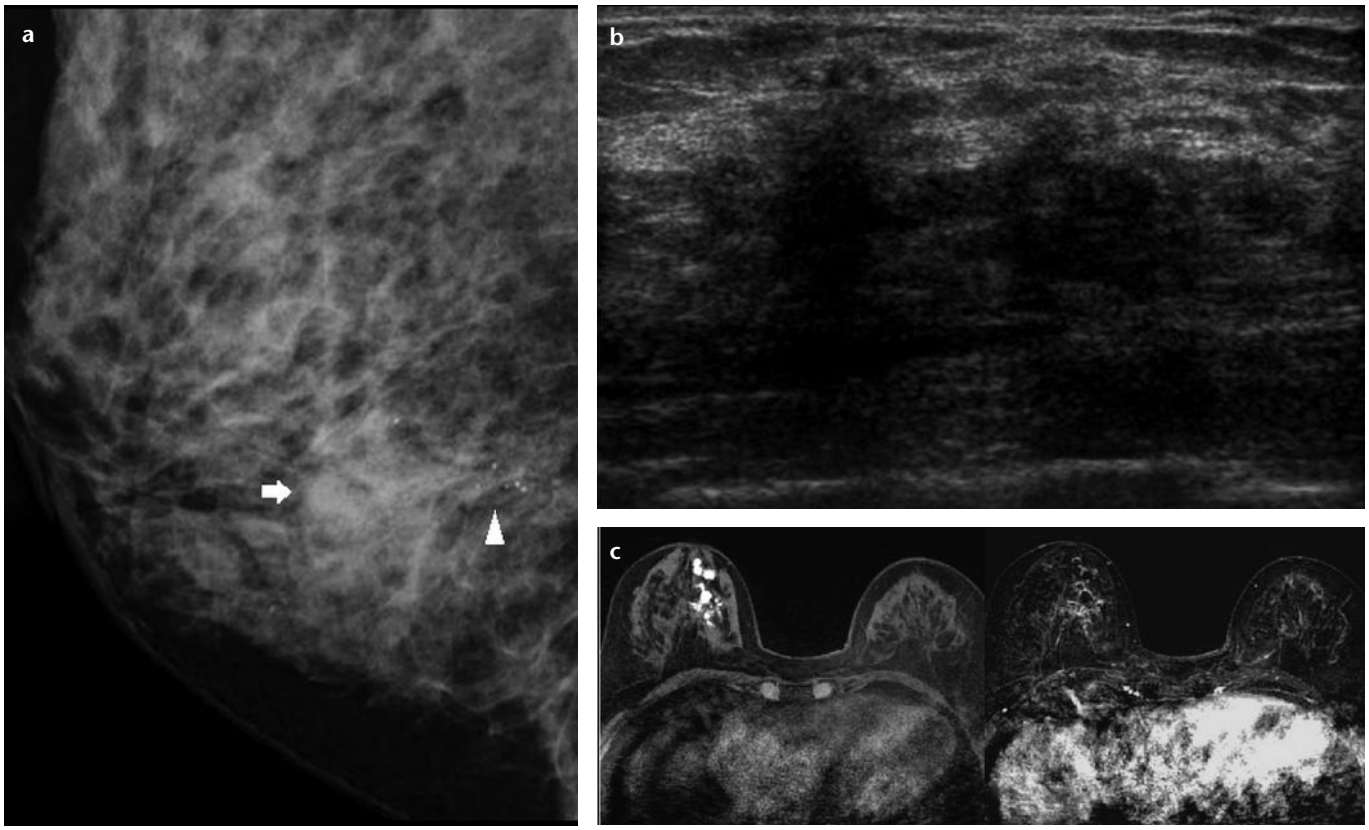

Figure 4. a–c. A patient recalled for assessment of a screen-detected abnormality in the right breast. The mammography in mediolateral-oblique view **(a)** shows an asymmetric density *(arrow)* associated with loosely clustered calcifications *(arrowhead)* in the right lower breast. US **(b)** shows a poorly defined hypoechoic area from the 3 o'clock to 6 o'clock position in the right breast. MRI **(c)** performed for further evaluation shows the lesions as lobulated, high-signal nodules in a ductal distribution on the axial vibrant precontrast phase (left-sided image). Subtracted image (right side) of the fifth minute after contrast injection shows mild patchy enhancement in the affected area. MR-guided vacuum-assisted biopsy of the abnormal area yielded an intraductal papilloma. The patient declined surgical excision biopsy.

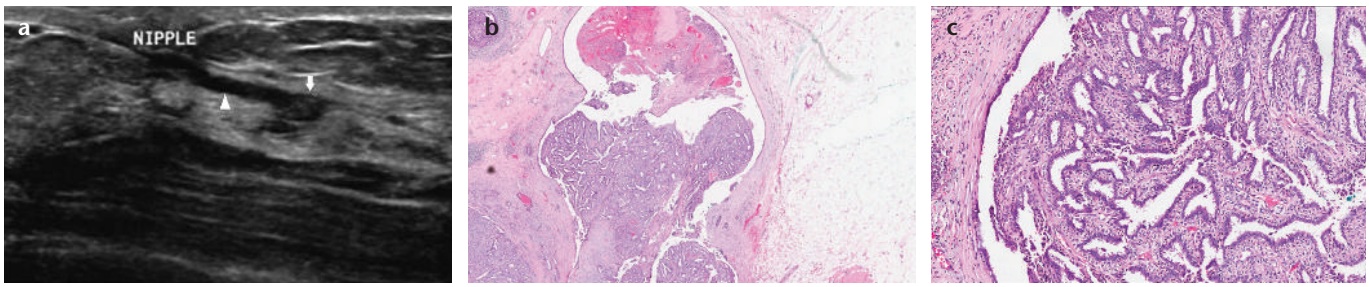

Figure 5. a–c. Benign intraductal papilloma in a patient with bloody discharge from the left nipple. US **(a)** shows a dilated duct *(arrowhead)* with an intraluminal hypoechoic lesion *(arrow)* in the left periareolar region. US-guided 14 G core biopsy showed an intraductal papilloma without atypia. Histopathological examination of the surgical excision specimen **(b** [H-E, ×40]**, c** [H-E, ×200]**)** showed a benign intraductal papilloma with an arborescent structure and focal sclerosis.

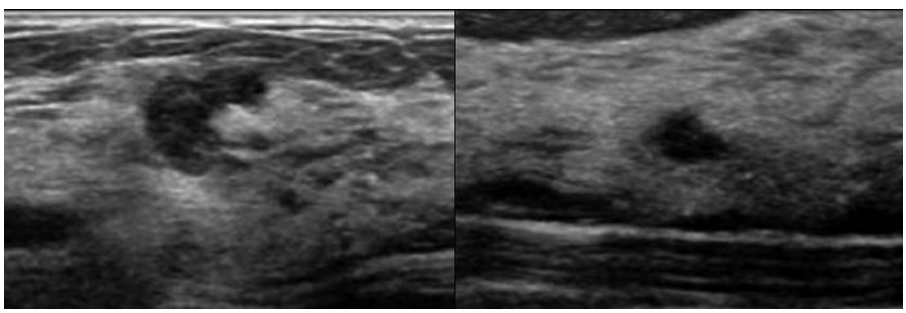

Figure 6. A patient with multiple papillomas who had a previous excision biopsy for a left breast nodule that was lobular *in situ* carcinoma and ductal papilloma on histopathological examination. Follow-up US shows new hypoechoic irregular nodules in both breasts; two of these are shown in the composite US image. Benign papillomas detected on histopathological examination of the US-guided 14 G core biopsy specimens did not show any atypia.

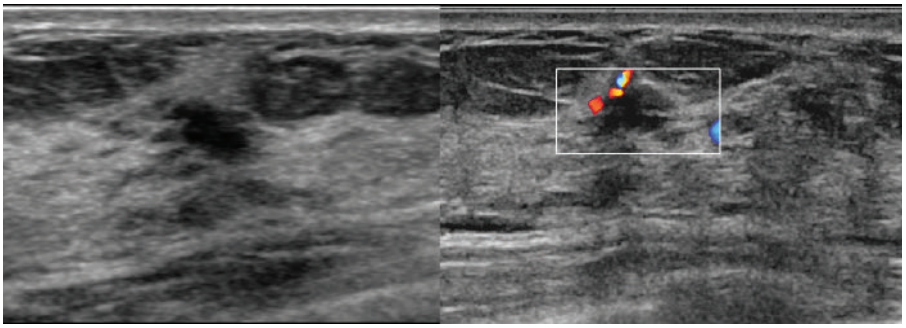

Figure 7. Atypical papilloma. The composite US and color Doppler image of the right breast shows an irregular hypoechoic mass with angular margins and peripheral vascularity. Histopathological examination of the excision specimen showed a papilloma with focal atypical ductal hyperplasia.

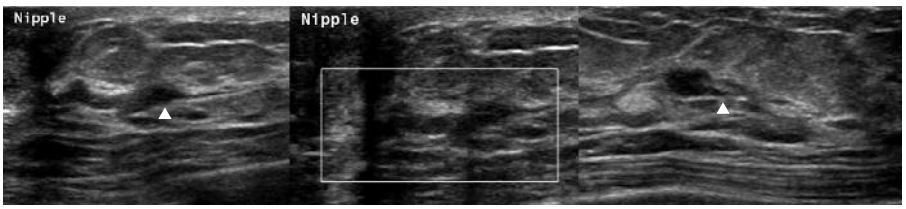

Figure 8. Papilloma with atypia in a patient with left bloody nipple discharge and a normal mammogram. The composite US and color Doppler image shows a distended duct *(arrowhead)* in the 4 o'clock position with some low-level internal echoes within (left side of image). No internal vascularity was observed on color Doppler insonation (middle image). At the 10 o'clock position (right side of image), there is a small, ovoid, hypoechoic intraductal structure near the nipple; the ductal extension is indicated by an *arrowhead*. The lesions underwent excision biopsy following hook-wire localization. Both were intraductal papillomas, and the 10 o'clock lesion showed a small focus of DCIS.

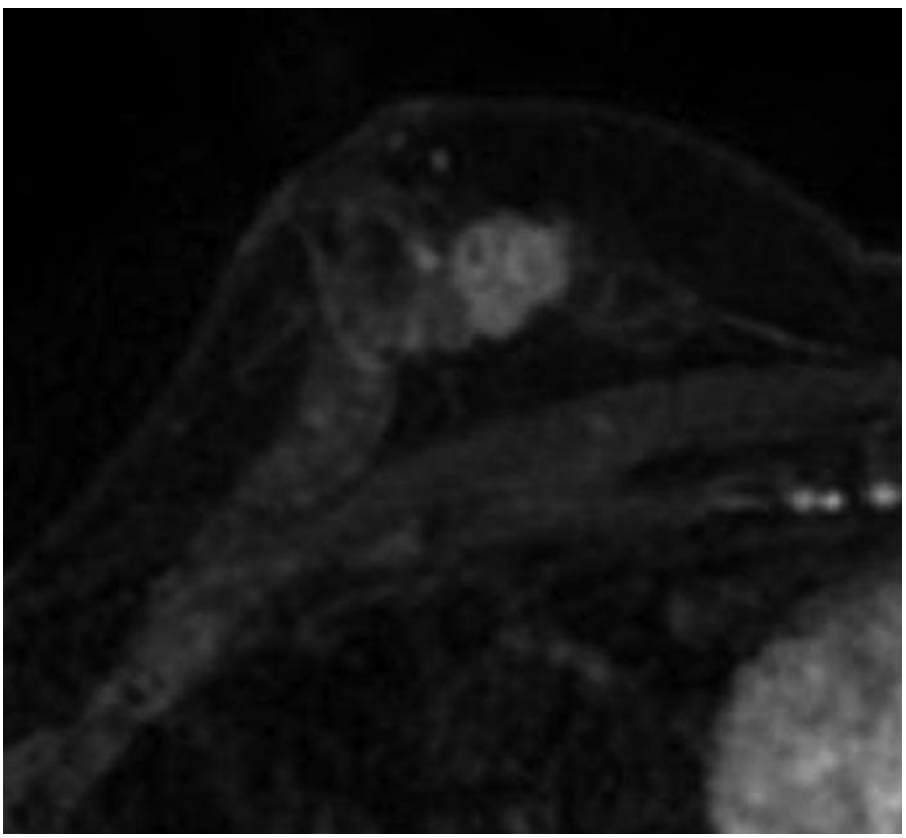

Figure 9. Intraductal papilloma on MRI. Axial MRI T1 vibrant fat-saturated postgadolinium image at 1 min postinjection shows an enhancing lobulated mass in the right breast. The mass had rapid initial enhancement and delayed plateau kinetics. Another papilloma with similar imaging features was observed in the left breast (not shown).

oval, circumscribed solitary or clustered masses, which may be associated with microcalcifications (Figs. 11–13). Spiculations are fairly uncommon probably due to the lack of fibrosis. On US, the lesion may be seen as an intraductal mass with or without ductal dilatation, a complex solid cystic mass, or single or multiple solid nodules (Figs. 11–14). These lesions are usually vascular and have a tendency to bleed spontaneously, resulting in intracystic fluid-debris levels (7, 9).

On MRI, papillary carcinomas may appear as enhancing nodular lesions or enhancing complex cysts with variable kinetic curves. There are no specific features in terms of morphology or kinetic analysis; thus, the usefulness of MRI for differentiation of benign and malignant disease is limited.

Differentiating benign and malignant papillary lesions on imaging

A nonparallel orientation, echogenic halo, posterior acoustic enhancement, and associated microcalcification are reported to be more frequent in malignant lesions (10). Another study evaluating the role of clinicoradiological features in core biopsy proved that benign papillomas without atypia showed a higher postexcision upgrade for patients >50 years, lesions that were ≥1 cm, lesions that were ≥3 cm from the nipple, and lesions categorized as Breast Imaging-Reporting and Data System (BI-RADS) 4c and 5 (11). However, due to overlapping findings, imaging is neither sensitive nor specific for differentiating benign and malignant papillary lesions (12).

Imaging differentials of papillary lesions

Segmental ductal dilatation with no demonstrable ductal mass may also be observed in ductal ectasia. Intraductal content such as blood products, inspissated secretions in ductal ectasia, and neoplastic cells in DCIS can mimic a papillary lesion. Differentials for a complex cystic le-

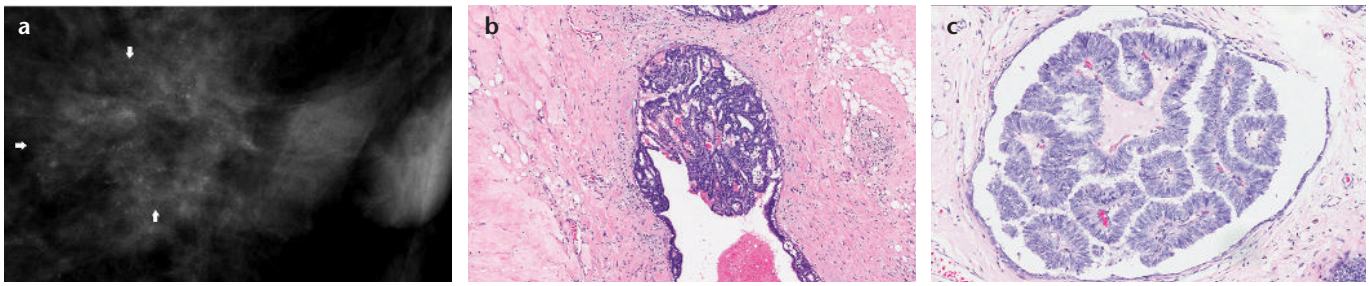

Figure 10. a–c. Papillary DCIS. A patient with a loose cluster of pleomorphic microcalcifications in the spot magnification view in the left central breast (**a,** *arrows*). Histopathological examination following wide local excision showed papillary DCIS **(b** [H-E, ×40]**, c** [H-E, ×200]**).**

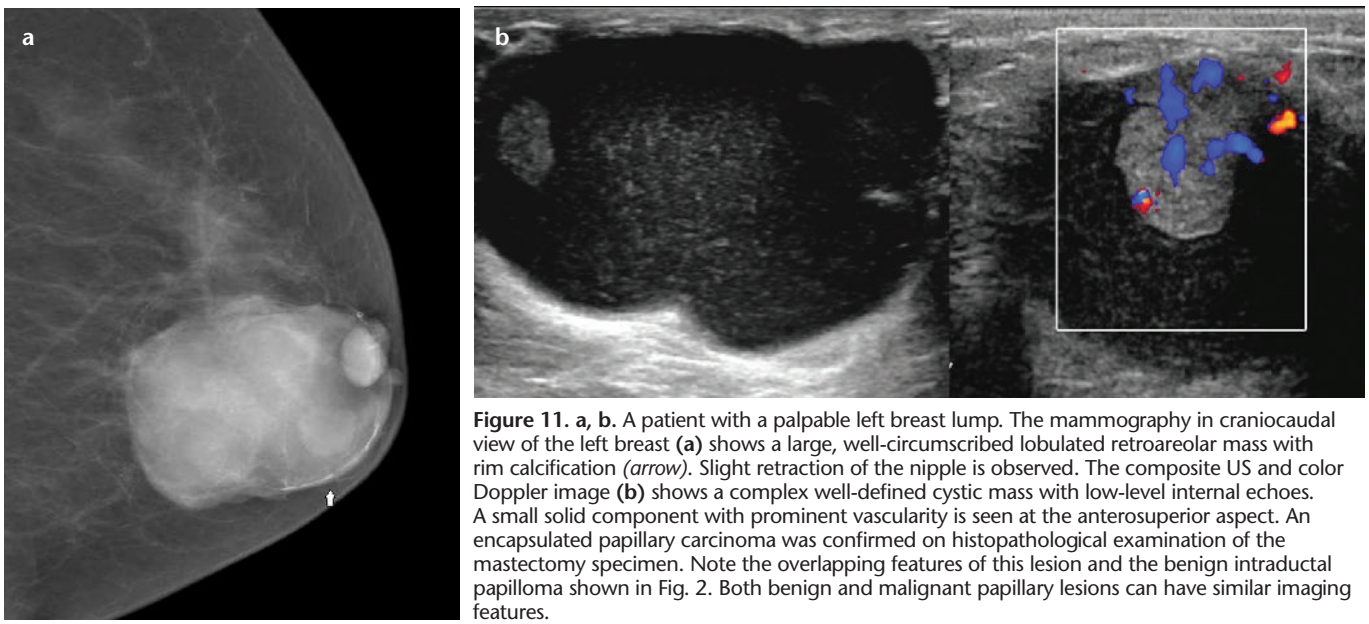

Figure 11. a, b. A patient with a palpable left breast lump. The mammography in craniocaudal view of the left breast **(a)** shows a large, well-circumscribed lobulated retroareolar mass with rim calcification *(arrow)*. Slight retraction of the nipple is observed. The composite US and color Doppler image **(b)** shows a complex well-defined cystic mass with low-level internal echoes. A small solid component with prominent vascularity is seen at the anterosuperior aspect. An encapsulated papillary carcinoma was confirmed on histopathological examination of the mastectomy specimen. Note the overlapping features of this lesion and the benign intraductal papilloma shown in Fig. 2. Both benign and malignant papillary lesions can have similar imaging features.

sion include hematomas, abscesses, and fat necrosis. A papillary lesion appearing as a well-defined solid nodule may be indistinguishable from a fibroadenoma (Fig. 15). Additionally nonpapillary and papillary carcinomas can have similar appearances.

The radiologist's role and challenges

Imaging is crucial for lesion identification and local staging, guiding tissue diagnosis, and follow-up.

Mammography and US form the mainstay of lesion identification. However, some lesions, such as small papillomas or papillary DCIS, may be occult or have equivocal findings such as nonspecific segmental ductal dilatation. Ductography can help to detect small papillary lesions. Assessing the extent of pathology is also critical, particularly for multiple papillomas, DCIS, and carcinomas. In the latter cases, MRI may be useful.

Tissue sampling of papillary lesions can utilize fine-needle aspiration, core biopsy, and vacuum-assisted biopsy. US-guided percutaneous core biopsy is used most frequently because it allows for real-time visualization, a feature that is essential for sampling the solid component of the lesion.

Nevertheless, definitive histopathological categorization of percutaneous biopsy samples may be limited by factors such as tissue fragmentation and undersampling. Numerous studies have found a significant upgrade in the atypia rate (6.9%–27.7%) or malignancy (3.1%–20%) for benign papillomas diagnosed by core-needle biopsy (13). These findings have resulted in surgical excision being recommended even for imaging concordant, percutaneous, biopsy-proven benign papillomas. Other authors have found a low risk of malignancy for benign papillomas diagnosed by core-needle biopsy and recommend mammographic follow-up for benign and excision for atypical papillomas (14). Vacuum assistance has also been utilized for the removal of select papillary lesions and has the potential to improve lesion sampling and reduce the number of open surgeries (15). Here, again, the potential for recurrence suggests the need for close follow-up.

Conclusion

Papillary lesions are an uncommon group of breast diseases that present unique diagnostic and management challenges due to a wide spectrum of imaging appearances, pathologies, and malignant potential. The radiologist plays an important role in the

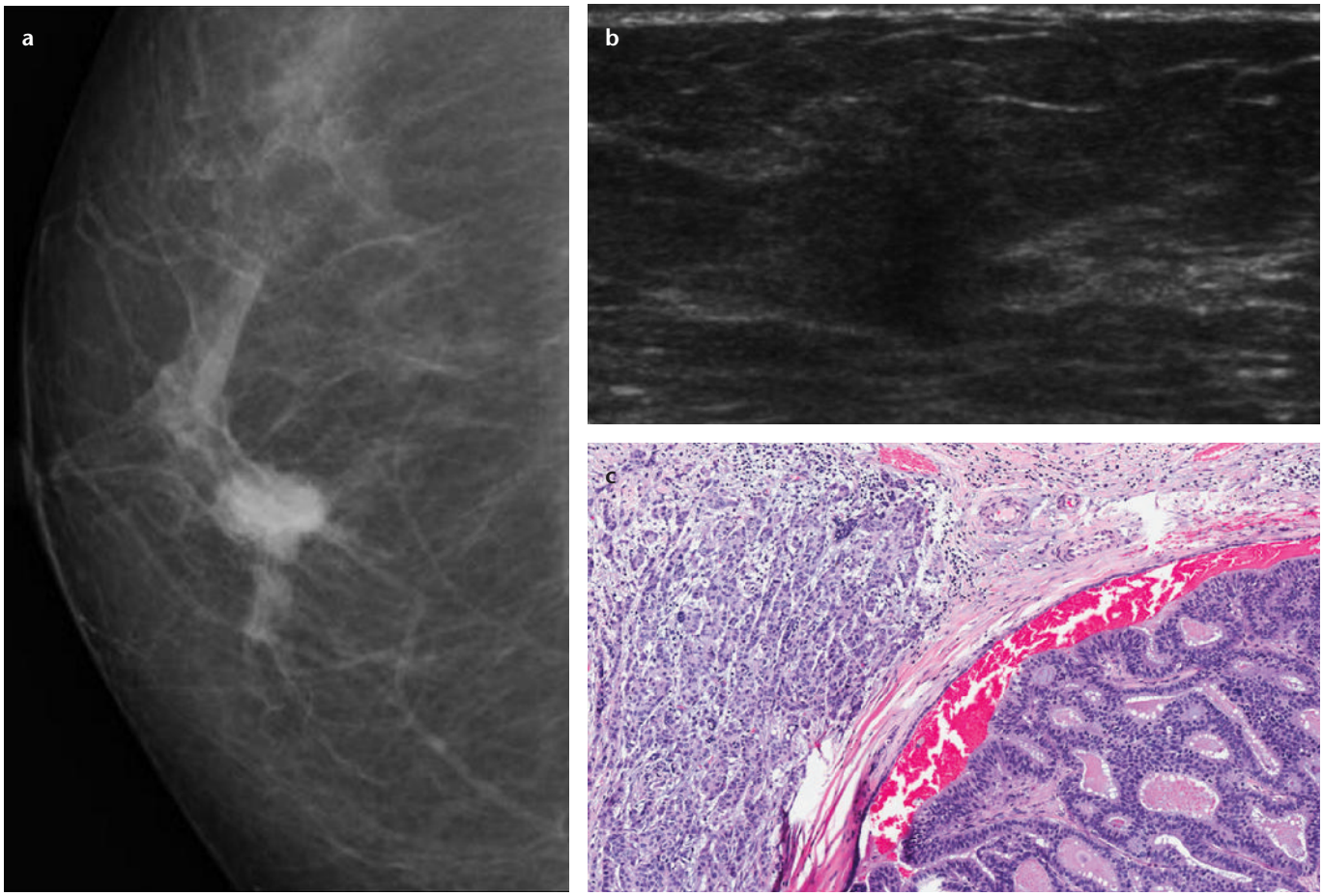

Figure 12. a–c. A patient with a palpable right breast lump. The mammogram in craniocaudal view of the right breast **(a)** shows a circumscribed lobulated opacity with partly ill-defined margins superiorly in the central breast. US **(b)** shows an irregular hypoechoic mass with ill-defined margins. This was shown to be an encysted papillary carcinoma with a focus of invasive ductal carcinoma on histopathological examination of the mastectomy specimen **(c** [H-E, ×200]).

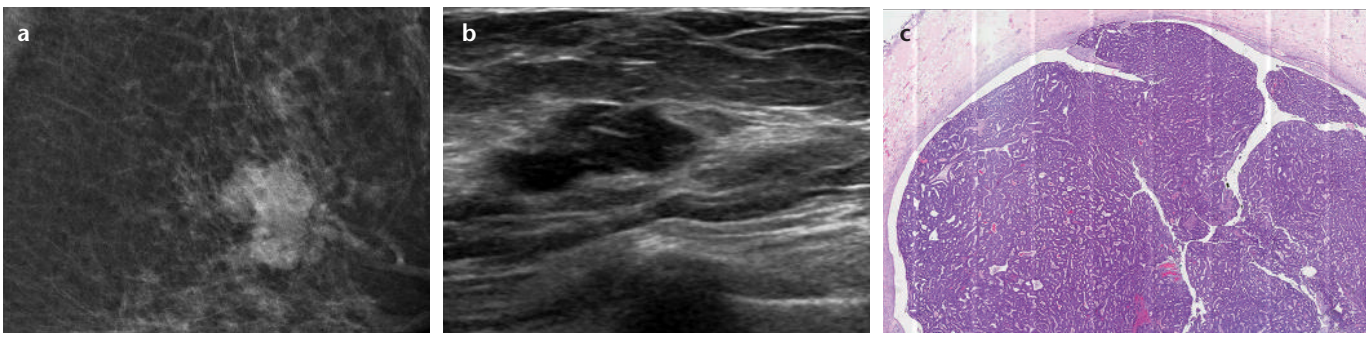

Figure 13. a–c. Solid papillary carcinoma. The mammogram in mediolateral-oblique view of the left breast **(a)** shows a mass with lobulated margins in the upper breast. US **(b)** shows an ill-defined, irregular hypoechoic mass. Histopathological examination of the wide local excision specimen **(c** [H-E, ×40]) showed a solid papillary carcinoma.

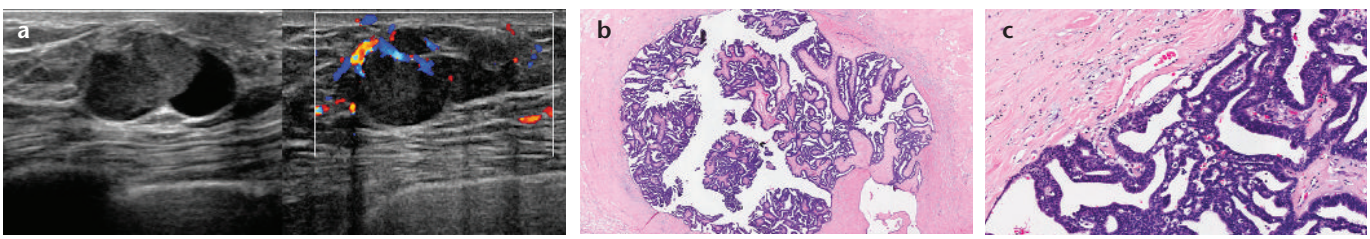

Figure 14. a–c. Encysted papillary carcinoma in a male patient presenting with a right breast lump. The composite US and color Doppler image **(a)** shows a complex solid cystic periareolar mass with lobulated margins and internal vascularity. The patient underwent a mastectomy after an initial US-guided 14 G core biopsy that showed the possibility of low-grade papillary DCIS or encysted papillary carcinoma. The mastectomy specimen confirmed an encysted papillary carcinoma **(b** [H-E, ×40], **c** [H-E, ×200]).

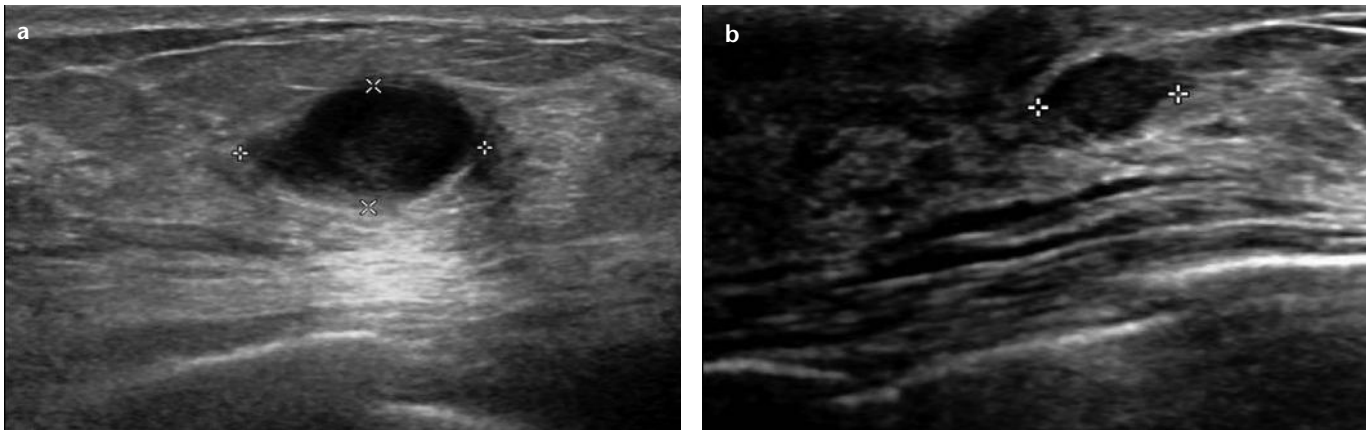

Figure 15. a, b. Mimics of papillary lesions. US **(a)** shows a cystic lesion with intracystic content; the cyst collapsed completely on fine-needle aspiration. Differentiating debris/clots and solid components within a cyst may be difficult, and demonstration of vascularity on Doppler imaging aids in establishing the solid nature. A biopsy-proven fibroadenoma is observed on US as a well-defined, ovoid hypoechoic retroareolar nodule that mimics a papillary lesion **(b)**.

diagnosis and management of these lesions. Knowledge of the types and imaging spectra of various papillary lesions and the role of imaging in their evaluation are thus essential.

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Conflict of interest disclosure

The authors declared no conflicts of interest.

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