

ABSTRACT

Background: Radiologic evaluation of breast lesions is being achieved through several imaging modalities. Mammography has an established role in breast cancer screening and diagnosis. Still however, it shows some limitations particularly in dense breast.

Methods : Magnetic resonance imaging is an attractive tool for the diagnosis of breast tumors¹ and the use of magnetic resonance imaging of the breast is rapidly increasing as this technique becomes more widely available.¹ As an adjunct to mammography and ultrasound, MRI can be a valuable addition to the work-up of a breast abnormality. MRI has the advantages of providing a three-dimensional view of the breast, performing with high sensitivity in dense breast tissue and using non-ionizing radiation.²

Results : Recent advances in MRI have shown the potential in bridging the gap between

sensitivity and specificity. Methods based on differences in physiological, cellular and biochemical characteristics of malignant, benign and normal tissues were developed to monitor changes in diffusion. Among these techniques is diffusion-weighted MRI (DWI).³

Diffusion-weighted magnetic resonance imaging detects Brownian motion of water protons, thus reflecting the biologic character of tissue. The apparent diffusion coefficient (ADC) is used to quantify the Brownian motion⁴⁻⁵

Conclusion : The use of DWI for breast tumors has recently been considered in clinical application, and many studies have shown lower ADC values for breast cancer compared to normal breast tissue or benign tumors³.

Keywords : MR imaging , Demonstration, breast

Introduction

Diffusion-weighted MRI imaging detects early changes in the morphology and physiology of tissues associated with changes in water content, such as changes in the permeability of cell membranes, cell swelling, and/or cell lysis⁴⁻⁵.

Areas of diseased tissue are highlighted with increased signal intensity on diffusion-weighted MR imaging. A decrease in the ADC is expected with increased intracellular tissue caused by either cell swelling or increased cellular density⁴⁻⁵.

The apparent diffusion coefficient (ADC) is related to the molecular translational movement of water molecules. This movement is limited in an environment that contains structures as molecules and cell membranes. Diffusion has been shown to decrease in tissues with high

cellularity. Malignant tumors in general have a higher cellularity than benign lesions.⁶

Diffusion-weighted imaging has a potential role for the characterization of breast mass and treatment monitoring after chemotherapy^{7,8}.

Methods

Breast imaging modalities:

1. Mammography.
2. Ultrasonography
3. Galactography.
4. Magnetic Resonance Mammography (MRM).
5. Computed Tomography (CT).
6. Positron Emission Tomography (PET)

The American College of Radiology BI-RADS⁹

BI-RADS® is a quality assurance guide designed to standardize breast imaging reporting and facilitate outcome monitoring. BI-RADS® serves as a comprehensive guide providing standardized breast imaging terminology, report organization and assessment structure, as well as a classification system for mammography, ultrasound, and magnetic resonance imaging

(MRI) of the breast. It is a systematic method for radiologists to report mammogram findings using 7 standardized categories, or levels. Each BI-RADS® category has a follow-up recommendation associated with it to help radiologists and other physicians appropriately manage a patient's care. (Table 1)

1- Mammography

Mammography has been described as a science of imaging and the art of positioning. The sensitivity of mammography is

dependent on the capabilities and limitation of the equipment, anatomic and patient factors,¹⁰

2. Ultrasonography

2.1. B-mode ultrasonography

2.2. Doppler US

2.3. Contrast-enhanced ultrasonography

2.4. US elastography:

3- Galactography (Ductography)

Definition

It is visualization of the lumen of the milk duct after cannulation and injection of contrast material for imaging. It is an underused procedure that often helps define the cause of unilateral, single-pore, spontaneous nipple discharge. It has been called the "diagnostic procedure of choice" in the evaluation of nipple discharge.^{11, 12}

The Galactography is an x-ray examination that uses mammography for examining breasts, and a contrast material to obtain pictures, called galactograms, of the inside of the breast's milk ducts.¹²

4-Magnetic Resonance Mammography (MRM)

MRI Anatomy of the Breast

results

The anatomy of the breast can be precisely demonstrated with magnetic resonance imaging (MRI). Areas of the breast that have been previously beyond the limits of conventional imaging, such as the extreme posterior breast and chest wall musculature, can be evaluated. Normal structures, such as vessels and lymph nodes, are clearly seen, particularly with the help of intravenous contrast. An understanding of the normal structures and anatomy of the breast is essential to the proper interpretation of breast MRI.¹³

On non-fat-suppressed T₁-weighted pre-contrast images, fat is high in signal intensity and the breast parenchyma is intermediate signal intensity. Fat can obscure contrast enhancement if not suppressed by some method. Fat suppression can be achieved by subtraction imaging so that the signal from fat is subtracted and only the contrast enhancing areas of the breast remain.¹³

Fibrous tissue is generally low in signal intensity. Foreign objects, such as metallic clips, produce signal void and are very dark. Calcifications, if large enough, can be seen as very low signal. Benign breast calcifications, such as those seen in sclerosing adenosis or fibrocystic changes, are rarely imaged on breast MRI.¹³

Advantages of MRM:

- (1) Multiplanar and multiparametric capabilities.
- (2) Its high sensitivity to inherent differences among normal and pathological tissues (tissue characterization).
- (3) Its capacity to acquire good spatial resolution.
- (4) The absence of ionizing radiation or any known adverse biologic effect.
- (5) Useful in characterization of small lesions.
- (6) Can be useful in dense breasts.
- (7) Can detect cutaneous anomalies as neurofibromatosis.¹⁴

The general requirements of an MR imaging system for breast imaging:

• The ability to survey, in a single acquisition an entire breast (19 or more slices), with 3 mm or thinner sections with an in-plane resolution of under 1 mm. It must also have the capability of obtaining two or more echoes simultaneously, MR images of the breasts are obtained using a dedicated breast coil which ensures a high signal-to-noise ratio and allows reduced slice thickness and optimum spatial resolution

• A T₁-weighted 3D FLASH sequence is used and the breasts are imaged before, and at one minute intervals following IV gadolinium-DTPA for four

minutes post injection. Detection of enhancing lesions is made easier if subtraction images are obtained using appropriate software.¹⁴

MRM and Ductal Enhancement

One of the criteria used by some to define breast cancer is a pattern of enhancement that investigators believe represents a duct or a series of ducts that enhance. This can represent DCIS or can even be the finding in invasive breast cancer. As with many signs, however, it is not specific, and many benign changes can produce ductal enhancement. The 3D MIP image clearly shows the segmental distribution of abnormal contrast enhancement. In my experience this pattern is often seen with extensive cancers.¹⁵

Indications of MRM:

- 1) The definite proof of malignant tumor and the exclusion of malignant tumor.
- 2) The status after radiation or operation after more than 6 months, the differentiation between scars and recurrent cancer, detection of response to therapy and pre-operative surgical planning.
- 3) The detection of multifocality/multicentricity.
- 4) The delineation of implants and possibly the search for the primary tumor when lymph node metastases have been detected.
- 5) MRM is used in all patients where there is a discrepancy between the radiographic, sonographic and clinical findings. These cases include:
 1. The Patients with dense breasts and clinically unclear findings (excluding cases where pathological lesion has been accurately identified by other imaging modalities).
 2. Density asymmetry.
 3. Unclear microcalcifications.
 4. Before proposed surgery, radiotherapy or plastic surgery.
 5. Pregnancy (early stages).
 6. Carcinophobia.
 7. Before a planned biopsy, as the great majority of biopsies performed on the basis of suspicious conventional mammogram have a non-malignant result.¹⁶

magnetic resonance (MR) imaging and has a high sensitivity in the detection of changes in the local biologic environment. A significant advantage of diffusion-weighted MR imaging over conventional contrast material-enhanced MR imaging is its high sensitivity to change in the microscopic cellular environment without the need for intravenous contrast material injection. In addition, the analysis of apparent diffusion coefficient (ADC) value can be undertaken either in isolation or in combination with diffusion-weighted and T₂-weighted imaging.¹⁷

The apparent diffusion coefficient (ADC) values are measured to estimate the degree of diffusion¹⁸

Water molecules in a sample are excited with the imposition of a strong magnetic field. This causes many of the protons in water molecules to precess simultaneously, producing signals in MRI. In T₂-weighted images, contrast is produced by measuring the loss of coherence or synchrony between the water protons. When water is in an environment where it can freely tumble, relaxation tends to take longer. In certain clinical situations, this can generate contrast between an area of pathology and the surrounding healthy tissue.¹⁹

In diffusion-weighted images, instead of a homogeneous magnetic field, the homogeneity is varied linearly by a pulsed field gradient. Since precession is proportional to the magnet strength, the protons begin to precess at different rates, resulting in dispersion of the phase and signal loss. Another gradient pulse is applied in the same direction but with opposite magnitude to refocus or rephase the spins. The refocusing will not be perfect for protons that have moved during the time interval between the pulses, and the signal measured by the MRI machine is reduced. This reduction in signal due to the application of the pulse gradient can be related to the amount of diffusion that is occurring.¹⁹

Other MRI techniques

has also been detected in metastatic nodes in patients with breast cancer. According to these initial results, proton spectroscopy could be complementary to other MRI methods.²⁰

MR elastography is a new imaging modality that produces images with a contrast proportional to the stiffness of the tissue, as in US elasticity imaging. It has been predicted to become a potential adjunctive tool for both lesion detection and characterization.²⁰

5-Computed Tomography (CT)

The most efficacious role for CT for breast evaluation lies in:

1. Its ability to image the deep structures of the breast close to the chest wall .
2. The simultaneous detection of affected internal mammary lymph nodes, malignant microcalcifications, retromammary spaces and axillary details are well demonstrated by body scanner.
3. It is useful in staging of breast cancer and detection of metastases.
4. Locally recurrent breast carcinoma
5. ct guided percutaneous needle biopsy may be helpful .
6. The disadvantage of requiring radiation of the entire thorax, and resolution is limited because of the large field of view.²¹

6- Positron Emission Tomography (PET)

Early PET imaging studies in patients with breast cancer used ¹¹C- or ¹⁵O-labeled tracers to determine blood flow to the tumor or oxygen extraction or utilization by tumors. An alternative radiopharmaceutical for PET has been 18F-fluoro-17-(β -estradiol, with specificity for the estrogen receptors expressed on many breast cancers. PET showed uptake of the radiotracer in the primary breast mass and the axillary nodes in 93% of estrogen receptors. Cancers generally have altered metabolism compared with normal tissue, which potentially can be detected by using specific metabolic tracers labeled with positron emitters. The tracer most useful in PET studies of tumors to date, has been one that shows the over consumption of glucose by the tumor cells.²²

Breast pathologies

• Benign breast disorders:

1-Fibroadenoma:

Fibroadenomas are the most common solid benign lesions of the breast which develop

under the hormonal

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influence of estrogen. Masses may be single or multiple, involving one or both breasts.

Milk ducts can dilate (swell) and the walls may thicken, so much so that the flow of fluid is blocked..

Fibroadenomas have a variable appearance at MR imaging. About half of the lesions demonstrated T₂ hyperintensity and enhancement and almost as many demonstrated low T₂ signal intensity and no enhancement. T₂ hypointensity was observed in the lesions of older patients, a finding that was associated with more sclerotic stroma at histopathologic analysis. Fibroadenomas are low in signal intensity on T₁-weighted images and hyperintense on T₂-weighted images. Most fibroadenomas demonstrate a benign enhancement pattern, with slow initial enhancement and delayed wash out.

Mammographically, the dilated ducts usually appear as tubular, serpentine structures converging towards the nipple in the subareolar region. Calcifications may be present within or around ducts.

The typical appearance in US is a dilated duct in the subareolar region which may not be entirely echo free because it contains cellular debris or lipids.²⁵

.⁶⁰.The ADCs of fibroadenomas range from 1.41 $\times 10^{-3}$ to 1.59 $\times 10^{-3}$ mm²/s, depending on the degree of cellularity.²³

Debris may be mobile. Intraluminal masses may be demonstrated. Debris may be difficult to differentiate from masses in this situation color or power Doppler may be beneficial.²⁶

4- Intraductal papilloma:

A small noncancerous growth within the milk duct itself, like a wart, usually located near the nipple. These benign tumors are composed of fibrous tissue and blood vessels.^{63, 64} Most papillomas are not visible by mammography because they conform to the duct lumen, which may itself be hidden in dense fibroglandular tissue.²⁷

2- Fibrocystic Changes:

The spectrum of fibrocystic changes is found clinically in 50% of women and histologically in 90%. This prevalence in the normal breast and the lack of specific radiologic findings has made this term of little value in the mammographic report.

At MR imaging, papillomatosis has been described as a lobulated mass with small internal cysts, which are seen best with T₂-weighted sequences, and that demonstrates marked enhancement with a benign enhancement profile²⁸

In dynamic bilateral breast MRI, so-called mastopathic or fibrocystic changes appear as diffuse, bilateral, patchy, and heterogeneous with multifocal enhancement. The heterogeneity of enhancement that is seen in patients with fibrocystic disease is due to the presence of areas with predominant epithelial proliferation next to areas with predominant regressive changes (fibrosis) and associated cysts.²⁴

5- Fibroadenomatoid change

A benign proliferative lesion, which differs from fibroadenoma in that it doesn't have well defined borders and usually involves several lobules. It may represent an intermediate step or arrested stage during histogenesis of the fibroadenoma.

The ADCs of breast cysts are significantly increased over that of normal tissue, reflecting the fluid compositions of these lesions. The signal intensity of breast cysts depends on the diffusion of their content. When the content is serous, the signal intensity is low because of the low restriction on diffusion. When the content is mucinous, the signal intensity increases according to the extent of restriction on diffusion²³.

Mammographically, they are mostly circumscribed, lobulated masses, with or without calcification, which may be coarse, amorphous, pleomorphic calcium.

Sonographically, they are circumscribed lobulated masses, with internal septations and mixed hypo and hyper echogenicity.²⁹

6- Epithelial hyperplasia

A- Atypical ductal hyperplasia (ADH)

B- Atypical lobular hyperplasia (ALH)

7- Galactoceles

Galactoceles usually develop in

3- Duct ectasia

lactating women, but they may occur in infants of either gender or in older boys in the absence of endocrinopathy. Galactocele typically appear as enlarging painless masses. They may be unilateral or

bilateral. ³⁰ In MRM of only the wall and septations. A fat-fluid level may be seen on a true lateral mammogram and is a specific finding of galactocele. ³⁰

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8-Mastitis

It is focal or diffuse inflammation of the breast. It may be infectious or non-infectious. ³⁰

Acute breast inflammation is a condition in which sonography is better than mammography as it determine exactly the extent of inflammation, can demonstrate focal alterations such as abscess. ²⁵

9-Abscess

Abscess is a localized area of pus collection within the breast. Most often, abscesses form beneath the nipple (subareolar), under the skin (subcutaneous), within the gland (Intra-mammary), or deep to the gland in front of the pectoral muscle (retro mammary). ²⁹

Non contrast T₂ W images show focal moderate-to-high signal mass depending on the water content. Shape and margins vary from round to irregular. The overlying thickened skin may be intermediate or bright in signal depending on the degree of edema. T₁-weighted non contrast images show the central mass as medium signal with a lower signal capsule surrounding the mass. Contrast-enhanced T₁W images demonstrate a non enhancing central, round, or irregular mass surround by an early intensely enhancing rim. The surrounding inflammatory tissues may enhance moderately and irregularly and may be thickened. Abscess may be confused with malignancy because the enhancement kinetics of the rim and the irregular appearance of the overlying tissues are similar. ¹³

● Malignant Breast Disorders:

I- Tumours of ductal epithelial origin

A- Ductal carcinoma in situ (DCIS)

DCIS accounts for approximately 20% of breast cancers and typically present with a mass or nipple discharge. It is formed of malignant ductal epithelial proliferation originating in terminal duct lobular unit (TDLU) without invasion of the basement membrane. ^{26, 29}

No particular ultrasound features have been defined to characterize these lesions. If a tumor mass is present particularly with papillary DCIS, intracystic or circumscribed or microlobulated mass with mild hypoechogenicity, ductal extension and normal acoustic transmission is the most common US finding. In power Doppler increased vascularity is common. ²⁹

B- Invasive ductal carcinoma

It is the commonest type of breast malignancy accounting for 70-80% of all breast carcinomas. ^{26, 31}

The classic description of breast cancer in US is an irregularly shaped extensively heterogeneously hypoechoic mass which taller than wider, producing retro-tumoral shadowing. Also architectural distortion can be seen. Microcalcifications may be detected. This is fairly characteristic of the speculated scirrhous carcinoma. The enlarged axillary lymph nodes with eccentric or lost hilum can be seen. Color Doppler shows hyper vascular lesion with penetrating vessels. ²⁶

Invasive ductal carcinoma includes the following varieties:

- 1- Invasive ductal carcinoma not otherwise specified (NOS).
- 2- Paget's disease of the nipple.
- 3- Tubular carcinoma.
- 4- Papillary carcinoma.
- 5- Colloid carcinoma.
- 6- Medullary carcinoma.
- 7- Inflammatory carcinoma. ²⁶

II- Tumors of lobular origin

A- Lobular carcinomas in situ (LCIS)

It is more commonly found in younger women than ductal carcinoma. LCIS is found more commonly in women with radiographically dense breast ³²

Calcifications in mammography are a common occurrence within the LCIS as well as in adjacent benign tissue. A tumor mass is rarely seen. ³²

The ultrasound features of LCIS are not well characterized. Some have described it as hypoechoic tissue with associated posterior acoustic shadowing. ³²

B- Invasive lobular carcinoma (ILC)

ILC comprises 5-10% of all breast cancer. There are no features that characteristically distinguish an ILC from an infiltrating ductal carcinoma. Asymmetric density without definable margins is the most common pattern of

ILC, associated microcalcifications are rare.³³

MRI of malignant breast lesions:

Ductal carcinoma in situ lesions rapidly enhance following the administration of gadopentate dimeglumine. Highest positive predictive value for malignancy included

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shape for masses, and segmental or clumped ductal enhancement for non-mass lesions. At MR imaging, they show rapid intense contrast enhancement and rapid washout typical of a malignant tumor.¹³

AIM OF THE WORK

This study aims at demonstration of the value of Diffusion Weighted MR Imaging for differentiation of benign from malignant breast lesions.

1) Personal history included:

Name, age, marital status, occupation, and residence.

2) Menstrual history included:

- Age of menarche.
- Regularity of the menstrual cycle.
- Duration and amount of blood loss.
- Associated pain or dysmenorrhoea
- Date and nature of last menstrual period.

3) Obstetrical and Gynecological history:

Previous abortions, ovarian or uterine pathology, history of lactation and any related problems.

4) Complaint and present history included:

- Mass felt by the patient in the breast and/or axilla.
- Sensation of breast swelling
- Nipple discharge
- Nipple erosion, retraction or inversion.
- General symptoms such as pain whether cyclic or non-cyclic, fever, malaise and loss of weight.

5) Past history of:

- Breast pathology.
- Milk retention.
- Diabetes, inflammation especially staphylococcal or tuberculous, trauma, tumors.

d) Bleeding tendency or blood disorders.

e) Endocrinal pathology

6) Family history included:

- History of similar condition or any other breast pathology with special concern for breast carcinoma.

7) Operative history included History of:

- Previous operations in the breast.
- Gynecological or endocrinal operations.

8) Drug history of:

- Contraceptive pills, its dose and duration.
- Any form of hormonal supplement or therapy.
- Corticosteroid intake.

II. Thorough Clinical Examination:**A. General examination****B. Local examination of the breasts:****1. Inspection:**

The following points were noted:

- The level and size of the two breasts.
- The condition of the nipple: if there was recent retraction, destruction, discoloration, displacement and spontaneous discharge.
- The condition of the areola: for ulceration, dimpling, vesicle formation, and hyper-pigmentation.
- Skin manifestations: as dimpling, puckering, retraction, peauod" orange, dilated veins, ulcerations and skin nodules.

2. Palpation:

The following were carried out:

- Confirmation of the presence of an associated mass and determining its:
 - Site, size, shape, tenderness and local temperature.
 - Surface: whether smooth, nodular, finely granular or irregular.
 - Borders whether well-defined or irregular.

- Consistency: whether soft, firm, cystic or hard.
- Attachment to skin, breast tissue, muscles or ribs.
- Examination of ipsilateral and contralateral axillary cervical and supraclavicular lymph nodes.

Conclusion

III. Investigations:

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in mammograms with a high film contrast, making it easier for the radiologist to read.

Views:

Four films (with the exception of prior mastectomy) were obtained for each case, two views for each breast, the craniocaudal and the mediolateral oblique views. Mediolateral oblique view was done with an angle 45°. All views were taken while the patients were standing. Compression was applied to all breasts.

Technique:

For all cases, the patient was made to stand with her breast placed horizontally on the film cassette and compression was applied to flatten out the breast, to avoid motion and enhance visualization. A craniocaudal film was taken, where the beam was directed 90 degrees from the mediolateral position. Then breast was held vertically, side to side compression was applied and a mediolateral film was taken where the X-ray beam was directed from medial to lateral.

Interpretation and data analysis:

A comparison of both breasts was done. Both the MLO and CC views are mounted back to back, so that the right breast is compared with the left breast. The contour, size of the breasts and its symmetric density are evaluated. Any suspicious area which causes disruption of the normal symmetrical pattern of the breast and architectural distortion was looked for. Interpretation involves careful viewing of the normal mammographic pattern and any abnormalities which present itself as a disruption of the normal pattern.

Viewing the mammogram:

- Was carried out on viewing box, with dim light of the surroundings.
- The MLO, and CC films of both breasts were put back to back, and

Patients were subjected to

(I) Mammography

All mammograms were obtained using a dedicated X-ray unit (siemens, mammomat nova machine) having 0.5 target focal spot in a molybdenum anode. Technique used for a mammogram is low Kilo-voltage Peak (KvP) about 24 to 30. The milli-Ampere-seconds (mAs) vary depending on breast tissue density, ranging from 30 to 60

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both breasts were compared to each other.

- A magnification lens was used sometimes to confirm subtle findings.
- Confirming adequate positioning was done, using the following criteria:
 - a) The whole breast tissue was included in the mammogram, and in cases of large breasts, overlapping films were needed to image the whole breast.
 - b) The pectoralis major muscle was seen till the level of the nipple in the MLO view.
 - c) The axilla and infra-mammary fold were included in the MLO films.
 - d) The nipple should be seen in profile in all projections.
 - e) Any lesion detected in mammography in the CC view, should be detected within 1cm from its depth at the MLO view.
 - f) Fat should be seen posterior to breast parenchyma in all views.
- Identifying the normal breast pattern, and detecting any abnormality.
- The lesions were evaluated as follows:
 - a) Position of the lesion (upper outer, upper inner, lower outer or lower inner quadrants, retro areolar or axillary)
 - b) Regular or irregular outlines.
 - c) The borders were described as circumscribed, obscured, speculated, lobulated or ill defined.
 - d) The lesions were classified as dense or lucent.
- Calcifications were classified according to size into macro and micro calcifications and according to distribution as regional and segmental.
- Architectural distortion and tissue edema were detected. Skin thickening

was also reported. Axillary lymph nodes were detected.

(II) Ultrasound:

All the patients were subjected to bilateral breast US using 7.5 MHz linear probe Toshiba (Nemio) machine and GE (Logic 5).

The transducers were directly applied to the skin surface with the patient in the supine position to examine the inner quadrants of the breasts, and the supine oblique position, to evaluate the outer quadrants. The examined side is elevated and the

ipsilateral arm is extended above the head to stabilize the breast and flatten it against the chest wall. Scanning was performed in the radial and anti-radial planes in relation to the nipple, and/or sagittal and transverse planes were used, where it begins in the upper inner quadrant of the breast and proceeds slowly to the outer quadrant to obtain sagittal images. The transducer is then moved lower on the breast and the scanning action is repeated until the whole breast has been examined. At that point the transducer is rotated 90° and transverse

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from inner to outer. Both axillary regions are then examined by longitudinal scanning. All nodes were examined in the longitudinal and transverse nodal planes that demonstrated the largest and smallest diameters of the node.

This study was carried out on 20 female patients presenting with breast lesions; they were divided into two groups according to the **BI-RADS** of the mammosonographic study (Table 3):

- ▶ Group I include 12 patients (60%) with radiologically non suspicious breast lesions (**BI-RADS 1, 2 and 3**).
- ▶ Group II include 8 patients (40%) with radiologically suspicious breast lesions (**BI-RADS 4, 5 and 6**).

Table (3): The classification of 20 female patients presenting with breast lesions

%	.No	BI-RADS
60.0	12	Radiologically non suspicious (3 – 1)
40.0	8	Radiologically suspicious (6 – 4)
100	20	Total

The most common in our cases was **BI-RADS 2** (7 cases) followed by **BI-RADS 5** (6 cases). 5 cases were reported **BI-RADS 3** and 2 cases **BI-RADS 4**. None of our cases were **BI-RADS 1** or **6**. (Table 4):

Table (4): Distribution of studied cases according to BI-RADS (n = 20)

BI-RADS	No.	%
1	0	0.0
2	7	35.0
3	5	25.0
4	2	10.0
5	6	30.0
6	0	0.0

Table (6): The correlation between age and pathological results

Pathology results				Age
Malignant (n = 7)		Benign (n = 13)		
%	.No	%	.No	

0.0	0	15.4	2	20>
0.0	0	30.8	4	40 – 20
100.0	7	53.8	7	40<

1. Family history of breast carcinoma

The clinical history of 20 patients presenting with breast lesions had shown that 7 of them had a relative with history of breast cancer, 3 of these patients proved to have a malignant lesion at current study.

Mammographic data:

► **Density of breast parenchyma**

In the current study, the density of the breast tissue was assessed from the mammographic findings and then correlated to the final pathologic diagnosis. The breast density was classified into four grades according to **ACR** Classification;

ACR 1: predominately fatty (Fatty breast) type of breast parenchyma.

ACR 2: Fibroglandular type of breast parenchyma.

ACR 4: Dense breast.

The **ACR 1** is most common type of breast density in our studied patients (11 cases), while the least common type was **ACR 3** (1 case).

The distribution of studied cases according to the type of breast density is shown in table (7), figure 23.

Table (7): Distribution of studied cases according to ACR (n = 20)

%	.No	ACR
55.0	11	1
25.0	5	2
5.0	1	3
15.0	3	4

The correlation between grades of breast density and pathological diagnosis in our study is shown in Table (8)

MRI data:

► **MRI findings**

► **Dynamic patterns of enhancement**

- Type I a curve** (“persistent enhancement”). Enhancement continues over the entire dynamic series; the emerging curve is a (more or less) straight line.
- Type I b curve** (“persistent with bowing”), enhancement continues over almost the entire dynamic period, but the rate is slowed down during the late post contrast phase, resulting in a flattening (bowing) of the curve.
- Type II curve** (“plateau curve”), enhancement reaches a steady state after the initial phase.
- Type III curve** (“washout curve”), enhancement decreases again directly after the strong signal increase in the early phase.

► **MRI diffusion findings:**

Our studied cases were classified according to the diffusion pattern in the detected lesions into two groups:

Group 1 includes 7 cases showed restricted diffusion (35%) and group 2 includes the remaining 13 cases showed no significant diffusion restriction (65%).

Table (13): Distribution of studied cases according to diffusion and ADC (n = 20)

	No.	%
Diffusion		
No significant diffusion restriction	13	65.0
Restricted diffusion	7	35.0
ADC		
Range	0.50 – 2.70	
Mean ± SD	1.53 ± 0.70	
Median	1.75	

DISCUSSION

Classic breast magnetic resonance imaging (MRI) is based on the enhancement pattern of lesions in dynamic breast MRI, and morphologic changes. With these two criteria breast MRI has a

sensitivity of about 85–99% in detecting malignant breast lesions. However, there is an overlap of these criteria with benign lesions which leads to a reported specificity of about 40 to 80%.³⁴

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There is an increasing number of congress abstracts and published studies that the specificity of breast MRI could be increased using diffusion-weighted (DW) sequences.⁶

Group I include 12 patients (60%) with radiologically non suspicious breast lesions (BI-RADS 1, 2 and 3) while, group II include 8 patients (40%) with radiologically suspicious breast lesions (BI-RADS 4, 5 and 6). Both groups were subjected to further MRI with DWI and ADC calculation and findings were correlated to the final histopathological results.

Age of patients presenting with breast lesions at current study:

The present study has shown that the mean age of patients presenting with breast lesion was 42.5 years. The age range of the patients presenting with breast lesions in this study was (15 -65), it agreed with some reports of similar literature who reported mean ages of (50+/-15). Our findings did not agree with other reports who reported mean ages ranging (33–83 years old) with median age around 50 years⁽³⁶⁻³⁸⁾.

Breast density:

In the current study, the density of the breast tissue in our patients was assessed from the mammographic findings. The breast density was classified into four grades according to ACR Classification.³⁹

ACR 1: predominately fatty (Fatty breast) type of breast parenchyma.

ACR 2: Fibroglandular type of breast parenchyma.

ACR 3: Hetrogenous dense type of breast parenchyma.

ACR 4: Dense breast.

The ACR 1 constituted most common type of breast density in our studied patients, while the least common type was ACR3.

In our study more than 85% (6 cases) from the total (7) pathologically proved malignant cases were ACR 1 and only one case (14.3%) was ACR 2

Mammographic finding

The mammographic findings in our study were classified as follows:

1. opacity
2. Asymmetrical density
3. Micro calcification in breast parenchyma.
4. Skin thickening with prominent trabeculae.
5. Focal mixed density lesion.
6. Lucent focal lesion
7. Patients with normal or extremely dense mammogram.

Most of our patients were presented with opacity in their mammogram (12 cases). In patients with previous breast surgery skin thickening and prominent trabeculae with asymmetric density between the two breasts were the dominant mammographic findings. Microcalcifications in the breast parenchyma were seen in 2 patients. There was 3 patients with normal mammogram i.e., negative or extremely dense.

We used the same criteria used by M. Muller-Schimpfle et al⁷⁷ for identifying malignant and benign lesions in mammography. Criteria of malignant lesions were speculated outlines, irregular or ill-defined borders, microlobulation, and suspicious clustered micro-calcifications.

Criteria of benign lesions were smooth and sharp borders and gentle macrolobulation.⁴⁰

Sonographic finding

Criteria of malignancy by US were speculation, if the lesion was taller than it was wide, ill-defined or irregular margins, shadowing, hypoechogenicity or heterogeneous echogenicity. Criteria of benign lesions were hyperechogenicity or homogenous iso to hypoechogenicity, gentle macrolobulation, posterior acoustic enhancement and smooth borders. These were again the same criteria used by M. Muller-Schimpfle et al⁷⁷ with some modifications.⁴⁰

The solid mass was the most common sonographic finding present in 16 patients out of 20 (80%) followed by enlarged lymph node found in ultrasound of 5 patients (25%), the fibrocystic changes were present in 2 patients (10%).

MRI data:

Lesion characteristics, included size in millimeters, type (mass, non-mass like enhancement, cystic lesion) and BI-RADS

category, this agreed with the study of Savannah C. Partridge⁴²

► Dynamic patterns of enhancement

We analysed the dynamic patterns of enhancement of each lesion by means of time intensity curves (TIC) which was interpreted as follows⁴²:

1. **Type I a curve** (“persistent enhancement”). Enhancement continues over the entire dynamic series; the emerging curve is a (more or less) straight line.
2. **Type I b curve** (“persistent with bowing”), enhancement continues over almost the entire dynamic period, but the rate is slowed down during the late post contrast phase, resulting in a flattening (bowing) of the curve.
3. **Type II curve** (“Plateau curve”), enhancement reaches a steady state after the initial phase.
4. **Type III curve** (“washout curve”), enhancement decreases again directly after the strong signal increase in the early phase.

The dominant finding in MRI in our study is enhancing focal lesion, which was found in 14 patients (70%).

Type I a curve was the most common type of dynamic curves and was seen in 12 patients (60%), followed by type III curve in 7 patients (35%). Type II found in 3 cases and type I b was the least common and have been seen in 2 patients.

The TIC is useful for discrimination between benign and malignant masses. However, this TIC differs according to the ROI setting. We set ROIs based on visual inspection. TIC was obtained with the use of a small ROI inside the mass and avoidance of central hemorrhagic necrosis or fibrosis. The enhancement areas are seemed to show uniform in one mass, but there were actually regions of continuous or washout enhancement in the dynamic phase.⁴²

Type III curve was the dominant type in the pathologically proved malignant cases and has been found in 6 out of 7 total malignant cases (85.7%). This agreed with the study done by Jack, Ph.D.⁴³ who found that III (washout) curve was 86.49% (32/37).⁴³

Type I curve was seen in 14.3% of malignant lesion compared to 10.81% in Jack, Ph.D.'s study.⁴³

The most common type of curve expressed by the pathologically proved benign cases in our study was type I a curve (92.3%) , this did not agree with Jack, Ph.D.'s results who stated that The type I for benign lesions was 65%.⁴³

We agreed with Jack, Ph.D.⁴³ in that there was significant difference between the malignant and benign lesions at the distribution of curve types ($P < 0.001$)⁴³ and in that the time-signal intensity curve is useful in differentiating malignant lesions from benign ones.⁴³

CONCLUSIONS

From this study, we concluded that:

- Dynamic contrast-enhanced MRI (DCE-MRI) of the breast has a high sensitivity for breast cancer detection and is considered the most sensitive breast screening technique for women at high risk.
- Breast MRI has a sensitivity of about 85–99% in detecting malignant breast lesions and a reported specificity of about 40 to 80%.
- Breast MRI is analyzed according to morphologic criteria, the enhancement kinetics and the T2 characteristic of breast lesions. However, all these criteria show an overlap between benign and malignant lesions
- Diffusion-weighted MR imaging is a noninvasive technique, requires no ionizing radiation exposure, and does not require the administration of

contrast medium. The short examination time is an additional advantage. Furthermore, both conventional morphologic and physiologic assessments can be made during the same examination.

- Diffusion-weighted imaging is a potential resource as a coadjutant of MRI in the differentiation between benign and malignant lesions. Such imaging can be performed without a significant increase in examination time.
- The simultaneous assessment of diffusion-weighted and T2-weighted imaging data and ADC value has the potential to improve specificity. In addition, the use of diffusion-weighted imaging in a standard breast MR imaging protocol may heighten sensitivity and thereby improve diagnostic accuracy.

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- The reported mean ADC values of benign and malignant breast tumors ranged from 1.6 to 2.01 and 0.90 to 1.2 x 10⁻³ mm², respectively, resulting in recommended threshold values of ADC ranging from 1.2 to 1.4 x 10⁻³ mm²/sec
- When the MRI technique was different among institutions, the appropriate threshold value of ADC may be different.
- DWI should be included as routine modality when examining any breast lesion by MRI.

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