



Role of Magnetic Resonance Imaging in Assessment of Intra-ductal breast lesions

2633

Rania Mostafa El-Molla; Mohamed Hamed Abo_Warda; Samar Mohamed Shehatah; Dina Mahmoud Abdel-Wahab

Department of Radiodiagnosis, Faculty of Medicine, Zagazig, Egypt

Corresponding author: Dina Mahmoud Abdel-Wahab

Email: diabdina63@gmail.com

Abstract

Ductal breast disease is a serious and little recognized problem in breast imaging that causes delays in management and therapy. Benign ductal lesions include duct ectasia, inflammatory changes, fibrocystic changes, intraductal papilloma and papillomatosis. Malignant ductal lesions include ductal carcinoma in situ, invasive ductal carcinoma. The patients with ductal lesions can present with variety of symptoms, the most common reported symptom is pathological nipple discharge. Clinically, the patient with ductal disease can present in a variety of scenarios, including for specific diagnostic evaluation of symptoms such as classic serous or sanguineous nipple discharge, mastitis, or generalized infectious symptoms; for evaluation of lactation-associated issues; or in the setting of routine or high-risk screening. Ultrasonography (US) and occasionally magnetic resonance (MR) imaging have largely replaced galactography or ductography at our institution secondary to increased attention to patient comfort and the dramatic increase in image resolution in US and MR imaging. There are multiple methods to evaluate the ductal system in female patients. Galactography or ductography remains the standard of reference for evaluation of the ductal system. However, because of its increased resolution, availability, and ease of use, high-resolution US is replacing galactography in evaluation of ductal disease near the nipple, such as in patients with nipple discharge

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Introduction

Ductal breast disease is a serious and little recognized problem in breast imaging that causes delays in management and therapy. Benign ductal lesions include duct ectasia, inflammatory changes, fibrocystic changes, intraductal papilloma and papillomatosis. Malignant ductal lesions include ductal carcinoma in situ, invasive ductal carcinoma. The patients with ductal lesions can present with variety of symptoms, the most common reported symptom is pathological nipple discharge. **(1)**

Clinically, the patient with ductal disease can present in a variety of scenarios, including for specific diagnostic evaluation of symptoms such as classic serous or sanguineous nipple discharge, mastitis, or generalized infectious symptoms; for evaluation of lactation-associated issues; or in the setting of routine or high-risk screening. **(2)**

Ultrasonography (US) and occasionally magnetic resonance (MR) imaging have largely replaced galactography or ductography at our institution secondary to increased attention to patient comfort and the dramatic increase in image resolution in US and MR imaging. **(3)**

Percutaneous biopsy is a critical technique in the diagnosis of ductal disease, and the increased availability of vacuum-assisted devices has enabled more accurate sampling of tiny ductal lesions under US guidance as well as suspicious areas of enhancement seen only at MR imaging. Subtraction imaging is an important tool in MR imaging to assess for suspicious enhancement associated with ductal disease in specific cases and aid in diagnosis. **(4)**

Imaging evaluation:

There are multiple methods to evaluate the ductal system in female patients. Galactography or ductography remains the standard of reference for evaluation of the ductal system. However, because of its increased resolution, availability, and ease of use, high-resolution US is replacing galactography in evaluation of ductal disease near the nipple, such as in patients with nipple discharge. **(5)**

Benign diseases:

Benign diseases involving the ducts are relatively common in clinical practice. They range from inflammatory processes that can result in duct ectasia to infectious entities such as mastitis and blocked ducts. Benign filling defects, such as papillomas and papillomatosis, can also occur. There are imaging clues to the benign features of these diseases. However, these entities will likely need further evaluation with percutaneous biopsy. **(6)**

Duct ectasia:

Duct ectasia predominantly affects ducts in the retroareolar region and is defined as nonspecific dilatation of one or more ducts. This finding can be palpable to the patient or referring provider and may also manifest in combination with nipple discharge. Duct ectasia may be visible at mammography, depending on the overall density of the breast parenchyma as well as the extent of the dilatation. **(7)**



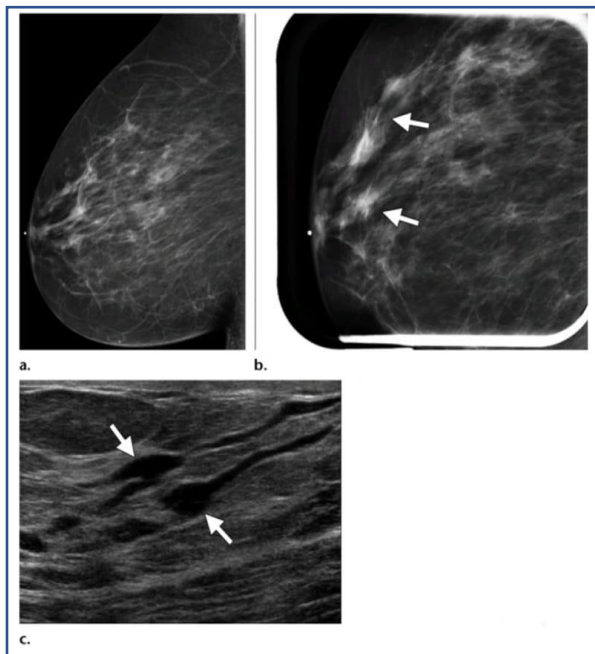


Figure (1): Duct ectasia. (a, b) MLO (a) and spot compression MLO (b) mammograms show radio dense tubular structures converging toward the nipple in the anterior and slightly superior right breast (arrows in b). (c) US image shows anechoic tubular structures extending toward the nipple, findings that correspond to dilated ectatic ducts. Note the focal areas of dilatation (arrows). **(8)**

Sonographic evaluation demonstrates anechoic smooth-walled branching structures that taper peripherally and distended branching or tubular structures with anechoic contents measuring more than 2 mm diameter. Duct ectasia can also be seen in the spectrum of malignant disease. Sonographic features that favour a malignant process include the location of the ectasia; a peripheral location favours a malignant process, whereas a central location favours a benign process. **(7)**

By MRI, On T1 and T2 weighted images, duct ectasia appears as dilated increased signal intensity branching ducts converging towards the nipple without an overlying mass. Hyperintense signals are due to thick proteinaceous fluid or blood. **(9)**

Blocked ducts:

Blocked ducts typically occur in lactating women due to poor or incomplete drainage of milk. These patients often present with a lump with or without associated tenderness. If the symptoms do not resolve, this could progress to mastitis. Organisms often found in the breast parenchyma in the setting of lactation-associated infection include *Staphylococcus aureus*, including strains of methicillin-resistant *S aureus* if the infection is hospital associated. Other possible organisms include streptococci and *Staphylococcus epidermidis*. **(10)**

Ultrasound appearances of a blocked duct range from a discrete incompressible mass to a diffuse echogenic area with a hypoechoic rim associated with a hardened area of the breast. Ultrasound can also be used for blocked ducts for therapeutic purposes. It is a non-invasive treatment applied directly to the breast(s). Sound waves created by the machine help to reduce obstruction that surround the ducts which carry the milk, allowing for pressure relief, pain/swelling reduction, and promotes milk flow. **(11)**

At MRI, normal ducts blend in with the background breast parenchyma and are not typically visible. However, if the ducts are dilated, typically as a result of a chronic obstructive process, they will be visible on nonenhanced T1-weighted images as high-signal-intensity branching tubular structures (an appearance due to proteinaceous or sometimes haemorrhagic material). They usually show no associated enhancement. **(8)**



Periductal mastitis:

Periductal mastitis typically occurs in premenopausal women when the ducts beneath the nipple become inflamed and infected. Clinically, the patient may present with a tender serous or sanguineous nipple discharge, infection involving the ducts around the nipple, or an inverted nipple. If the infection is not treated, a retro areolar abscess may occasionally result. Smoking and nipple rings are independent risk factors for periductal mastitis. **(7)**

Breast MR imaging is occasionally performed as part of the work-up for nipple discharge, which is common in these patients. It is not uncommon to see enhancement of the duct wall in cases of chronic inflammation. If there is focal enhancement adjacent to a dilated duct, biopsy is recommended to exclude adjacent malignancy. **(10)**.

Ultrasonic appearances may vary due to the duration and extent of the inflammation. Very early in the acute phase there may be no discernible ultrasonic changes in echogenicity of the breast. Skin thickening can occur, and the skin becomes more hyperechoic (brighter than the surrounding tissues). Normally hyperechoic structures such as the Cooper's ligaments and stromal fibrous tissue decrease in echogenicity and become more difficult to distinguish from adipose tissue. **(12)**.

Apocrine metaplasia:

Apocrine metaplasia consists of dilated ducts and adjacent cysts that may contain inspissated secretions, the latter of which could calcify and manifest as heterogeneous calcifications. This entity is believed to arise from the lobular cells of the TDLU of the breasts. Apocrine metaplasia is often present in the epithelial lining of cysts in gross cystic disease. About 10% of women with

apocrine metaplasia have clinically evident disease. **(10)**.

Radiographic diagnostic features of apocrine metaplasia are variable. MRI features are nonspecific. There are no distinguishing MRI features, although a new or enlarging lobular, microlobulated mass or heterogeneous calcification cluster may sometimes represent apocrine metaplasia. When this is seen, a needle biopsy is required for definitive diagnosis. On the other hand, ultrasound may show a cluster of small (2-5 mm) anechoic foci with intervening septae. **(10)**.

Papillomas:

Single papillomas occur in major ducts and consist pathologically of epithelial proliferation on a fibrovascular stalk. Typically, they are located within a few centimeters of the nipple and grow within the duct, usually resulting in duct obstruction. Clinically, they may be asymptomatic or manifest as serous or sanguineous nipple discharge. **(10)**.

At US, papillomas typically appear as ovoid solid masses with associated ductal dilatation; they may appear hypervascular at color Doppler assessment. Occasionally, patients present with persistent serous or sanguineous nipple discharge but have normal results at galactography and US. **(9)**

In these cases, MR imaging can be used as a diagnostic tool to aid identification of the causative lesion, as papillomas often appear as an enhancing mass-like lesion. At MR imaging, papillomas can appear as a well-circumscribed oval or round mass, an irregular mass, or a solid and cystic lesion; they may also be occult at imaging. Kinetic evaluation can reveal progressive, plateau, or washout-type enhancement. **(6)**



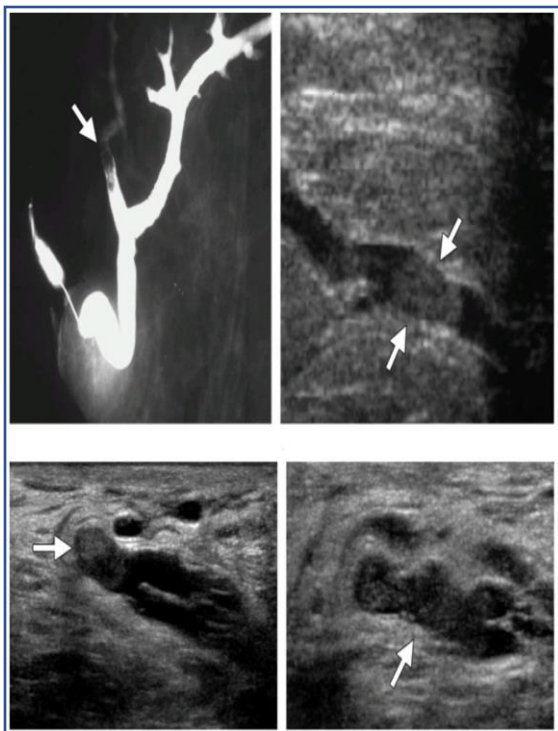


Figure (2): Papilloma in a 43-year-old woman with spontaneous nipple discharge. **(8)**

Papillomatosis:

In contrast to solitary intraductal papillomas, which tend to involve larger ducts, papillomatosis or multiple papillomas tend to occur in distal ducts in the TDLU. They are more often associated with hyperplasia, atypia, DCIS, invasive cancer, sclerosing adenosis, and radial scars. **(6)**

Regarding the radiographic features of papillomatosis, breast ultrasound may reveal an ill-defined, inhomogeneous hypoechoic mass with multiple small (up to 4 mm) predominantly peripheral cysts. Microcalcifications may be seen at sonography. **(6)**

On the other hand, these lesions are usually negative on mammography. Occasionally mammograms may show pleomorphic or amorphous microcalcifications, an asymmetric density or a prominent intraductal pattern. In addition,

galactography may show a multiple irregular filling defects within the breasts. **(13)**.

Breast MRI may show special characteristics according to one report including:

- T1: hypointense lobulated mass.
- T2: may show presence of multiple small internal cysts, best shown on this sequence and considered the most specific feature.
- T1 C+ (Gd): may show marked rapid enhancement.
- dynamic sequence: shows a benign enhancement profile. **(13)**.

Malignant diseases:

The most common malignant disease affecting the ductal system of the breast is DCIS. The vast majority of these cases manifest as abnormal or suspicious microcalcifications at mammography, but they can also manifest as solid masses. They can be localized with US and subsequently biopsied as an alternative to stereotactic core biopsy, depending on the size and number of the calcifications. Rarely, DCIS is occult at both mammography and US and is seen only at MR imaging as non-mass like enhancement. **(2)**

Ductal carcinoma in situ:

DCIS arises in the TDLU near the junction of the terminal duct with the lobule. By definition, the cellular proliferation is contained within the duct by the basement membrane. Histologically, DCIS often demonstrates comedonecrosis, but cribiform and papillary changes may also be seen. **(14)**

Typically, DCIS manifests as calcifications at mammography, although in up to 14% of cases it may manifest as a solid mass with or without associated calcifications. At US, DCIS



can appear as an intraductal mass or a solid intraparenchymal mass with adjacent ductal dilatation or extension. **(15)**

At MR imaging, linear nodular or ductal enhancement or focal non-mass-like enhancement with persistent, plateau, or washout kinetics may be seen. Non-mass-like enhancement can be seen with both DCIS and invasive ductal carcinoma but is more commonly seen with the former entity. **(15)**

Invasive ductal carcinoma:

Invasive ductal carcinoma arises from the ductal epithelium in the TDLU. Other cancers that arise from ductal epithelium include papillary, mucinous, medullary, and adenoid cystic cancer. At mammography, these cancers most commonly appear as spiculated or irregular masses with or without associated calcifications or as developing asymmetries. **(2)**

Focused US evaluation typically reveals a mass with classically suspicious features; the patient then undergoes US-guided percutaneous biopsy and surgical management. At US, a mass demonstrating ductal extension is highly specific for malignancy. **(2)**

Less commonly, however, an irregular cystic lesion or an actual intraductal mass can be identified. At US, the former type of lesion can manifest as a dominant cystic area with surrounding rounded or tubular hypoechoic areas that represent ductal extension. Percutaneous biopsy of the area is warranted for definitive diagnosis. If the mass is within a duct or appears cystic, biopsy with vacuum assistance to ensure adequate tissue sampling may be considered. **(14)**

MR imaging is occasionally used for work-up of bloody nipple discharge to exclude underlying invasive malignancy when results

of mammography and US are unrevealing. In specific cases and clinical circumstances, MR imaging with contrast material can be a strong adjunctive tool in the setting of a negative imaging work-up for nipple discharge. **(15)**

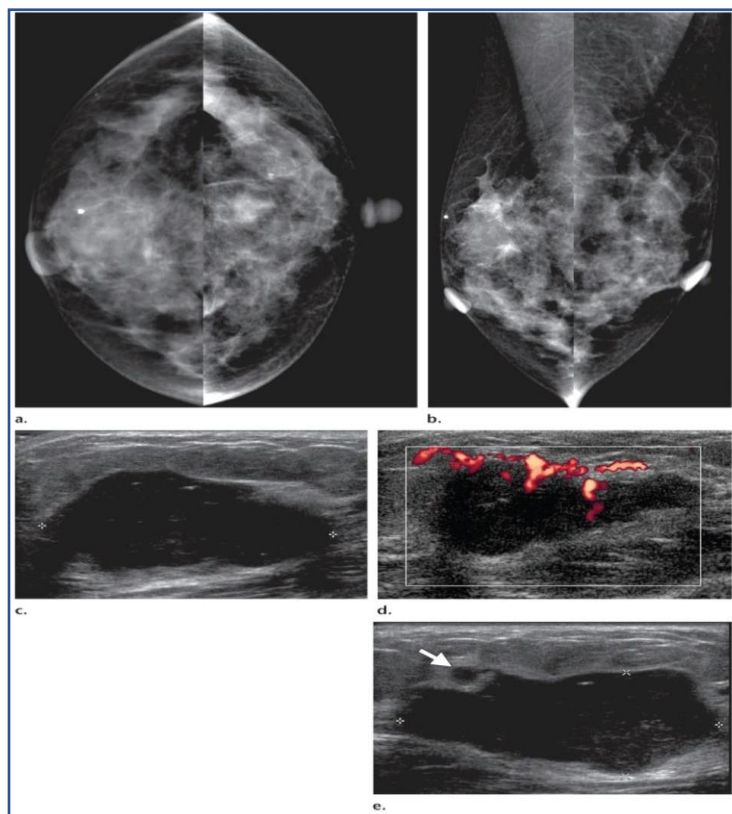


Figure (3): Invasive ductal carcinoma in a 41-year-old woman with a palpable lump in the right breast. (a, b) Craniocaudal (a) and MLO (b) mammograms show a focal asymmetry with associated distortion in the central upper right breast, a finding that corresponds to the area of concern as indicated by the patient. The area of concern is marked with a BB. (c) Antiradial US image shows a large irregular mass with heterogeneous echotexture at the 12 o'clock position, 3 cm from the nipple. (d) Color Doppler image shows that the mass is hypervascular. (e) Radial US image shows ductal extension (arrow). Biopsy demonstrated grade III invasive ductal carcinoma. **(8)**

Paget disease:

Paget disease accounts for less than 5% of all breast cancers and is thought to most likely arise from pre-existing DCIS or invasive ductal cancer. Paget disease typically



manifests with symptoms limited to one breast, including nipple discharge (serous or sanguineous), nipple inversion, a palpable mass, or an eczema-type rash involving the nipple. The diagnosis is made with skin biopsy. **(2)**

Most of these patients have an underlying malignancy, either DCIS or invasive carcinoma. In a minority of cases, these lesions may manifest as an intraductal finding, although at times diagnostic evaluation does not result in identification of the primary breast lesion. Most patients with Paget disease undergo mastectomy. **(14)**

US may be helpful and should be considered part of the initial evaluation, especially when results of mammography are negative. A lesion that is invisible at mammography may be imaged with breast US. Findings that may be seen at US include a mass, microcalcifications, ductal ectasia, or morphologic changes of the nipple-areolar complex such as flattening, asymmetry, and thickening. **(16).**

MR imaging can have a role in preoperative evaluation of patients with Paget disease in assessment of the nipple-areolar complex as well as underlying breast cancer, especially when results of mammography or US are negative. **(16).**

Findings that may be seen at MR imaging include abnormal nipple enhancement, thickening and enhancement of the nipple-areolar complex, an associated enhancing DCIS or invasive tumor, or a combination of these. There are clear differences and asymmetries in the characteristics of the nipple-areolar complex between the normal and abnormal sides. **(14)**

At contrast-enhanced MR imaging, the degree of normal nipple enhancement varies and there is a bilaterally symmetric enhancement pattern: The enhancement may be absent, mild, or intense. Intense enhancement is due to the presence of numerous vessels. In contrast to the normal side, asymmetric nodular, discoid, or irregular enhancement may be seen in the abnormal nipple or nipple-areolar complex. **(16).**



Conflict of Interest: None

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