# Radiology of the breast

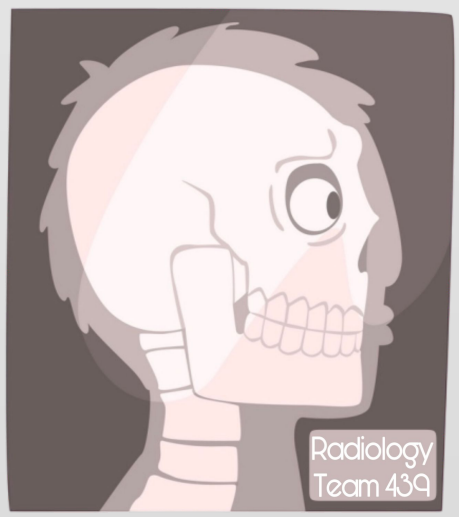
## Lecture 19

### Objectives

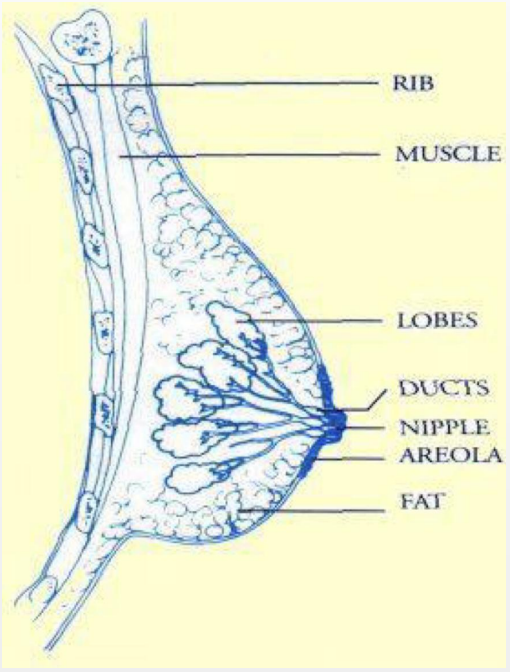
1. To understand the anatomy of the breast radiology / imaging based
2. To highlight the suitable modality for age and disease of the breast .
3. To understand the role of radiology in diagnosing breast lesions particularly breast cancer .

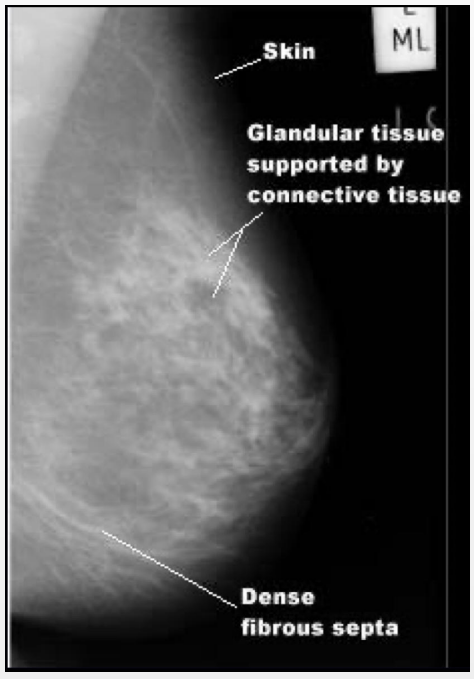
**Color index:**

Black: Main text
Red: Important
Yellow: Golden notes
Green: Drs notes 439
Dark green: Drs notes 438
Gray: Extra

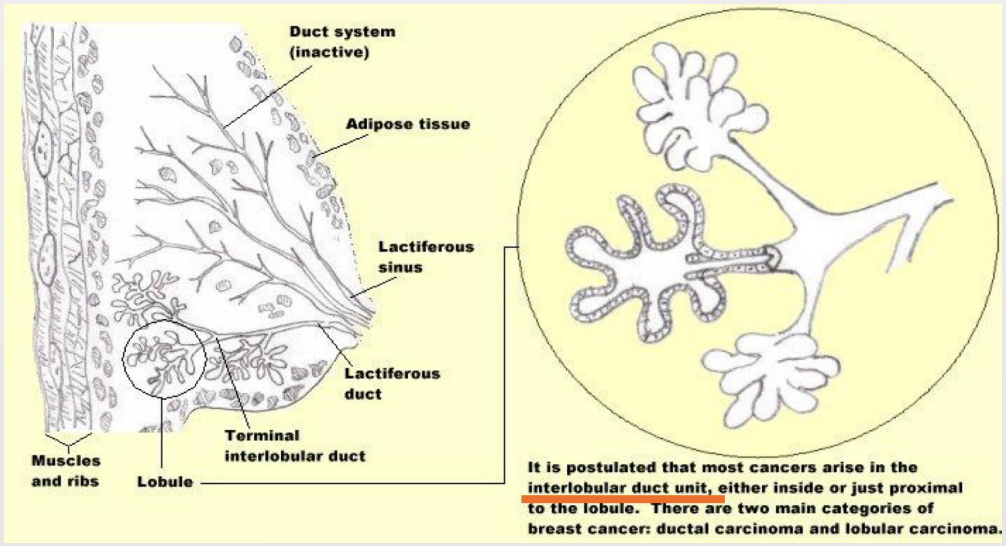


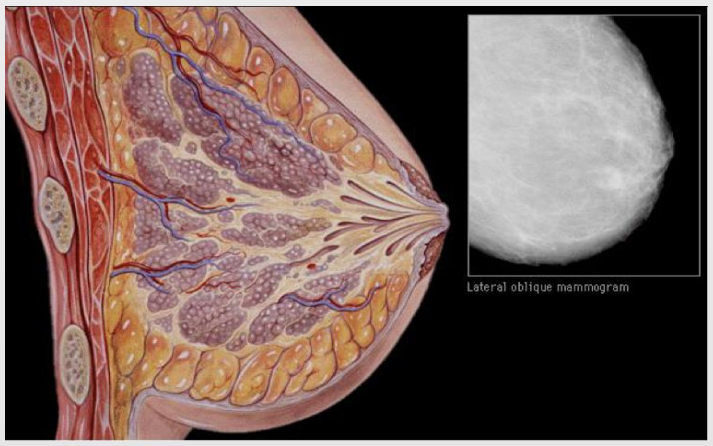
# Basic Anatomy

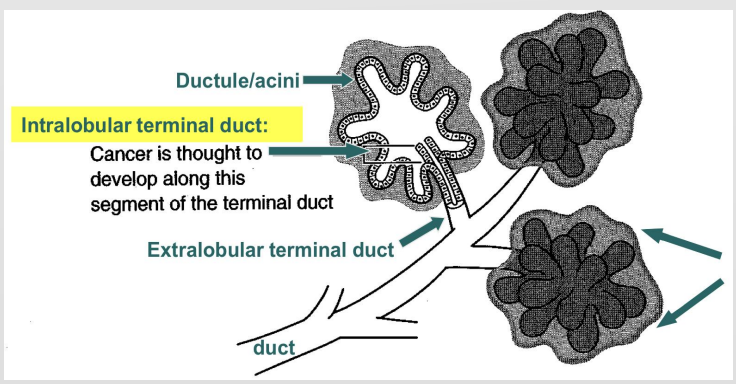


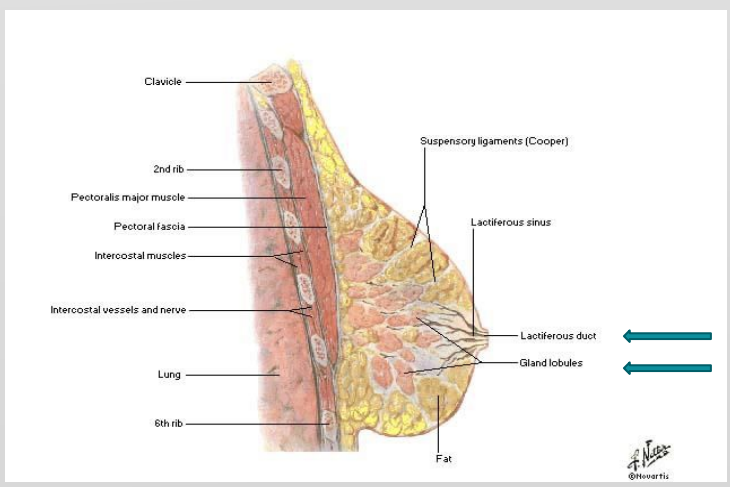




The younger the patient the denser the breast so it becomes difficult to identify lesions, the same for lactating women.



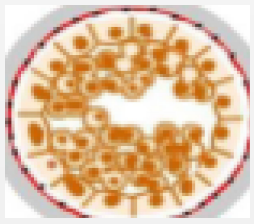
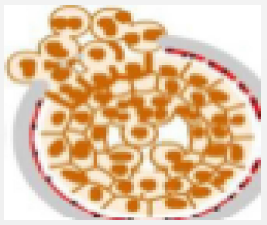




Most breast cancer develops in the terminal ductal lobular unit (TDLU)
Terminal ductal lobular unit is composed of:
1- intralobular terminal ducts. (95% of malignancy arises from the ducts)
2- Acini (5% of malignancy arises from acini)

The epithelium inside the lobules is histologically distinct from the epithelium in the extralobular ducts .

# Breast Cancer

## Breast Cancer can be divided into two major groups :

| In situ | Invasive |
|---|---|
| • Tumor cells **have not** invaded the basement membrane .<br>• Tumor cells remain confined to the ducts or lobules .<br>DCIS<br>The membrane here is intact  | • Tumor cells **invade** the breast stroma .<br>• They have the potential to metastasize and result in death of the patient .<br>Invasive ductal carcinoma<br>The membrane here is invaded  |

## Ductal cancer evolves over time:

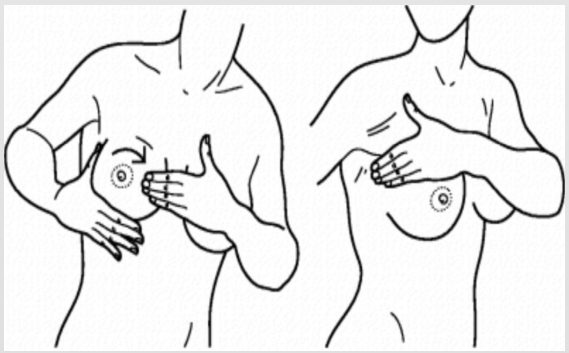
Clinical and molecular research have demonstrated that there is likely often a linear progression of sequential stages of epithelial proliferation .

1. **Normal Terminal Ductal Lobular Unit**
2. **Atypical Ductal Hyperplasia** (ADH)
3. **Ductal Carcinoma In Situ (DCIS)**
4. **Invasive Ductal Carcinoma (IDC)**

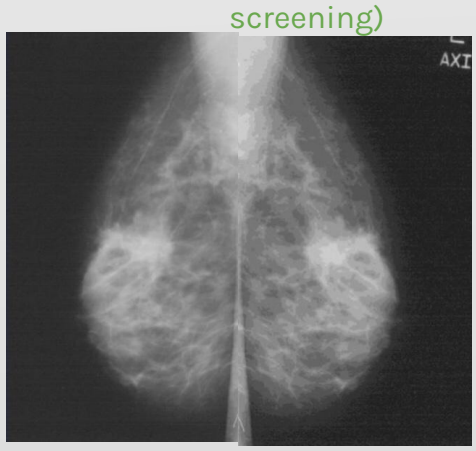
Chance of survival here is higher and treatment is easier

## The Four Pillars of Diagnosis:

1- Clinical or Self Examination (PE)

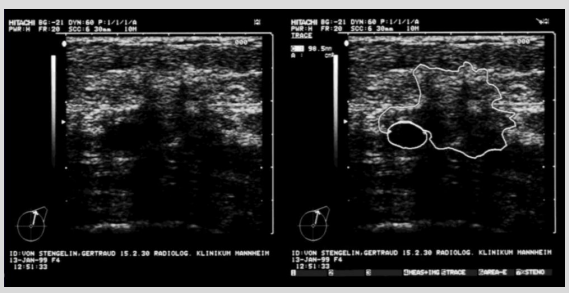


2- Mammography (MG) (gold, used in screening)

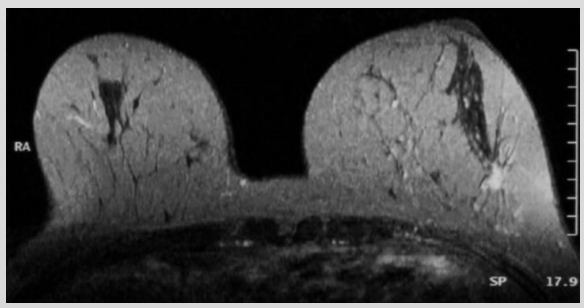



3- Ultrasound (US)

If we did a mammogram and the breast was very dense we aren't sure about the findings we do US at the same day



4- Magnetic Resonance Imaging (MRI)




You can use 2,3,4 to guide biopsy

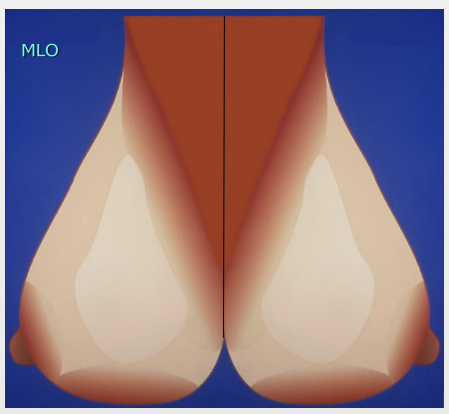
# Breast Tests

1. **Mammography**
   Can rule IN cancer, but can not rule it OUT .
2. **Ultrasound**
3. **CT scan**
   (with and without contrast)
   Not for breast lesions but for staging . (Detection of distant metastases)
4. **MRI**
   (with and without Gd contrast)

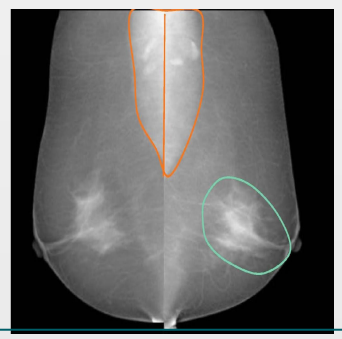
CT have no diagnostic role

5. **Ultrasound or MRI** guided biopsy and wire localization
6. For bone metastasis
   **Bone radionuclide scan**
7. **Lymphoscintigraphy**

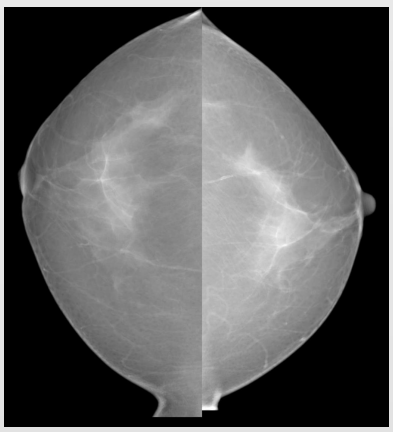
## Views:

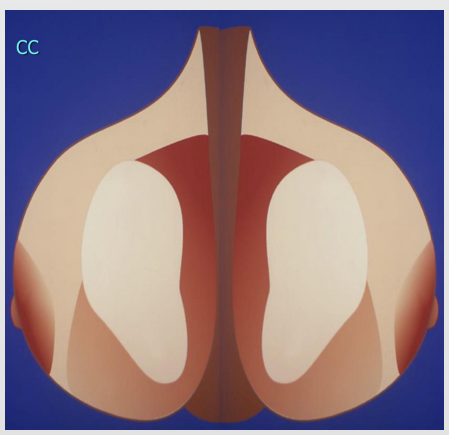



**MLO**



- ★ Pectoralis muscle and axillary lymph nodes.
- ● fibroglandular tissue.



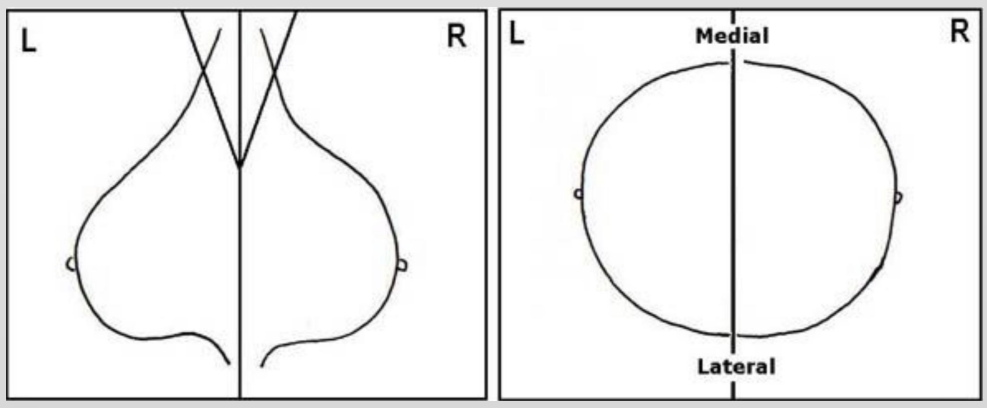



**CC**

-right and left breast are beside each other in these so it's easier to compare sides.
-when we write reports we use o'clock position.

## Viewing method:

Mediolat.obliques views:are very good to avoid the axilla from blocking the sight and seeing the axilla and lymph nodes at the same time.
Has Lower, upper anterior and posterior borders.



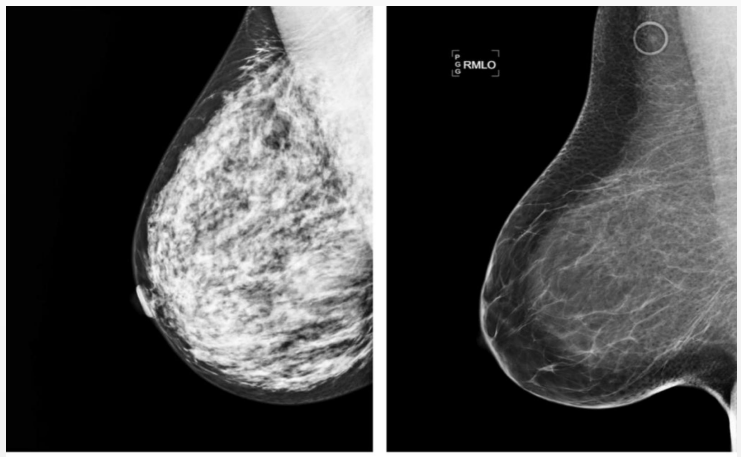

Optimal positioning for mammography is the aim of this diagram

Carnio-caudal views: tube is above and film below breast.
Has Latral, medial, anterior and posterior borders.

# Basic Tests

## Dense breasts:

Needs :
1- Extra images
2- Extra modality




Dense Breast | Fat-Replaced Breast

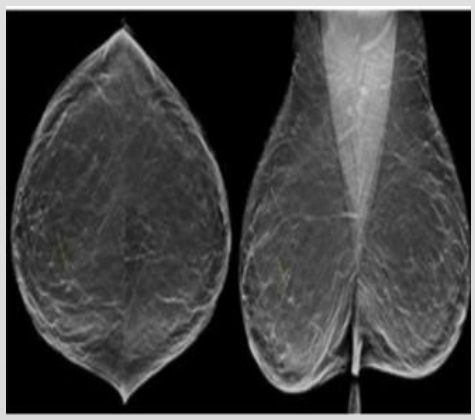
## FIRST Decide if there is a mass (compare both breasts):

| Mass (can be benign or malignant) | Asymmetrical Density |
|---|---|
| • **Convex** borders (3D)<br>• **Denser towards center**<br>• Distorts related parenchyma (if benign displace ,if malignant erosion and distortion of surrounding tissues)<br>• Seen in **multiple projections** ie. multiple views CC and MLO<br>• Still seen in focal compression view to better see the details of the mass | • ill defined or irregular<br>• Amorphous could be peripherally hyperdense<br>• NO<br>• NO<br>• Tissues spread over it the shape becomes different in focal compression |

Mammographic findings of breast cancer:
1- first thing to suspect breast cancer is a mass with specific characters mentioned later on in this lecture.
2-malignant calcifications
3-mass with malignant calcifications

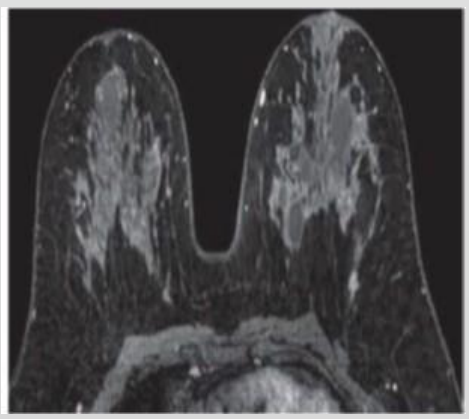
❖ If mass is palpable at the site of focal asymmetry —> Biopsy!

If we are not sure or even if 80% sure biopsy is gold standard. Because 1- some scars look very malignant although they are benign. 2-biopsy helps to determine the hormonal dependance, aggressiveness and cells type so it's not only diagnostic it's also prognostic and helps choosing treatment 3- It is the most accurate test for defining whether the mass is malignant or benign



Mammogram

Ultrasound



MRI

# Breast Tests

## Modality and age

| | |
|---|---|
| <30 | Ultrasound |
| 30-39 | No complain —> **US**<br>Complain —> **MG** then **US** |
| >=40 | Mammogram :<br>- If **+ve** Do **US**<br>- If **-ve** you are **DONE** |

❖ **US is preferred because:**

* Low radiation.
* Glandular tissue is more than the adipose tissue .

❖ Always start with mammogram in women above 40 year old .

❖ Mammography should be avoided in females age less than 30 as much as possible because of radiation .

## Mammogram

**Mammogram indications**

### Screening (No complain) :

❖ Patients 40 year old and above, it is not necessary to have a history of breast cancer.
❖ Young patient with first degree relative (Mother/ Sister) diagnosed with breast cancer due to genetic mutations in BRCAl & BRCA2 we start the screening 10 years before the first relative was diagnosed but **remember we don't start screening before the age of 25!.** Another situations includes one of these syndromes : **Cowden syndrome** (multiple hamartoma syndrome) or Li-Fraumeni syndrome , and if the patient has a history of chest exposure to radiation in her childhood .

### Diagnostic (Complain):

❖ Palpable mass.
❖ Nipple discharge.
❖ Skin changes.

## Ultrasound

### Indications:

❖ Differentiation of both palpable and mammographic lesions as either **cystic or solid.**
❖ Subsequent characterization and classification of solid nodules according to certain sonographic features.
❖ Evaluation of palpable breast mass in patient younger than age 30 (**very dense breast**) and lactating and pregnant women.
❖ Interventional procedures (**BIOPSY**) .

# Basic Ultrasound

## Identification of Malignant Features:

First , they identified lesions with any of the following malignant features, the more you have of these features the more likely its malignant:

- **Spiculation** تسنين
- **Angular margins** which means invasion not rounded smooth surface in US
- **Hypoechogenicity** all malignancies in US
- **Shadowing**
- **Calcification**
- Duct extension
- Branch pattern
- **Microlobulation**

## Example of benign fibroadenoma on ultrasound:

Here its a mass with no spiculation, has very smooth outline capsule is not invaded, no angular margins although it's hypoechoic.

Thin echogenic capsule

Ellipsoid shape (wider than tall)

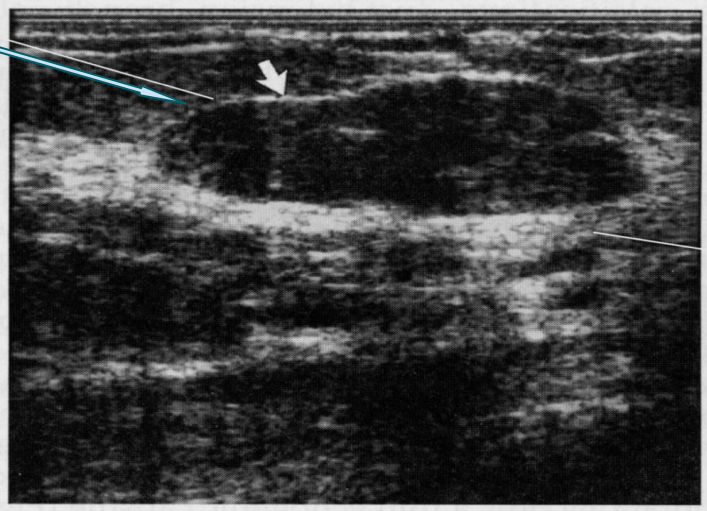
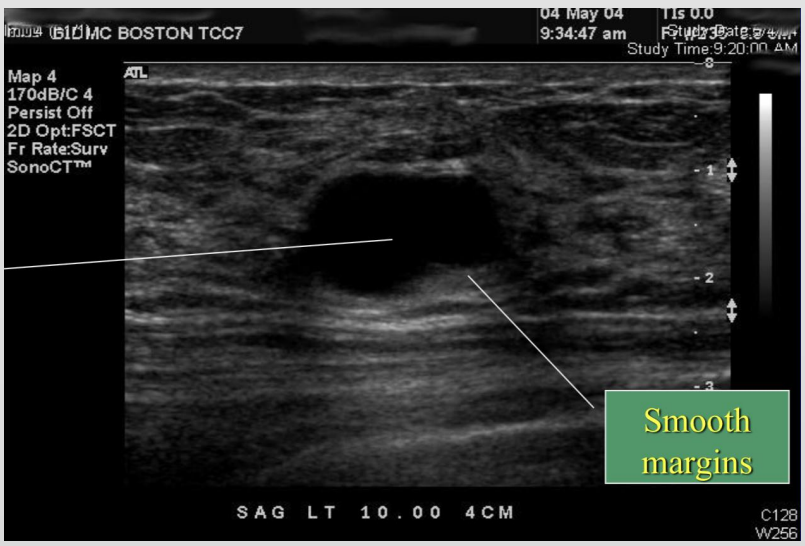


**Figure 3.** Fibroadenoma showing an echogenic pseudo-capsule *(arrow)*.

Most common benign solid mass of the breast

## Example of simple cyst on breast ultrasound:

Anechoic Jet black



# Breast MRI

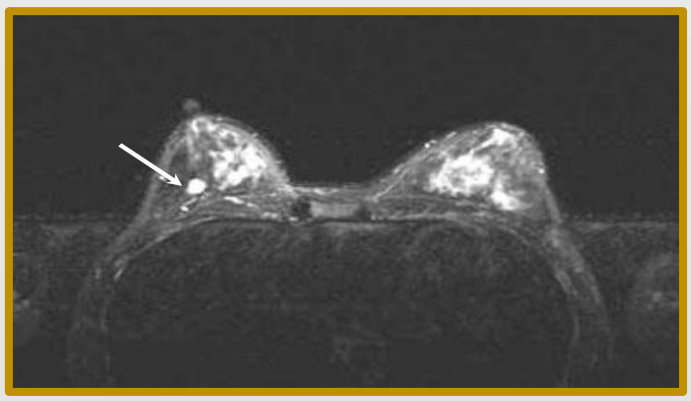
❖ **High-field strength (1.0 – 1.5 Tesla) necessary , resulting in:**
- a higher signal-to-noise-ratio
- shorter acquisition time
- better separation of fat and water peaks
- better contrast characteristics (T1 time increase)
-Prone positioning (the best position to perform breast MRI) .

❖ **Indications:**

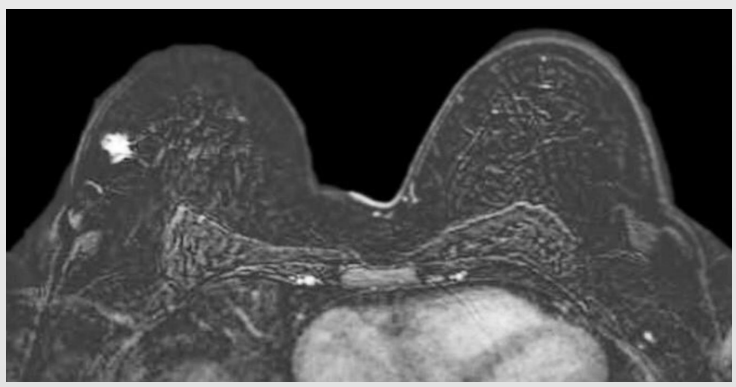
- Staging, adherence to nipple, surrounding parenchyma. Extension of the disease
- High risk patients, family Hx (mothers or sisters)BRCA1 and BRCA2.
- Monitoring response to therapy.
- Post operative to differentiate surgical scar versus recurrence.
- Occult breast cancer.
- Assess the contralateral breast.
- Breast implant (Silicon) patient with breast implant complains we do MRI .

❖ **Contraindicated in :**

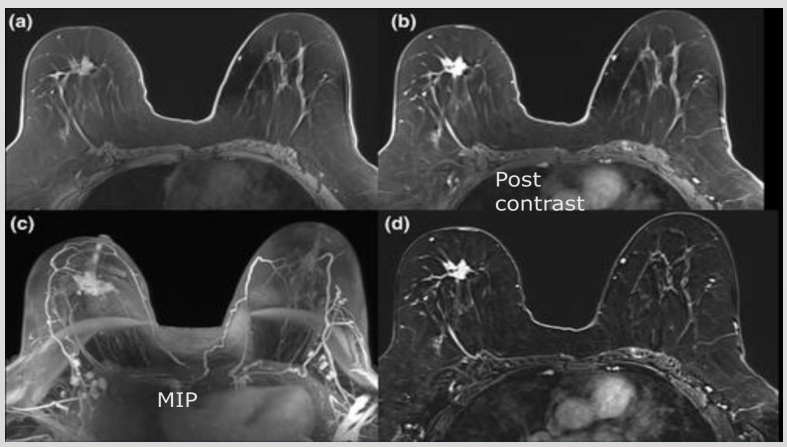
- Claustrophobia
- Cardiac pacemaker or any metal prosthesis



**Static Imaging**
STIR (Short tau inversion recovery)
**Prone position with IV contrast**



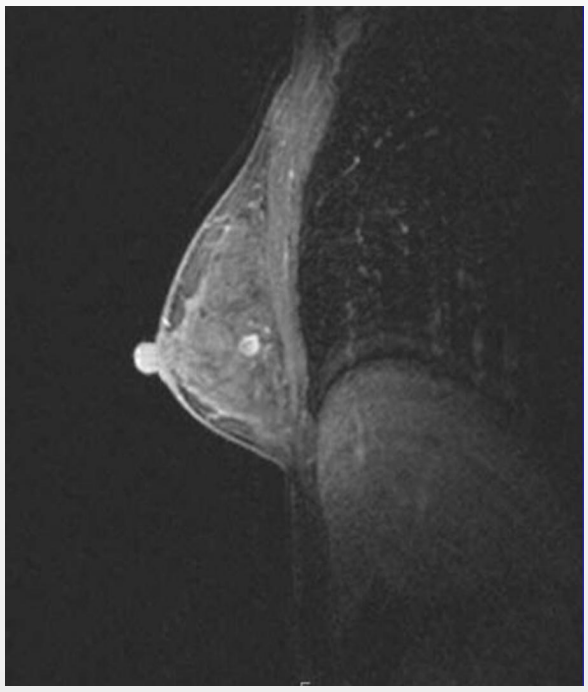
**Subtraction images in MRI**




**Different phases and post processing**

# Basic Anatomy

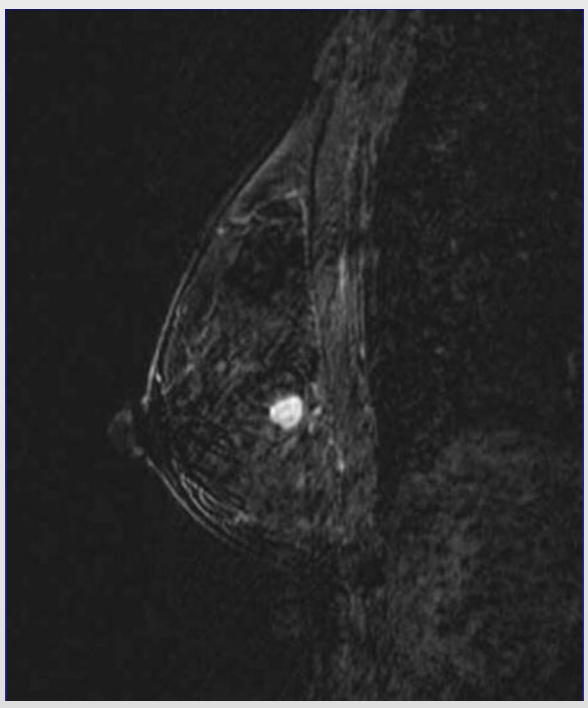
## High resolution Imaging:



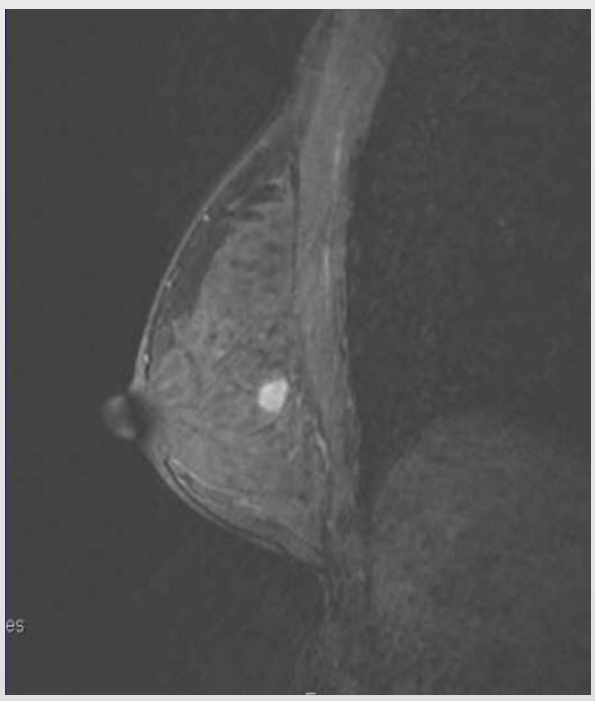
Flash 3D Vibe


Flash 3D HR

## Dynamic Imaging :



**Post contrast with fat-suppression**



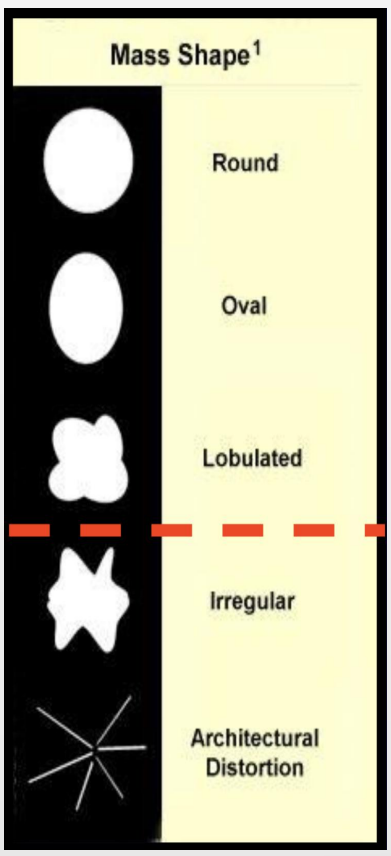
**Flash 3D HR**

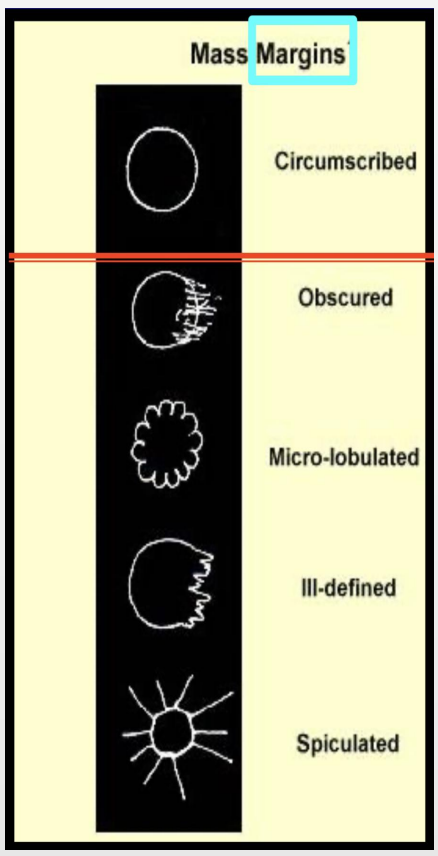
-With IV contrast we see the lesion flares up and clears up
-We can do fat suppression so the lesion becomes more clear.

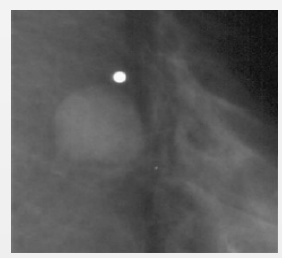
# Breast malignancy

1- Mass — In the search of malignancy — 2- Calcifications

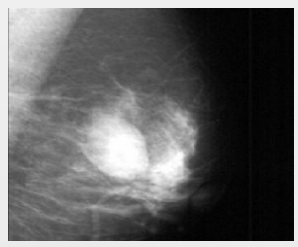
## Characters of masses



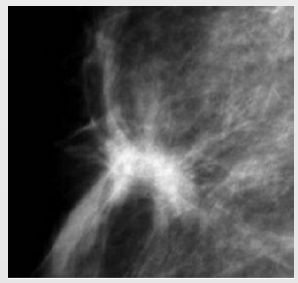



**Rounded**
**(benign lesion)**



**Oval**



**Irregular**
(suspicious)
more with aggressive mass

## Margins

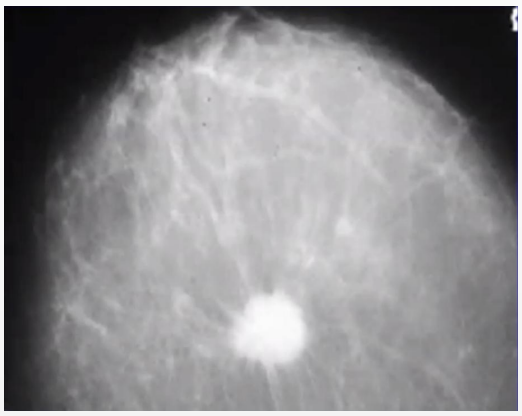
- **Most important character .**
- If margins are obscured by breast tissues ——> Compression / magnification views

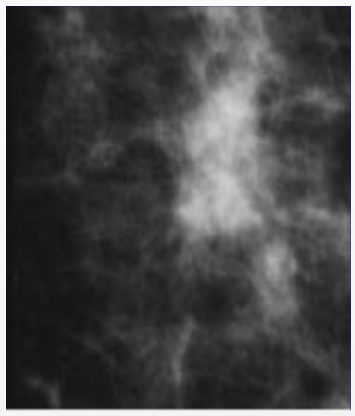
**What's the most important character to differentiate between benign and malignant?** Margins

| Spiculated margins | Well circumscribed (well-defined) margins |
|---|---|
| **Classical carcinoma**<br>**More common in :**<br>invasive>tubular >lobular<br><br>**DDx :**<br>- Fat necrosis (previous surgical biopsy)<br>- Scars (previous surgery)<br>  • Radio-opaque mark<br>  • Previous scar<br>  • Any increase in size —> biopsy<br>- Radial scar (complex sclerosing lesions) | **Almost always benign .**<br>5% of them may be malignant .<br><br>**ultrasound :**<br><br>**Cyst** —> No further assessment .<br><br>**Solid** —> Compression / magnification views :<br>- Microlobulated —> Biopsy<br>- Well Circumscribed —> F/U |

# Spiculated margins

**Spiculated mass**
**invasive ductal carcinoma**

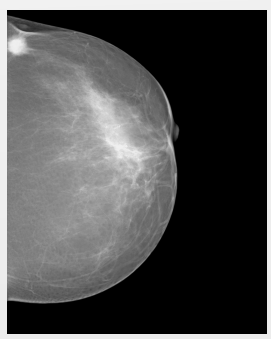


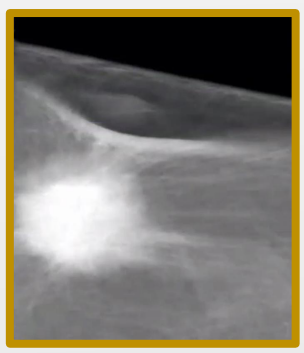


This picture is asymmetric  density not a mass

Mediolat. oblique view

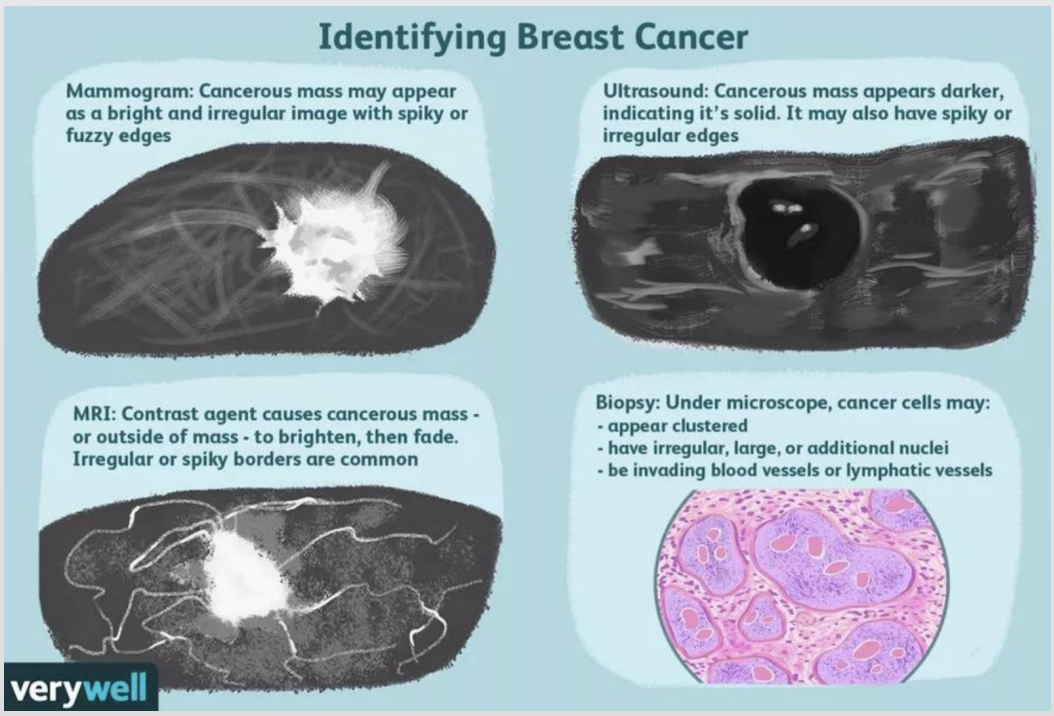
Carnio-caudal view



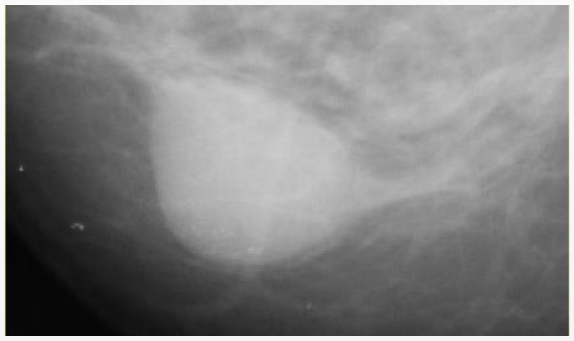


Malignant lesion because it is speculated and associated with skin dimpling and retraction

Some areas well defined and some have microinvasion hypoechoic mass lesion with angular margins

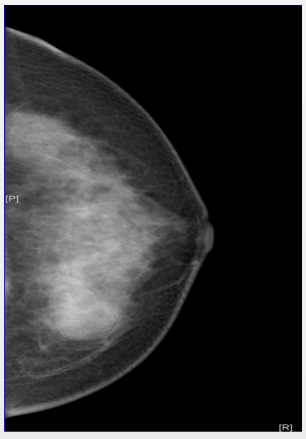


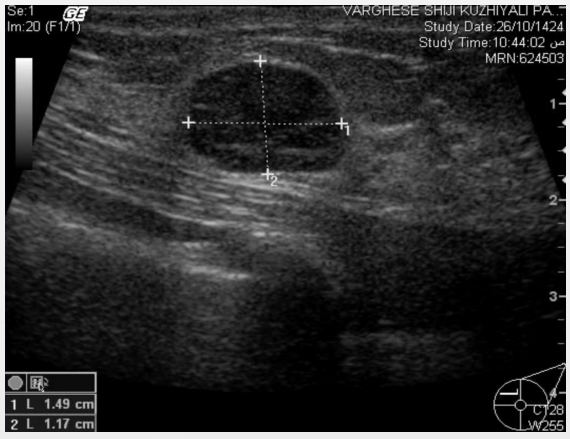
# Well circumscribed



**Oval well circumscribed**

This breast is dense with mass lesion with very smooth outline so its benign

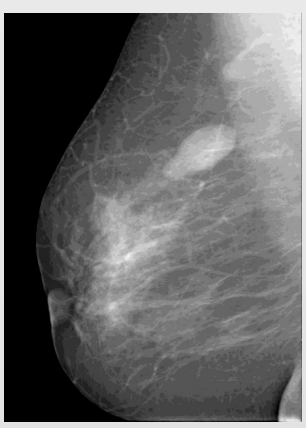





**Large Fibroadenoma (benign)**

In this mammogram the outline is smooth but the upper part of it is hidden by parenchyma so we need compression magnification view if still not clear we do US

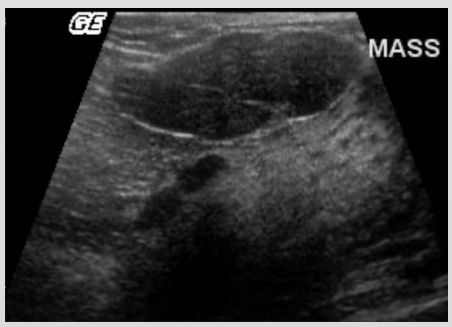
In US outline is very smooth and capsulated and its hypoechoic. if we do have 1% suspicion we do biopsy but if young patient follow up is enough




**Fibroadenoma (benign)**

Smooth outline

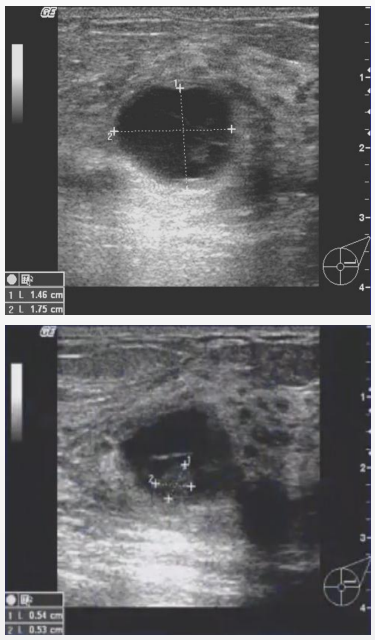
Hypoechoic mass with well-defined capsule

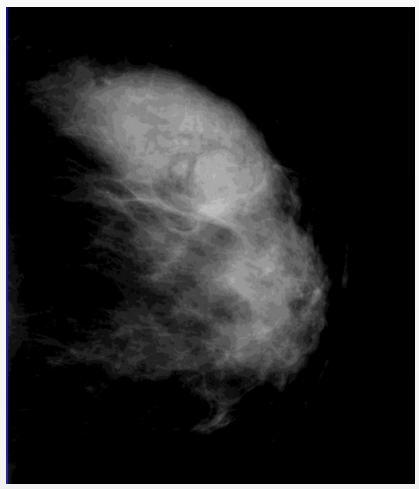




**Hamartoma (Fibroadenolipoma)**

At US , a sharply defined , heterogeneous oval mass is seen , or the lesion may manifest as normal glandular tissue .

# Cysts





**Hemorrhagic cyst in dense breast**

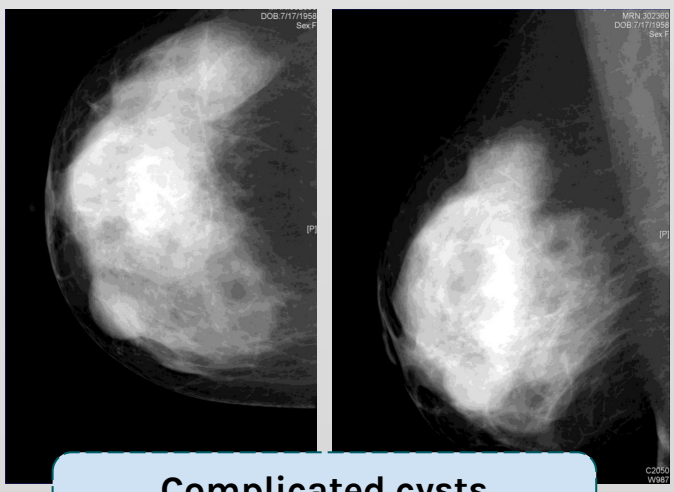
Dense breast, we did US, the lesion has a very well defined outline but inside there's something So it's complicated cystic lesion with biopsy you will find that its hemorrhagic cyst

## Density categories:

| | |
|---|---|
| High Density | Clearly higher than surrounding , suspicious. |
| Equal Density | Density not appreciably different, neutral significance. |
| Low Density | Density lower, but not fat containing , neutral significance. |

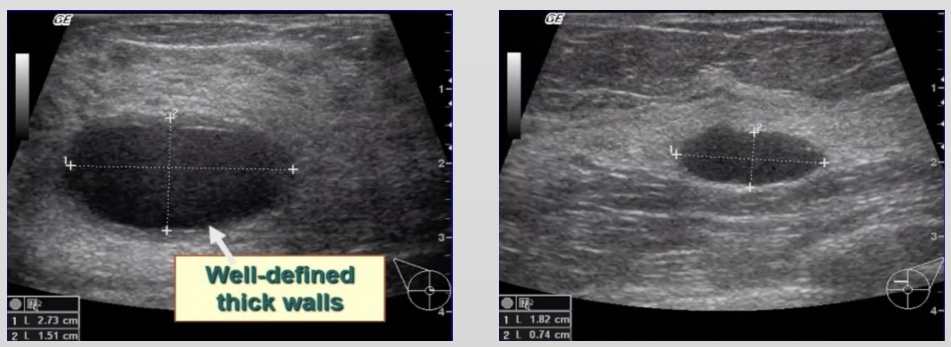
## Number of masses:

- Multiple well defined masses are probably **benign** .
- Multiple primary malignant lesions are obviously **ill defined** or **stellate lesions** .
- **Benign and malignant lesions CAN coexist !!**



**Complicated cysts mammography**

Be meticulous in patient with multiple benign lesions, to make sure there is no hidden malignant lesions in between




**Complicated cysts US**

# Calcifications

## Calcifications

| Size | Number | Morphology |
|---|---|---|
| ❖ **Micro calcifications :** are associated with a malignant process .<br><br>❖ **Macro calcifications :** are associated with a benign process .<br><br>❖ 0.5 mm or less **Microcalcifications** to have a high probability of association with cancer .<br><br>❖ 2.0 mm or larger **Macrocalcifications** are typical of a benign process .<br><br>❖ The smallest visible calcifications on a mammogram is approximately 0.2 - 0.3 mm . | ❖ Any number of calcifications less than four will rarely lead to the detection of breast cancer in and of itself .<br><br>❖ Two or three calcifications may merit greater suspicion if they exhibit worrisome morphologies . | ❖ **Most important indicator in differentiating benign from malignant .**<br><br>❖ Round and oval shaped calcifications that are also uniform in shape and size are likely benign<br><br>❖ Irregular in shape and size **calcifications** fall closer to the malignant end of the spectrum .<br><br>❖ It has been described that calcifications associated with a malignant process resemble small fragments of **broken glass** and are rarely round or smooth . |

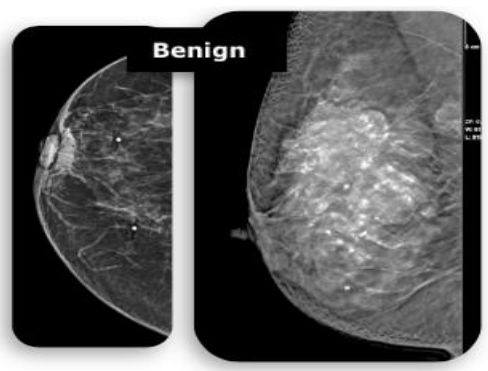
**Not all calcifications are malignant:**

1- **Micro-calcifications:** 0.5 mm or less

2- **CLUSTERED :** > 5 microcalc. in 1 cm2

The more clusters you have the worse.


clustered micro-calcifications

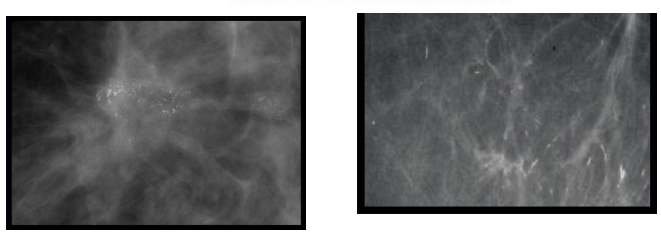



Scattered macro-calcifications

**Typical MALIGNANT Microcalcification:**

❖ Clustered : > 5 in 1 $cm_2$

❖ Branching interrupted ill-defined ductal .



# BI-RADS

## Breast Imaging Reporting system And Data System

Breast Imaging Made Brief and Simple: BI-RADS is an assessment scale indicating the likelihood of breast cancer for mammographic findings.
The American College of Radiology (ACR) Breast Imaging Reporting and Data System (BIRADS) has classified findings of **calcifications** into three categories :

- Typically benign ;
- Intermediate concern ; and
- Higher probability of malignancy .

| | | |
|---|---|---|
| 0 | **Incomplete** | Additional imaging/ view required (Further information needed to put in assessment category) |
| 1 | **Negative (normal)** | Routine screening recommended |
| 2 | **Benign finding** | Routine screening recommended |
| 3 | **Probably benign** | **(<2% malignant)**<br>6 month short interval follow up |
| 4 | **Suspicious of Malignancy (Suspicious-biopsy)** | (>= 2% to 95% malignant)<br>Biopsy should be considered |
| 5 | **Highly suspicious of Malignancy (Malignant-biopsy)** **(we are sure here its malignant)** | (>95% malignancy)<br>Take appropriate action |
| 6 | **Known Biopsy proven Malignancy (follow up patient)** | Malignancy |

# Summary

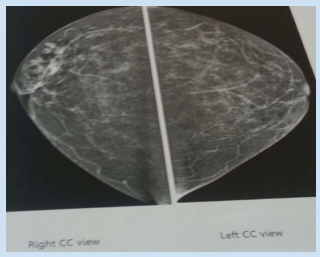
| 4 Pillars for Diagnosis of breast cancer : | | | |
|---|---|---|---|
| **Clinical or Self Examination (PE)** | **Mammography (MG)** | **Ultrasound (US)** | **Magnetic Resonance Imaging (MRI)** |
| | • Can rule IN cancer, but can not rule it OUT .<br>• Not useful for dense breasts ( < 30 y/o ) | • **Indications :**<br>• Differentiation of both palpable and mammographic lesions as either **cystic** or **solid .**<br>• Subsequent characterization and classification of solid nodules according to certain sonographic features .<br>• Evaluation of palpable breast mass in patient younger than age 30 (**very dense breast**) .<br>• Interventional procedures (**BIOPSY**) .<br>• Identification of Malignant Features | - High-field strength (1.0 – 1.5 Tesla) necessary , resulting in :<br><br>- a higher signal-to-noise-ratio<br>- shorter acquisition time<br>- better separation of fat and water peaks<br>- better contrast characteristics (T1 time increase)<br><br>**Contraindicated in :**<br>- Claustrophobia<br>- Cardiac pacemaker or any metal prosthesis |

| In searching for Breast malignancies : | | |
|---|---|---|
| **Mass : Margins is most imp character** | | **Calcification** |
| **Spiculated margins** | **Well circumscribed (well-defined) margins** | **Morphology is most important indicator in differentiating Benign vs malignant lesions** |
| **Classical carcinoma**<br><br>❖ **DDx :**<br>- Fat necrosis (previous surgical biopsy)<br>- Scars (previous surgery)<br>- Radio-opaque mark<br>- Previous scar<br>- Any increase in size —> biopsy<br>- Radial scar (complex sclerosing lesions) | ❖ **Almost always benign .**<br>❖ 5% of them may be malignant .<br><br>❖ **ultrasound :**<br><br>**Cyst** —> No further assessment .<br><br>**Solid** —> Compression / magnification views :<br>- Microlobulated —> Biopsy<br>- Well Circumscribed —> F/U | ❖ Round and oval shaped calcifications that are also uniform in shape and size are likely benign .<br><br>❖ Irregular in shape and size **calcifications** fall closer to the malignant end of the spectrum .<br><br>❖ It has been described that calcifications associated with a malignant process resemble small fragments of **broken glass** and are rarely round or smooth . |

# 438 Quiz

**1- The abnormality seen in the shown mammogram is consistent with which ONE of the following?**

a. Lipoma
b. Hamartoma
c. Spiculated mass
d. Intra-mammary lymph node




**2- What's the most important character to differentiate between benign and malignant breast tumor?**

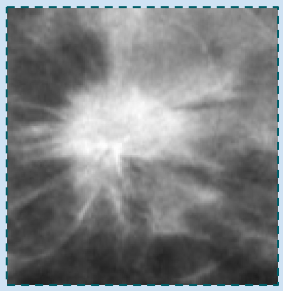
a. Density
b. Margins
c. Shape
d. Location

**3-What is the best modality of breast imaging used for staging ?**

a. MRI
b. Ultrasound
c. Mammogram
d. CT scan

**4- describe the picture seen below :**

a. Circumscribed marigin - benign
b. Indistinct-intermediate probability of malignancy
c. Spiculated-benign
d. Spiculated-high probability of maligna



**5-from which of the following most breast cancer develop ?**

a. terminal ductal lobular unit
b. Adipose tissue
c. Areola
d. Lobules

**6-which of the following calcification character is considered benign lesion ?**

a. Irregular
b. Micro calcification
c. Broken glass fragment
d. Round, oval

Answers
1)B
2)B
3)A
4)D
5)A
6)D

# 439 Quiz

**1- A young pregnant lady presented with breast mass. What's the appropriate modality to use?**

a. Mammogram
b. US
c. CT
d. MRI

**2- A CT scan is used in breast assessment for which one of the following?**

a. Detection of breast lesion.
b. Characterization of breast lesion.
c. Detection of distant metastases
d. Detection of presence of other breast lesions

**3- Which of the following breast lesions is a characteristic for malignancy?**

a. Ill defined
b. Speculated
c. Well circumscribed
d. Wider than taller

**4- 45-year-old female patient presented with right breast mass. Pre-operative MRI shown below was done. The imaging was done in which of the following positions?**

a. Supine with IV contrast
b. Supine without IV contrast
c. Prone with IV contrast
d. Prone without IV contrast

**5-Which one of the following views in mammogram best displays the pectoralis major muscle?**

a. Medial Lateral magnification views
b. Craniocaudal views
c. Craniocaudal magnification views
d. Mediolateral oblique view

Answers
1)B
2)C
3)B
4)C
5)D

# Team leaders

- Reem Alamri
- Alwateen Alaradi
- Abdulaziz Alamri

# Team members

- Reema Alhadlq
- Farah Albakr
- Sara Alrashidi
- Nouf Albrikan
- Renad Alosaimi
- Duaa Alhumoudi
- Norah Almasaad
- Salem Alshihri
- Arwa Alkahtani
- Ibrahim Alabdulkarim
- Mohamed Albabtain
- Abdulaziz Alamri
- Abdulrahman Alswat
- Munib Alkhateb
- Mohammed Alkathiri
- Omar Alhalabi
- Homoud Algadheb
- Nasser Almutawa

Work done by