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REVIEW – OPEN ACCESS

Breast Imaging for Non-radiologists

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ABSTRACT

Breast carcinoma is the most frequent malignant tumor among women worldwide, and the incidence is increasing in Turkey. Screening with imaging modalities can provide early and accurate identification, and result in a lower treatment burden. While mammography (MG) and ultrasonography (US) continue to be the principal imaging methods, breast magnetic resonance imaging (MRI) is a more advanced imaging tool. This narrative review examines imaging modalities (MG, US, and MRI), pathology, breast carcinoma screening, axilla and male breast cancer for specialists other than radiologists, such as residents and students.

Keywords: Breast, breast cancer, diagnostic ultrasound, magnetic resonance imaging, mammography

INTRODUCTION

Breast carcinoma is the most common malignant tumor seen in women and the reported incidence of breast carcinoma in Turkey increased from 24/100,000 in 1993 to 50/100,000 in 2017 (1). Imaging is needed for early and accurate diagnosis. Population screening with mammography (MG) has decreased the mortality rates of breast carcinoma (2).

MG and ultrasonography (US) are the first-line imaging methods used in case of breast symptoms (Table 1). A percutaneous breast biopsy will provide an accurate diagnosis of breast lesions. A physical examination, evaluation by MG and US, and a needle biopsy are known as the "triple assessment" of breast lesions (3). Breast magnetic resonance imaging (MRI) is an advanced imaging method with high sensitivity for detecting invasive carcinoma.

This narrative paper reviews imaging methods of the breast. Additionally, it describes the advantages and disadvantages of the various methods, such as the energy they rely on, ionization, contrast material requirements, imaging plans, real-time imaging, acquisition time, anatomical coverage, availability, operator dependency, and soft-tissue contrast. Furthermore, diseases of the breast, breast cancer screening, and axilla and the male breast are discussed.

Mammography

MG is the principal imaging (diagnostic and screening) modality for the breast. MG provides 2-dimensional data, shows the breast globally, and can be used to examine findings suspicious for breast carcinoma (4). X-rays are used for the acquisition of MG.

The breast is composed of fatty, glandular, and connective tissue and has a relatively narrow range of densities. MG illustrates microcalcifications, their number, and shape (5). To show minimal differences or subtle abnormalities and to obtain high-contrast images, lower-energy X-rays are required.

Tungsten is not appropriate because it creates higher-energy X-rays. To obtain lower-energy X-rays, molybdenum anode material is used in the X-ray tubes. The spectrum of the X-ray is narrowed further by filters. Modern MG devices provide the ability to determine appropriate target/filter combinations, automatic dose exposure control, and kilovolt peak and current modulation based on the breast content and the thickness (6).

Compression of the breast is needed for optimal MG because:

- Radiation dose and scatter are reduced.
- Superimposition of breast tissues is diminished.
- Contrast is improved; unsharpness is reduced with both shorter exposure time and immobilization of the breast.

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Table 1. Advantages/disadvantages of breast imaging modalities

	Imaging modality							
	DMG	**DBT**	**CEM**	**US**	**CDUS**	**SE**	**MRI**	**DWI**
Energy	X-rays	X-rays	X-rays	High-frequency sound waves	High-frequency sound waves	High-frequency sound waves	Radiofrequency waves	Radiofrequency waves
Source	Absorption and penetration of X-rays	Absorption and penetration of X-rays	Absorption and penetration of X-rays	Transmission, refraction, and reflection of sound waves	Transmission, refraction, and reflection of sound waves	Transmission, refraction, and reflection of sound waves	The body's natural magnetic properties	Diffusion of water molecules
Ionization	Yes	Yes	Yes	No	No	No	No	No
Contrast material	No	No	Yes	No	No	No	Yes	No
Imaging plane	Superposition /2D	Quasi3D	Superposition/2D	Cross-sectional /3D	Cross-sectional /2D	Cross-sectional /2D	Cross-sectional /3D	Cross-sectional/ 2D/3D
Real-time imaging	No	No	No	Yes	Yes	Yes	No	No
Acquisition time	Short	Short	Short	Long	Relatively long	Relatively long	Long	Short
Anatomic coverage	Wide (whole breast)	Wide (whole breast)	Wide (whole breast)	Narrow	Narrow	Narrow	Wide (bilateral whole breast)	Wide (bilateral whole breast)
Widely available	Yes	No	No	Yes	Yes	No	No	No
Operator dependency	Low	Low	Low	High	High	High	Low	Low
Soft-tissue contrast	Low	Low	Low	High	High	High	High	Low

2D: Two dimensional; 3D: Three dimensional; CDUS: Color Doppler ultrasonography; CEM: Contrast-enhanced mammography; DBT: Digital breast tomosynthesis; DMG: Digital mammography; DWI: Diffusion-weighted imaging; MRI: Magnetic resonance imaging; SE: Sonoelastography; US: Ultrasonography

The indications for MG are:

- Screening
- Diagnosis
  - Any signs and symptoms suggestive of breast carcinoma for males or females
  - Follow-up of formerly treated breast carcinoma patients
- Interventional procedures
  - Guidance
  - Localization of MG-only lesions

The mediolateral oblique (MLO) and craniocaudal (CC) views are standard MG projections (4). The MLO view is obtained with the X-ray beam directed from the superomedial to the inferolateral compressed breast positioned perpendicular to that plane. During acquisition of the CC view, the X-ray beam is perpendicular to the ground directed at a horizontally compressed breast.

The purpose of MG screening is to detect breast carcinoma at an early stage. However, breast composition is heterogeneous and can differ significantly between women. The absence of a consistent normal pattern can prevent the identification of abnormal findings. Therefore, the breast composition must be defined for each individual woman. Four types of glandular density have been defined (Fig. 1):

- Type A: Almost fatty
- Type B: Dispersed glandular densities
- Type C: Heterogeneously dense breast
- Type D: Very dense breast

Glandular tissue, masses, and carcinomas appear as areas of bright, high density on MG images. A dense breast means not only the possibility of some abnormalities remaining hidden, but also a slight increase in the risk of breast carcinoma (7). Every patient should be informed about their breast composition.

On MG, masses, clustered calcifications, asymmetries, and architectural distortion should be examined, and in general, abnormal findings must be further evaluated with additional projections and/or US. Additionally, every annual mammographic control should include a comparison of the previous and new mammograms side by side, not merely the interpretation reports, and if necessary, an US recommendation should be made. Subtle abnormalities may only become visible with this additional inspection.

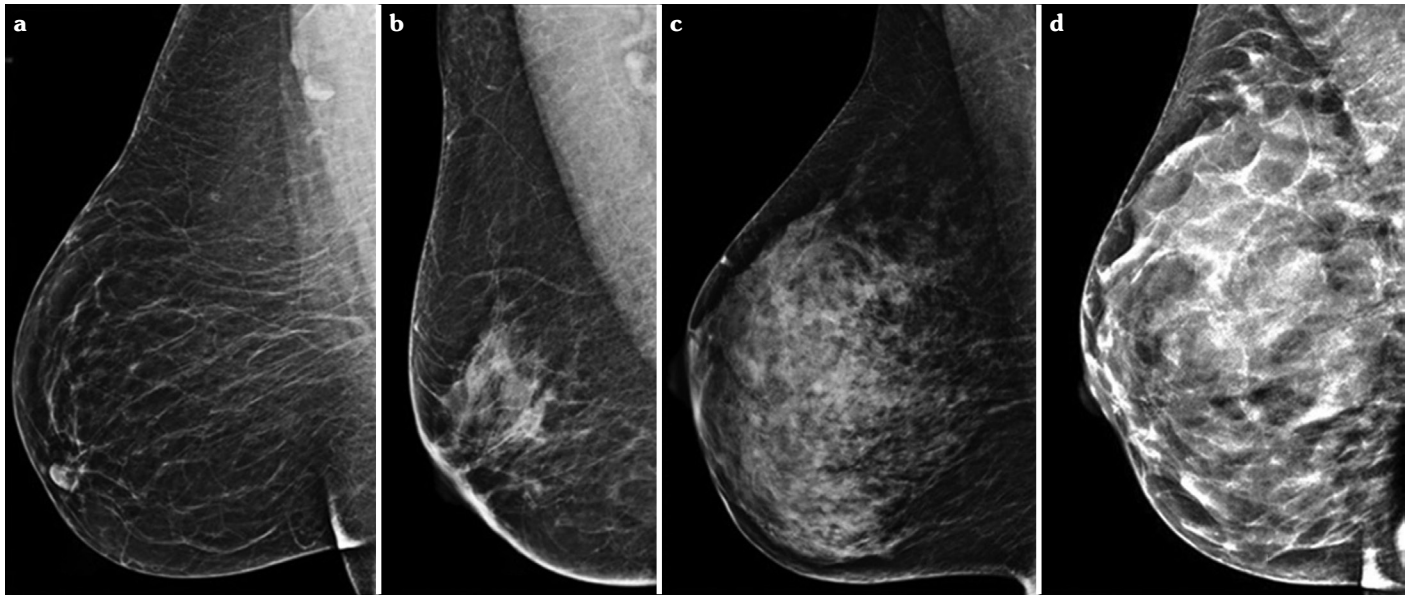

Figure 1. Breast density. Illustrations of the four breast density categories: Type A is almost entirely fatty, Type B has scattered glandular densities, Type C is a heterogeneously dense breast, and Type D is an extremely dense breast. Increased density can hide subtle and even major abnormalities

Classic findings of breast carcinoma on MG are (Fig. 2):

- Spiculated or irregular mass
- Microcalcifications (clustering, dense, pleomorphic)
- Architectural distortion
- Asymmetry

Enlarged axillary lymph nodes, ductal dilatation, skin-areola-nipple changes, edema, or increased vascularity are secondary signs.

The usage of X-rays means applying ionizing radiation. The mean effective radiation dose of MG corresponds to 61 days of average natural background radiation (6). Modern MG devices yield high-quality images with low doses of radiation.

Digital Mammography

Digital MG images are obtained via picture archiving and communication systems (PACS) just after the acquisition. PACS provide advanced image storing, viewing, and reporting options using high-resolution (5-MP) screens (6). These features provide better average image quality with less workload than screen/film MG imaging.

The overall diagnostic accuracy of digital and screen/film MG is similar. However, for some situations, digital MG is considerably superior because it provides better diagnostic accuracy (6, 8):

- Women <50 years of age
- Heterogeneously dense or extremely dense breasts
- Pre- or peri-menopausal period

Digital Breast Tomosynthesis

MG creates 2-dimensional images; the superimposition of normal glandular tissue might obscure a possible tumor. Alternatively, the superimposition of normal tissue may simulate an abnormality and lead to unnecessary recalls for further investigation with additional projections and/or US (9). This can lead to false-negative or false-positive results, additional cost and workload, and unnecessary patient anxiety.

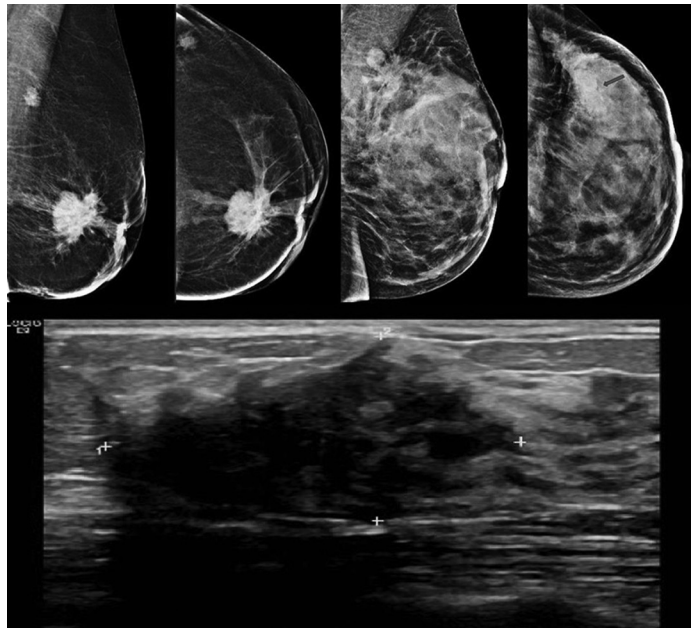

Figure 2. Breast carcinomas. Two breast carcinoma cases illustrating the difference between fatty and dense breasts on a mammography image. Above: mediolateral oblique and craniocaudal views. For the patient with fatty breast density (left), the high density, spiculated mass is clear. The mass causes architectural distortion and areola-nipple retraction. However, the mass on the images to the right is hidden under glandular tissue. Some density increase (arrow) and distortion are prominent. Below: Ultrasonography reveals suspicious features of the mass more clearly. Both patients have suspicious lymph nodes at the anterior axilla

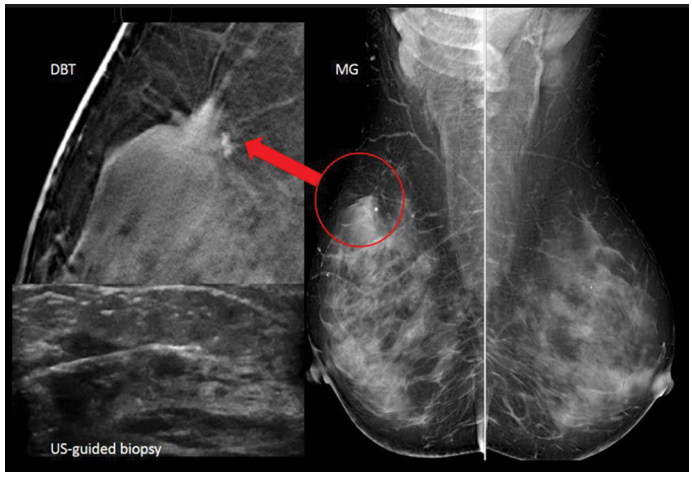

Figure 3. Digital breast tomosynthesis for breast carcinoma. A 42-year-old female patient with breast carcinoma. A dense breast pattern is seen. Digital breast tomosynthesis (DBT) shows the mass and its spiculated margins more prominently than digital mammography (MG). On MG, it is not easy to see the carcinoma. Ultrasonography-guided biopsy confirmed the diagnosis of carcinoma

Digital breast tomosynthesis (DBT) is an emerging digital MG procedure. Thin slices of the breast are reconstructed from multiple low-dose projections acquired at varying angles of the X-ray tube (6). This can provide 3-dimensional images of the breast.

- DBT increases the carcinoma detection rate (9).
  - DBT is superior to MG in determining mass and distortion.
  - It defines the edge properties of the masses more accurately (Fig. 3).
  - DBT is superior to MG in assessment of disease extent (multifocal, multicentric, bilateral disease).
- DBT can reduce the number of recalls due to the ability to eliminate false asymmetries due to overlapping tissues (10, 11).
- DBT's potential to detect and characterize microcalcification is similar to that of digital MG (12).
- DBT is tolerable (13).

X-ray is used for DBT as well. Two projections of MG and 2 projections of DBT tomosynthesis double the radiation dose. However, this increase still does not exceed the recommended limits (United States Food and Drug Administration safety limits of 3mGy/view) (9).

Contrast-Enhanced Mammography

Breast carcinoma has high micro-vessel density due to neo-angiogenesis, and these vessels have pronounced permeability. This leads to prominent contrast enhancement within malignant lesions. Contrast-enhanced MG using a dual-energy method is performed following intravenous injection of iodinated contrast material. This technique provides information about anatomic and physiologic abnormalities. The combination provides superior sensitivity and specificity in diagnosing breast carcinoma than digital MG alone (14). The information obtained using contrast-enhanced MG is analogous to a breast MRI, but with a shorter acquisition time and less expense.

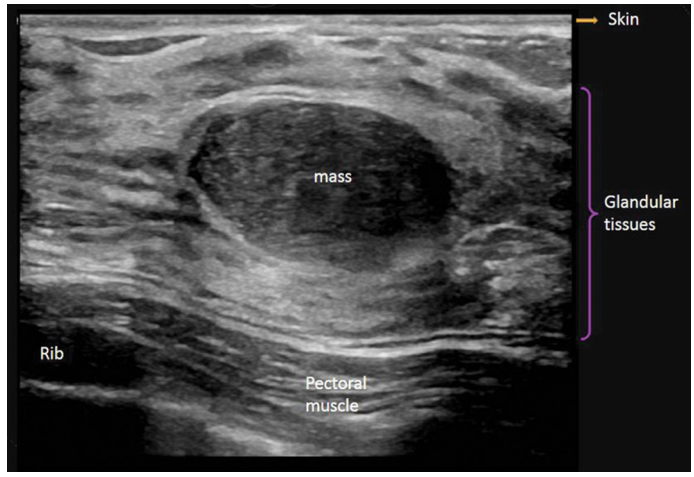

Figure 4. Breast ultrasonography. The first superficial echogenicity is the skin. There is a thin layer of fatty low echogenicity. Under the fat tissue, there is a thick layer of glandular tissue. A well-bordered, hypoechogenic, relatively homogenous mass (possibly benign), can be seen located centrally within the glandular tissue. The pectoral muscle and rib are visible in the deep plane

Ultrasonography

US uses high-frequency sound waves to examine biological tissues (Fig. 4). No ionizing radiation is used. The main indications for breast US are:

- Evaluation of symptomatic females or males (palpable changes, skin dimpling, nipple discharge, breast pain or tenderness)
- Primary imaging for women under 30 years of age, lactating, or pregnant
- Complementary evaluation of MG or MRI (second-look) abnormalities
- Guidance for biopsy, marking, and wire localization

The probe sends US waves to the body and collects reflected echoes from the tissues (15). High-quality, linear probes with high-resolution (7.5–15 MHz) are required for grey-scale imaging of the breast. Harmonic and compounding options enhance the display by contributing contrast and spatial resolution, respectively (15).

Classic findings of breast carcinoma on US are:

- Spiculated or irregular, extremely hypoechoic, taller-than-wide lesions
- Echogenic desmoplastic reaction surrounding the mass
- Acoustic shadowing

Enlarged axillary lymph nodes, ductal dilatation, skin-areola-nipple changes, or increased vascularity are secondary signs.

Color Doppler Ultrasonography

Color Doppler US is an advanced US tool that reveals vascular properties within both normal anatomical structures as well as lesions. Moving blood in the vessels changes some characteristics of the echoes, which allows for the measurement of some distinctive qualitative and quantitative features.

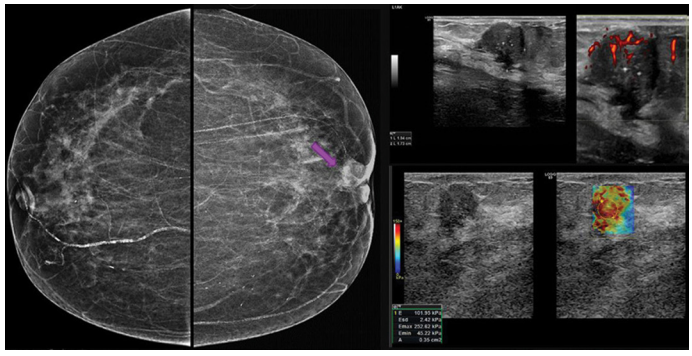

Figure 5. Breast carcinoma. There is an irregular suspicious mass (arrow) in the subareolar region of the left breast close to the nipple. Ultrasonography, Doppler, and elastography show an irregular, stiff, vascular lesion (red code). Core biopsy confirmed the diagnosis of breast carcinoma

Breast carcinoma shows increased Doppler signals. Abnormal vessels of breast carcinoma are irregular and centrally penetrating. Benign lesions are likely to demonstrate the displacement of normal vessels around them. Decreased resistive index and increased flow volume (low-resistance flow pattern) are associated with malignant lesions (16).

Elastography

Elastography is an advanced US technique to demonstrate tissue stiffness (15). Malignant lesions will be stiffer (elasticity >80 kPa) than the surrounding breast tissue or benign breast lesion (Fig. 5). Two methods of elastography are:

- Strain elastography (relies on manual compression)
- Shear wave elastography (the transducer produces transverse shear wave transmissions)

The major benefits of shear wave elastography are that it is more objective, quantitative, and reproducible than strain sonoelastography.

Magnetic Resonance Imaging

MRI uses the inherent magnetic properties of protons (hydrogen ions) in biological tissues. It provides detailed images with excellent soft-tissue contrast. MRI does not cause ionization, however, safety is an important concern due to the high magnetic field of the machine. Safety issues should be reviewed before ordering an MRI for patients.

Dynamic contrast-enhanced MRI is the most sensitive and accurate imaging method used for the detection and local staging of breast carcinoma (17). However, cost, examination time, and contrast material usage have limited the widespread use of this method (18).

Indications are:

- Screening for high-risk women
- Diagnosis
  - o Extent of breast carcinoma
  - o Treatment response (higher accuracy for HER2+ or triple-negative tumors)
  - o Implant evaluation
- Interventional procedures

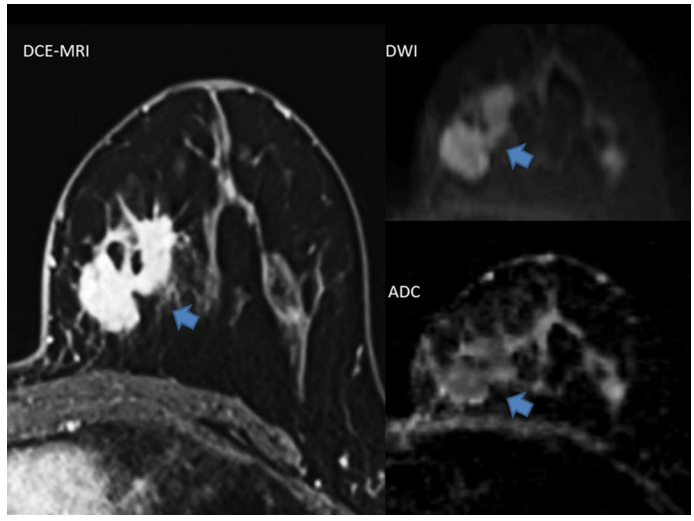

Figure 6. Breast carcinoma. A 52-year-old female patient with breast carcinoma. Dynamic contrast-enhanced (DCE) magnetic resonance image (MRI) shows an intensely enhanced spiculated mass. The lesion is hyperintense (bright) on diffusion-weighted imaging (DWI) and hypointense (dark) on the apparent diffusion coefficient (ADC) map. The lesion is restricting diffusion

Breast MRI provides the most detailed information about the lesions (cellularity, molecular properties, and vascularity) using various and comprehensive imaging tools and conventional sequences (T1, T2, TIRM), contrast-enhanced (dynamic and perfusion) studies, diffusion-weighted, diffusion tensor and diffusion kurtosis imaging, intravoxel incoherent motion, and magnetic resonance spectroscopy (19–21).

Classically, malignancies have spiculated borders, heterogeneously-intense-peripheral enhancement, fast contrast intake and fast contrast release (wash-out pattern), diffusion restriction, and high cellularity.

Diffusion-weighted Imaging

Diffusion-weighted imaging (DWI), a non-contrast MRI tool, uses the motion of water in vivo to reflect microscopic tissue structure: cellularity, membrane integrity, viscosity, sheaths, fibers, tubules, and macromolecules (20). Diffusion in biological tissue is not free and is quantified using the apparent diffusion coefficient (ADC). ADC is the mean distance a water molecule moves per second. ADC maps are generated mathematically from DWI.

Breast DWI has been reported to reduce false-positive results and excessive biopsies and provide accuracy for lesion characterization. In general, breast carcinoma displays limited diffusion through high signal intensity on DWI and low ADC values. This feature is related to increased cell concentration and decreased extracellular space (Fig. 6). Mastitis, abscess, bleeding, and intense proteinaceous content can also show limited diffusion (20).

Common Breast Pathologies

Ductal Dilatation

Ductal dilatation refers to nonspecific dilatation of one or more ducts, and is predominantly seen in the subareolar region. By definition, the diameter of a duct is typically >2 mm or >3 mm in the ampulla

(behind the areola). The cause of benign ductal dilatation is not well understood; however, periductal inflammation is often seen (22).

MG illustrates ductal dilatation as tubular densities diverging from the nipple-areolar complex. A sonographic evaluation demonstrates anechoic tubular structures that narrow peripherally.

Cysts

A cyst is the most common radiologic finding for pre-menopausal women. They often occur in multiples and bilaterally. Simple cysts have no malignant potential and do not require close follow-up.

Breast cysts are the most common imaging finding. A simple breast cyst is classically a well-bordered, anechoic lesion with an indiscernible wall and posterior acoustic enhancement. The second type, a complicated breast cyst, contains intracystic echoes or debris with other features of a simple cyst; they may be infected or hemorrhagic. No intervention is required for a simple or complicated cyst unless it causes unbearable pain. Thirdly, a complex breast cyst is a neoplastic cyst with thick walls, thick septa, or an intracystic solid mass. This type requires sampling.

On MG, the simple cyst is generally a well-bordered round or oval mass with low density. US findings typically include well-defined borders and an oval or round shape. They are anechogenic masses with posterior acoustic enhancement. Thin septations and intense content are not suspicious findings. MRI shows fluid intensity, thin septations, simple or intense content, and no enhancement.

Fibroadenoma

Fibroadenomas are the most common solid mass encountered in pre-menopausal women. On MG, fibroadenomas generally appear as well-bordered, rounded, or oval masses. Macro-calcifications may be seen within older fibroadenomas. US findings will be hypoechogenic, oval, well-bordered, vascular, soft masses lying parallel to the skin. The principal differential diagnosis is well-circumscribed carcinoma, which can be achieved with a percutaneous biopsy. MRI will usually reveal a fibroadenomas as a well-bordered, homogenously enhancing mass with un-enhancing septations. Diffusion features vary.

Invasive Carcinoma

The most common type of breast carcinoma is invasive ductal carcinoma. It originates from the epithelial cells of the terminal duct lobular unit. If the basement membrane remains intact, it is classified as ductal carcinoma in situ (DCIS). Invasive malignancy describes a disruption of the barrier.

On MG, in general, breast carcinoma is seen as a dense, spiculated mass that creates parenchymal distortion. Some more aggressive, rapidly growing tumors may have relatively circumscribed borders, like a fibroadenoma. A percutaneous biopsy will provide a diagnosis. On US, breast carcinoma is an ill-defined or spiculated mass and is markedly hypoechoic. There is increased vascularity and a high stiffness value. MRI demonstrating peripherally intense enhancement, an irregular or spiculated mass with wash-out kinetics, and limited diffusion raises the suspicion of carcinoma.

Ductal Carcinoma in Situ

Breast carcinoma is believed to originate as DCIS. One of the most basic findings of DCIS MG is used to search for is microcalcifications. MG will reveal a DCIS lesion based on suspicious microcalcifications, asymmetric density, mass, and architectural distortion (23). When recognized, US should be performed to assess for invasion.

Calcified DCIS frequently displays echogenic foci inside a mass or duct, with internal micro-lobulations or a branching pattern. Non-calcified DCIS can be seen as a hypoechoic microlobulated mass or have a "pseudomicrocystic" appearance (24).

While calcified DCIS can be detected with MG, non-calcified components will show contrast enhancement on MRI. Non-mass, clumped enhancement in a ductal or segmental distribution of enhancement may be associated with DCIS (25). Enhancement kinetics or diffusion properties may vary.

Atypical Ductal Hyperplasia

Atypical ductal hyperplasia presents a high risk for breast cancer. Radiologic features are not definite, and it can initiate in a papillary lesion or within a fibroadenoma. MG may reveal grouped, amorphous, linear, or regionally distributed microcalcifications. US can occasionally detect atypical ductal hyperplasia based on irregular, tiny, hypoechoic findings, a mass with microlobulation, no posterior acoustic changes, and a parallel orientation to the skin. On MRI, a non-mass enhancement is more common (26).

Lobular Neoplasia

Lobular neoplasia (LN) is a nonobligate precursor for breast cancer. The lesions are frequently multicentric and bilateral. According to the World Health Organization classification, atypical lobular hyperplasia and lobular carcinoma in situ constitute the majority of lesions and differentiation is based on the extent of the involvement of lobular units. LN has no characteristic clinical or imaging expressions; it is generally found incidentally during breast biopsies. On MG, amorphous microcalcifications with grouped distribution, and less frequently, a mass, architectural distortion, or asymmetry, may be encountered. On US, an avascular, irregular, hypoechoic mass or area of shadowing may be seen. Contrast-enhanced MRI may reveal a non-mass enhancement (26).

Sclerosing Adenosis

Sclerosing adenosis is a benign, usually asymptomatic lobulocentric proliferative process that involves both the epithelial and the mesenchymal components. The majority show distortion or calcifications on MG, heterogenous hypoechogenic nodules on US, and mass-like lesions on enhanced MRI (27).

Radial Scar and Complex Sclerosing Lesion

A radial scar (RS) is a focus of <10 mm while complex sclerosing lesion (CSL) refers to a lesion that is >10 mm and has more complex features. On MG they consist of a radiolucent star-shaped lesion. Additional characteristics are varying distortion on altered projections, asymmetry, and no palpation finding. Calcifications are common. The US appearance of RS is inconstant, ranging from no clear correlate to a hypoechoic, irregular mass with indistinct margins, or a focal area of shadowing with no associated mass. The MRI appearance is similarly variable: a mass or non-mass enhancement with regional, homogeneous enhancement, and a Type 3 enhancement kinetic curve (26).

Papillary Lesions

Papillary lesions are infrequent. This pathology includes solitary and multiple intraductal papillomas, papillomas with atypia, pa-

pillomas with DCIS, and papillary invasive carcinomas. Clinically, they may be asymptomatic, or when symptomatic, may be a palpable mass close to the nipple or may cause bloody discharge. On MG, asymmetric areas of increased density, dilated ducts, or solitary lesions associated with microcalcifications may be observed. Breast US and Doppler or elastography tools are critical for the diagnosis of papillomas: a well-bordered, intracystic/ductal mass. The fibrovascular stalk and stiffness of the lesion can be further evaluated with US. MRI allows for a detailed delineation of the lesion and its relationship to the ductal system (26).

Idiopathic Granulomatous Mastitis

Idiopathic granulomatous mastitis is a benign, chronic, inflammatory disease of the breast. The incidence is increasing all around the world. The diagnosis should be confirmed pathologically to rule out carcinoma and provide appropriate management (28).

Idiopathic granulomatous mastitis presents with signs of mastitis or a mass, and is often seen in pre-menopausal women. The initial evaluation is done by US. Thickening of the skin, an irregular hypoechogenic mass with tubular extensions, smooth-edged hypoechogenic mass, hypo-hyperechogenic-heterogeneous mass, masses that tend to coalesce, heterogeneous parenchyma, parenchymal edema, distortion, acoustic shadowing, abscess, sinus tract formation, or lymphadenopathy may be detected. The lesions are generally soft on elastography (28). MRI is a follow-up tool in aggressive, diffuse, and unresponsive cases.

Breast Cancer Screening

Screening programs are often used to address important health problems. There is a period when the disease is silent but can be caught, and early detection provides advantages in terms of treatment. Screening tests provide an effective, accurate, and convenient means of reducing greater consequences. Breast carcinoma is an example. It is the most common carcinoma in women, has a long pre-invasive period, early detection decreases the treatment burden, and MG is an effective and accurate screening method.

The Society of Breast Imaging, the American College of Radiology, and the National Comprehensive Cancer Network recommend annual MG screening beginning at the age of 40 years for women at average risk for breast carcinoma to find any suspicious lesion as early as possible. Routine annual MG screening should be performed between the ages of 40-70. After the age of 70, the benefits are less clear (29). In addition, women should be informed about their breast density, especially if they have heterogeneously dense or extremely dense breasts. This kind of condition slightly increases the risk of breast carcinoma and reduces the sensitivity of imaging methods. US should be added as a complementary screening method.

MG screening has provided a substantial reduction in the disease-specific mortality rate. The benefits of screening and early diagnosis of breast carcinoma has been demonstrated in numerous randomized controlled studies. In Turkey, a breast carcinoma screening program started in the early 2000s within specialized carcinoma screening centers (Cancer Early Diagnosis, Screening, and Education Center [KETEM]) (30).

Interventional Breast Radiology

Breast radiology requires skills not only related to imaging modalities but also US and X-ray stereotactic-guided interventional procedures. Currently, suspicious lesions should be sampled before any excisional procedures or surgeries. A needle biopsy is highly accurate in determining the nature of most breast lesions and is now used instead of an open surgical biopsy.

A needle biopsy can provide accurate details of histological type and grade, and allows for assessment of tumor biology, cell markers, and genetics in cases of breast carcinoma.

The interventional methods used in breast radiology units are:

- Fine-needle aspiration for cytology
- Needle core biopsy for histology
- Hook-wire localization
- Lesion marking
- Vacuum-assisted biopsy
- Local excision systems-ablations

If possible, a suspicious breast lesion should be sampled using US guidance. US guidance is fast, provides real-time imaging, contains no ionizing radiation, and provides greater patient comfort due to the lack of breast compression.

The Axilla

The axilla contains skin, subcutaneous fat tissue-connective tissue, neurovascular structures, and lymph nodes. The region is associated with the skin, lungs, upper extremities, and breasts. Therefore, numerous pathologic conditions may affect the axilla. Axillary lymph node involvement is of great importance in determining the stage of breast carcinoma. Axillary lymph node biopsies are important in the diagnostic evaluation of cancers including breast cancer, lung cancer, and melanoma. Abnormal lymph nodes have a rounded configuration, a thickened cortex, and hilar loss. A biopsy of a suspicious lymph node should be performed for an accurate diagnosis.

MG is not sufficient for a complete axillary evaluation as it shows the anterior axilla. US is useful in the evaluation of non-palpable anterior nodes and palpable lymph nodes at all levels. Besides detecting all axillary pathological lymph nodes, MRI can also evaluate internal mammary and supraclavicular lymphadenopathies.

The axillary lymph nodes are divided into 3 levels according to the relationship to the pectoralis minor muscle:

- Level I is located at the anterior axilla, below the lateral border of the pectoralis minor muscle.
- Level II is located between the pectoralis minor and pectoralis major muscles.
- Level III is located at the apical axilla (infraclavicular lymph nodes).

Lymphatic drainage usually takes place from Level I to Level II, and from there to Level III. Skip metastases rarely occur. The internal mammary path may become involved with carcinoma located in the inner quadrants of the breast.

Male Breast

Most of the male breast pathologies are benign. Gynecomastia is the most common reason for a palpable, tender, subareolar mass in men. In general, MG is the first-line imaging modality for a male patient with a palpable mass. US can be performed to assess an MG abnormality (31).

CONCLUSION

In summary, principal screening modality used for the main population. MG and US are the primary diagnostic modalities for a suspicion of breast carcinoma in women and men, however, MRI is the most sensitive and accurate modality. A percutaneous breast biopsy should be performed for every suspicious lesion.

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