



## Radiology of breast diseases

### Objectives

1. Radiological anatomy of the breast.
2. Recognize the different modalities for breast imaging based on patient age.
3. Identify benign and malignant features of breast masses and calcifications.
4. Understand the BI-RADS assessment (Breast Imaging and Reporting and Data System).

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Color Coding

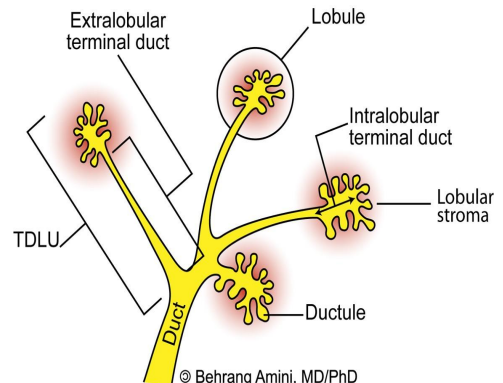
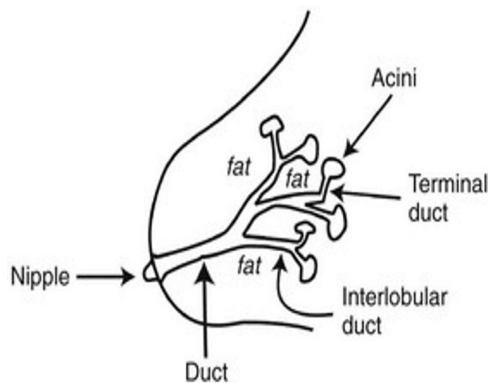
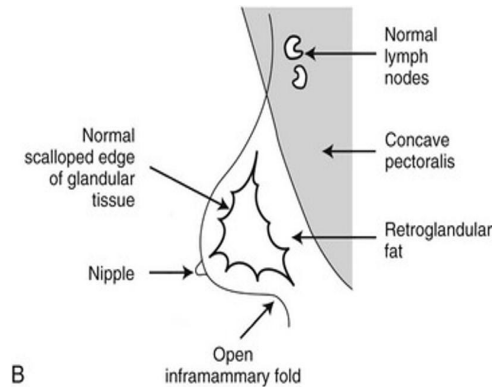
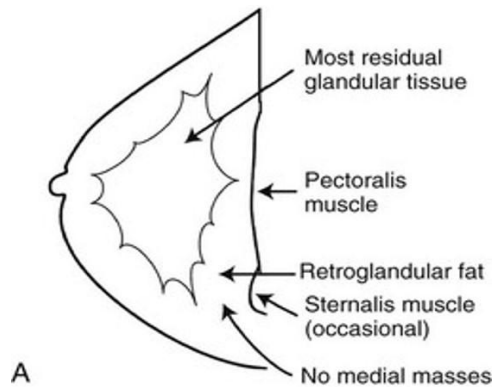
Important | Notes | Extra

Editing  
File



We advise you to study surgery team Breast Diseases lecture before studying our lecture for better understanding =)

## Basic Anatomy:



### Most breast cancer develops in the terminal ductal lobular unit (TDLU)

Majority of breast tumors arise in the upper outer quadrant.

b) Tail of spence (the axillary tail).

- **Terminal ductal lobular unit is composed of:**

1- Intralobular terminal ducts.

2- Acini.

#### - Borders:

a) Upper border: Collarbone (clavicle).

b) Lower border: 6th or 7th rib.

c) Inner border: edge of sternum.

d) Outer border: mid-axillary line.

- **Divisions:** each breast is divided into 5 segments.

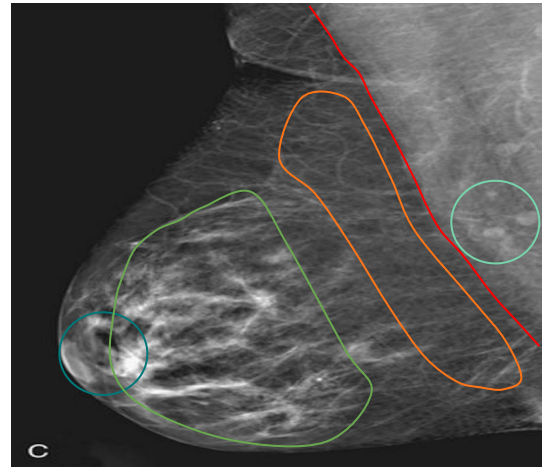
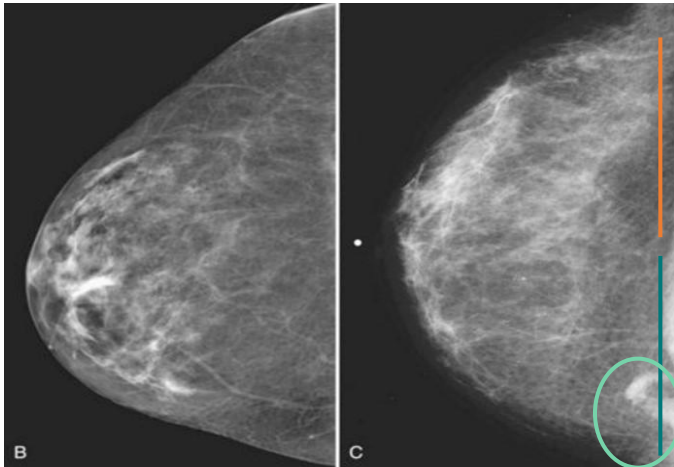
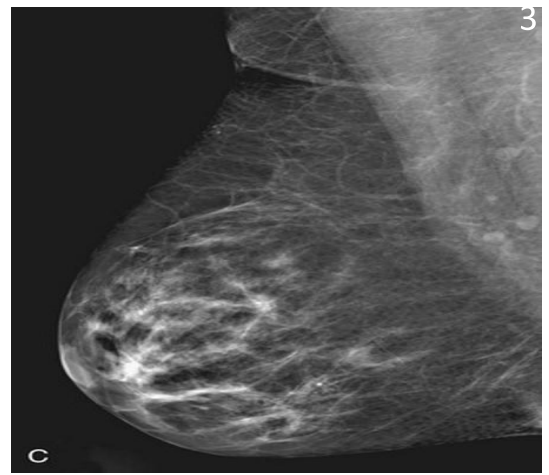
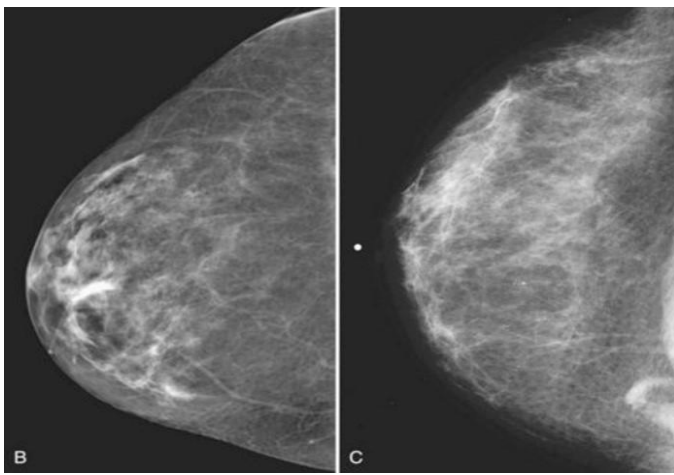
a) 4 quadrants:

2 inner: upper inner & lower inner.

2 outer: upper outer & lower outer.



[Amazing video explains the whole lecture!](#)



- 1. Lateral aspect.
- 2. Medial aspect.
- What's found in C and not in B?**
- The sternalis muscle.

- 1. Pectoralis muscle.
- 2. Axillary lymph nodes.
- 3. Retro-mammary or retroglandular fat.
- 4. Nipple.
- 5. Fibroglandular tissue (White).

Breast cancer can be divided into two major groups

### IN SITU

Tumor cells, they **do not** invade the basement membrane.

Tumor cells remain confined to the ducts or lobules.



DCIS

The membrane here is intact



### INVASIVE

Tumor cells **invade** the breast stroma.

They have the potential to metastasize and result in death of the patient.

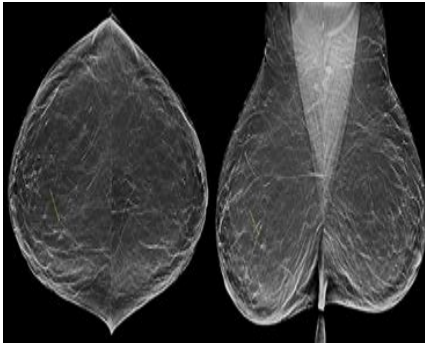


Invasive ductal carcinoma

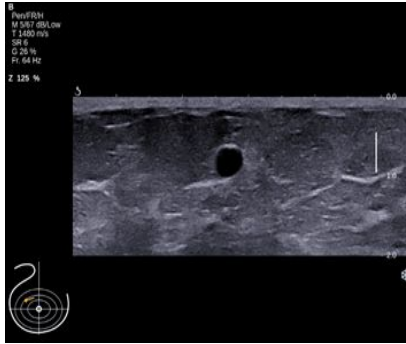
The membrane here is invaded

\* Diagnosis is important because the prognosis differs from early to late stage.

## Breast Imaging



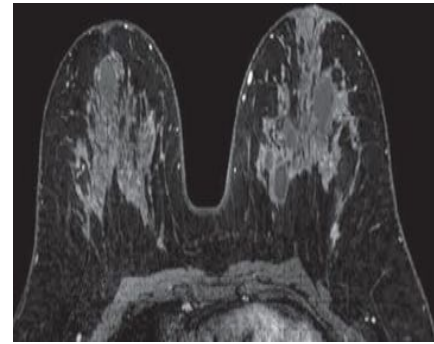
**Mammogram**



**Ultrasound**

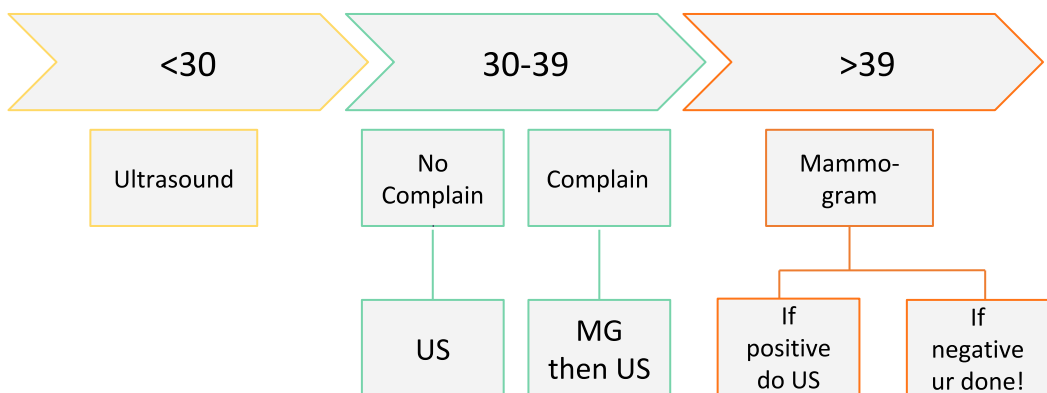
**US is preferred because:**

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



**MRI**

### Modality and Age



\* Always start with mammogram in women above 40 year old

### Mammogram

#### Mammogram Indications:

##### a) 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 BRCA1 & BRCA2** we start the screening 10 years before the first relative was diagnosed. 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.**

##### b) Diagnostic (Complain):

1. Palpable mass.
2. Nipple discharge.
3. Skin changes.

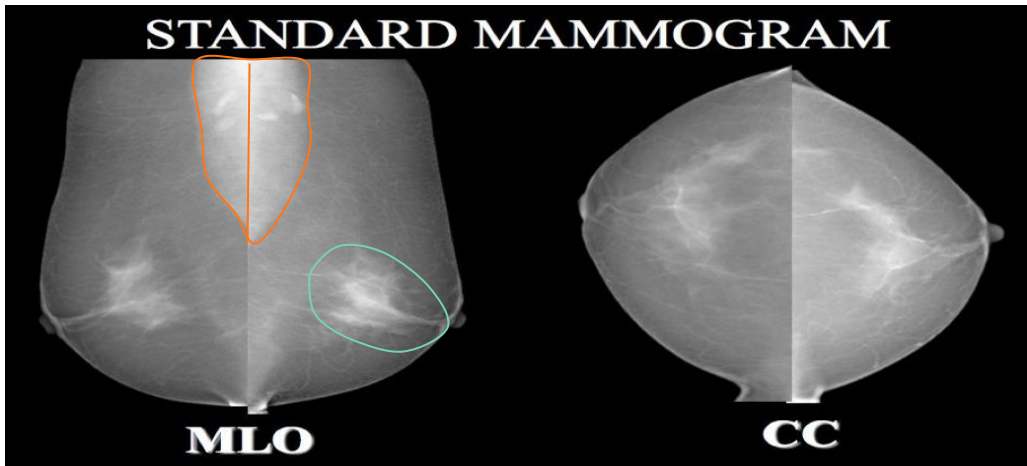


[Breast Mammogram](#)

## Views

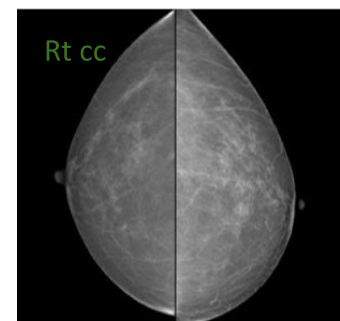
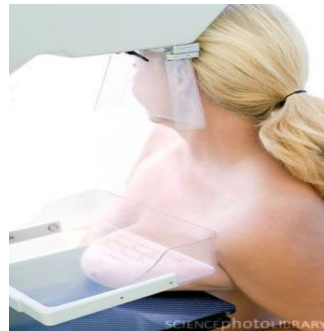
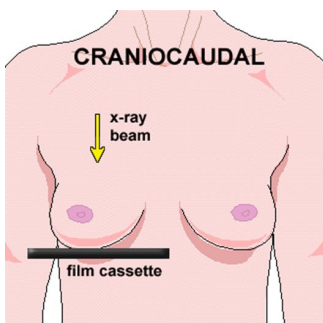
**We have 4 views:** Rt MLO, Lt MLO, Rt cc and Lt cc.

We can see the inframammary fold and pectoralis muscle in MLO view only.



- Pectoralis muscle and axillary lymph nodes.
- Fibroglandular tissue.

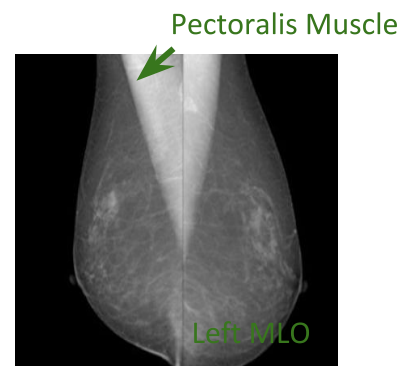
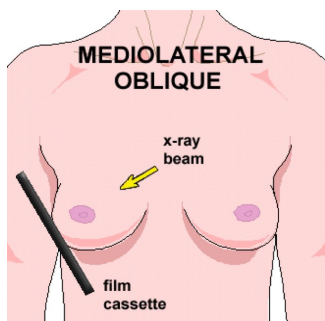
[Click here to see the original image!](#)



**In cranial-caudal (CC):**

Only in 15-20% of cases you can appreciate Pectoralis major muscle.

- The breast is compressed from up to down, with zero angulation.



**In mediolateral-oblique (MLO):**

You can appreciate Pectoralis major msc and the Axillary lymph nodes.

- The breast is compressed from medial to lateral, with 45 degree angle.

## Ultrasound

In mammogram we check shape, density and margins.  
In ultrasound we check **margins margins margins!!!**

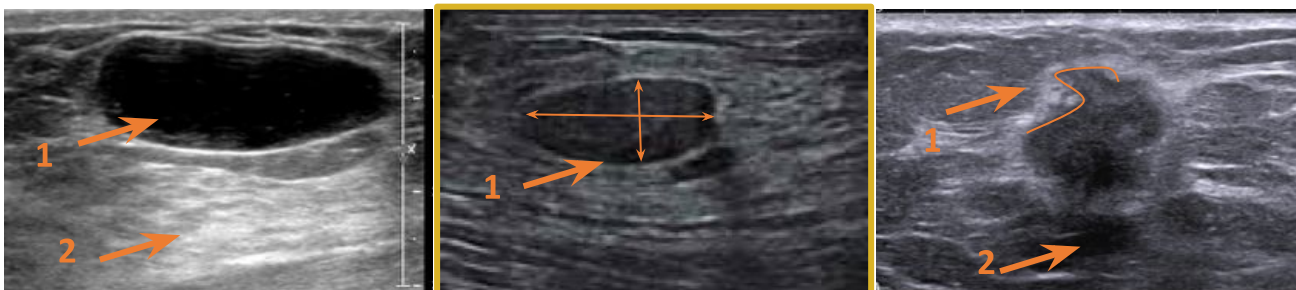
### Breast Ultrasound Indications:

1. Differentiation of both palpable and mammographic lesions as either cystic or solid.
2. Evaluation of solid masses according to certain sonographic features.
3. Initial imaging evaluation of palpable breast masses in patients under 30 years and in lactating and pregnant women.
4. Screening for occult cancers in certain populations, including of women with heterogeneously or extremely dense breasts.
5. Follow-up of breast cancer treated with neoadjuvant chemotherapy.
6. Guidance for breast biopsy and other interventional procedures.

Sometimes we follow up with MRI.

### Malignant VS Benign sonographic features of solid masses:

Malignant	Benign
Spiculation (radiation)	Circumscribed
Angular margins	Parallel oriented - wider than taller
Hypoechoogenicity	Gently curving smooth lobulations
Shadowing	Thin echogenic pseudocapsule
Calcification	
Duct extension	
Branch pattern	
Microlobulation	



#### Cyst

- 1- Anechoic cyst.
  - 2- Posterior enhancement.
- Well defined.  
Typical cyst and cyst is always benign.

#### Solid (benign)

- 1- Echogenic capsule.
- Circumscribed, wider, larger and parallel.  
Posterior shadowing is usually central, this doesn't have a shadow.

#### Solid (malignant)

- 1- Spiculated.
  - 2- Shadowing.
- A little bit hypoechoic and irregular.

## MRI

### MRI Indications:

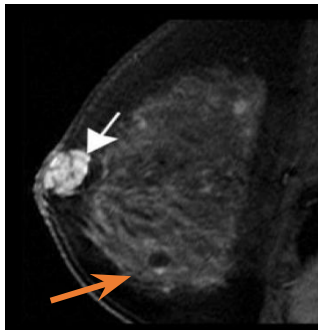
1. Staging, adherence to nipple, surrounding parenchyma.
2. High risk patients, family Hx (mothers or sisters).
3. Monitoring response to therapy.
4. Post operative to differentiate surgical scar versus recurrence.
5. Occult breast cancer.
6. Assess the contralateral breast.
7. Breast implant (Silicon) patient with breast implant complains we do MRI.

### MRI breast-Minimum equipment:

- System with field strengths 1.5 T.
- Dedicated bilateral breast surface coil.
- **Prone positioning** (the best position to perform breast MRI).
- Images obtained prior to gadolinium and multiple phases following gadolinium administration (Dynamic).

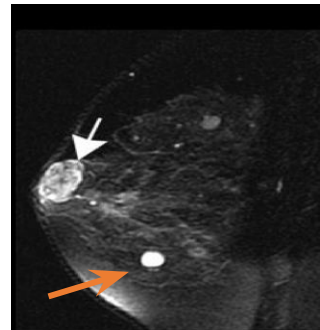


**Chest MRI Equipments**



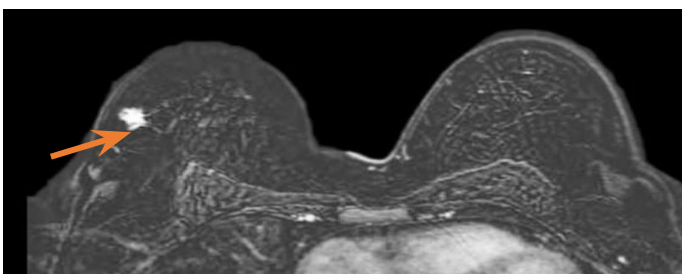
**T1 fat sat with Gadolinium**

fluid will appear hypointense  
which indicates cyst



**T2 fat saturation**

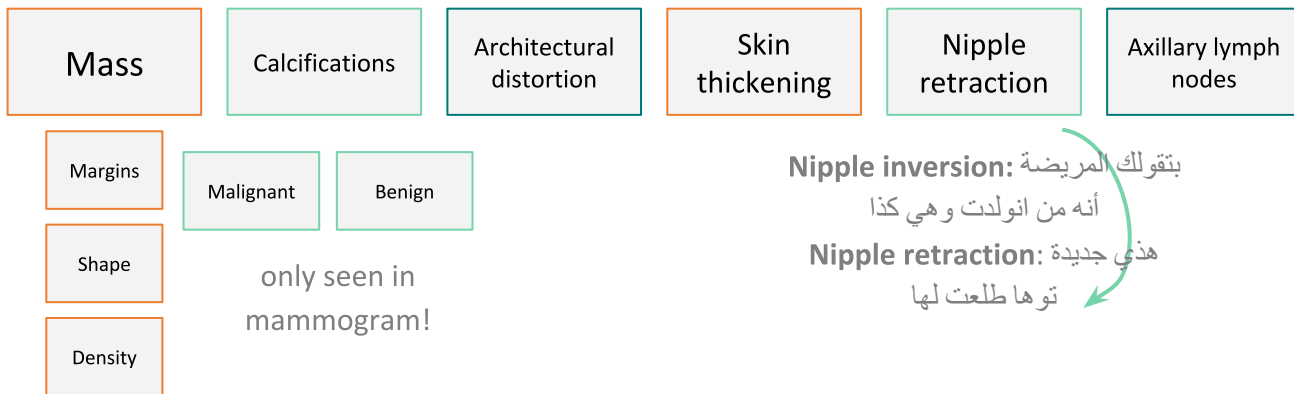
If we have something high signal intensity in T2 this is either a mass like fibroadenoma, mucinous cancer or cyst. Compare the lower lesion (cyst - orange arrow) in T1 and T2, it's high signal in T2 and low signal in T1 because it's water, meanwhile the upper lesion (mass - white arrow) is high signal in both T1 and T2 (enhanced post contrast) so this is enhancing mass with dark septation typical for malignancy.



**Subtracted images = Enhances - Unenhanced images**

In the right outer aspect, small irregular suspicious lesion because of its irregular margins. Always check the margins. We check paralleling in ultrasound only.

## Breast Abnormalities

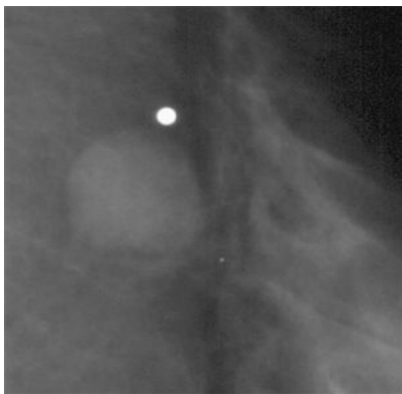


### a) Mass

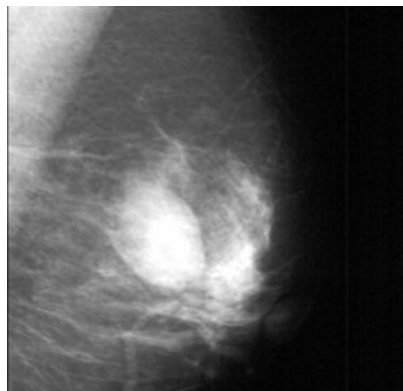
- Both views CC & MLO.
- Persist (spot compression view) to magnify the mass.  
(AKA compression mammogram, cone views, or focal compression views where they apply the compression to a smaller area of tissue for better evaluation). [Read more.](#)
- Shape.
- Margins (the most important feature).
- Density.
- In addition to location.

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

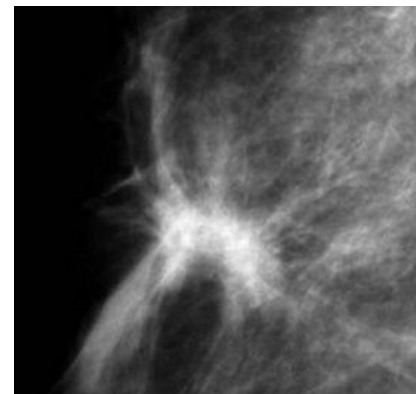
### Mass (shape)



**Rounded**



**Oval**

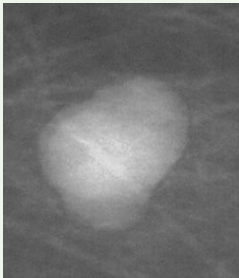
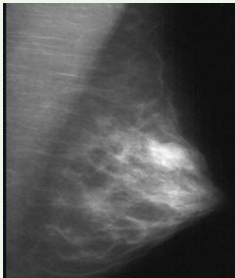
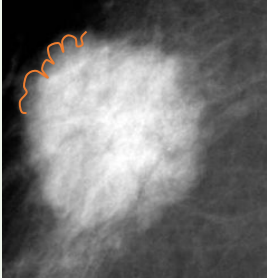
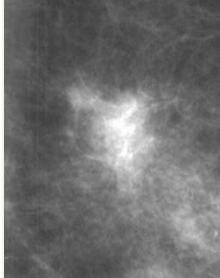
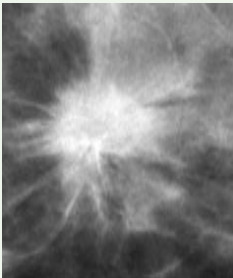


**Irregular (suspicious)**  
(more with aggressive mass)



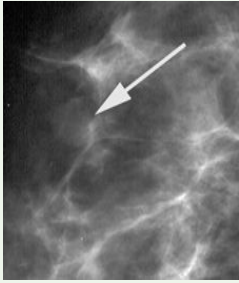
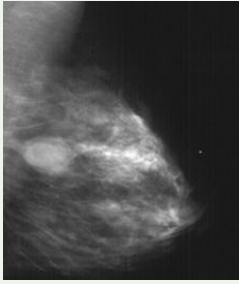
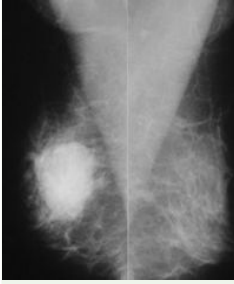
Mass Description

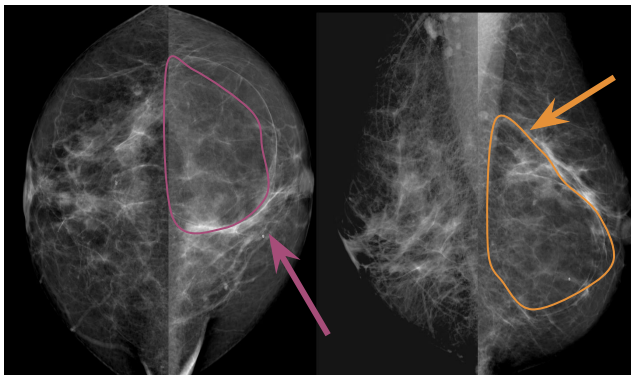
**a) Margins (Extreeeemly important!)**

Circumscribed	Obscured	Microlobulated	Indistinct	Spiculated
<p>كأنه مرسوم بقلم</p> <p>Abrupt transition between lesion and tissue.</p> <p><b>DDx:</b></p> <ol style="list-style-type: none"> <li>Cyst.</li> <li>Fibroadenoma (Breast mouse).</li> <li>It can be lipoma, but lipoma should be loosened and this is dense.</li> </ol>	<p>Margins (suspected to be circumscribed) hidden by adjacent superimposed normal tissue. Ask for compression or magnification views.</p> <p>Totally or partially obscured (usually benign).</p>	<p>Margin undulated with short cycle 1-2 mm (suspicious).</p>	<p>Ill defined. Possible infiltration (more suspicious).</p>	<p>Lines radiating from margins of a mass (from a DENSE center).</p> <p><b>DDx:</b></p> <ol style="list-style-type: none"> <li>Cancer.</li> <li>Surgical scar.</li> <li>Fat necrosis.</li> </ol> <p>The chance of malignancy is above 95% (most suspicious).</p>
				

**b) Density**

Most of the time benign but the lesion margins are important

Fat only	Mixed density	Low dense	Equal dense	High dense
<p><b>DDx</b></p> <ol style="list-style-type: none"> <li>Oil cyst/fat necrosis, post surgery/trauma.</li> <li>Lipoma, if you see a mass, its benign.</li> </ol>	<p><b>DDx:</b></p> <ol style="list-style-type: none"> <li>Hamartoma (it's a breast within the breast).</li> <li>Inframammary lymph nodes.</li> <li>Fat necrosis.</li> <li>Galactocele (lactating women comes complaining of mass decreases in size after lactation) if you see a mass, it's benign.</li> </ol>	<p><b>DDx:</b></p> <p>Cyst.</p>  <p>Cancer is less likely but still possible.</p>	<p><b>DDx:</b></p> <ol style="list-style-type: none"> <li>Cyst.</li> <li>Fibroadenoma.</li> <li>Cancer.</li> </ol>  <p>Cancer is less likely but still possible.</p>	<p>Cancer.</p>  <p>Most of the time suspicious.</p>



[Click here to see the original image!](#)

### Lipoma:

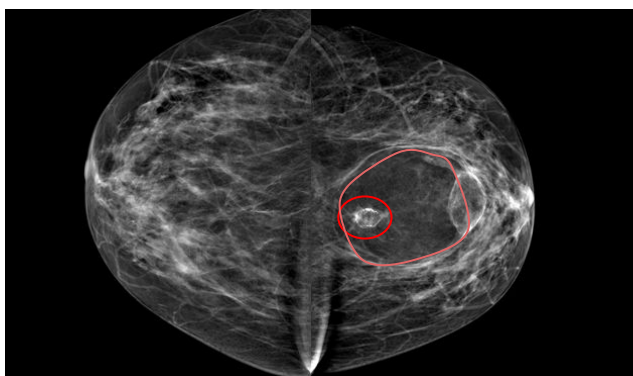
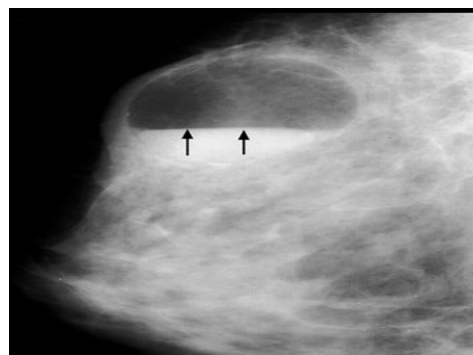
It's circumscribed with very clear margins  
This is all a mass and the glandular tissue here is pushed up. Meanwhile here it's pushed to the medial side.

Lucent (gray) lesion with thin dense (white) capsule represents the pushed breast parenchyma.

### Galactocele:

Fat-Fluid Level, this is typical for mixed density lesion and galactocele, just like water and oil, Fat is oil so it will flow and milk which represents water will go down, high risk of infection.

The surrounding tissue is highly dense because of lactating.



[Click here to see the original image!](#)

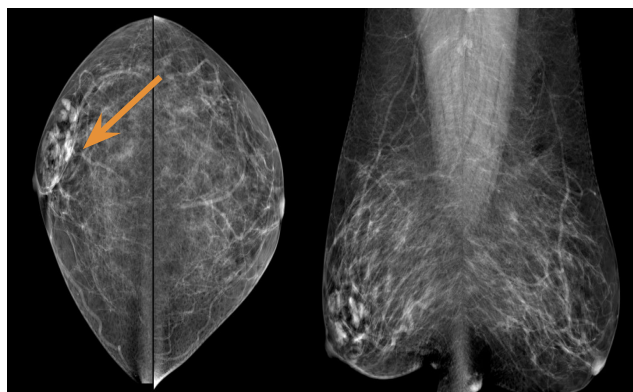
### Fat necrosis:

The only difference between fat necrosis and lipoma is the presence of **dystrophic calcification** in case of fat necrosis.

### Hamartoma (Fibroadenolipoma):

The abnormality is in the right breast, retroareolar area, mixed density mass. It's called (breast in a breast mass) typical for hamartoma.

- **Mammogram:** Partially circumscribed oval mass with some obscured margins.
- In **US**, a sharply defined, heterogeneous oval mass is seen, or the lesion may manifest as normal glandular tissue.
- It is not considered a malignant tumor.
- Mostly asymptomatic.
- No need for biopsy or follow up.



## Benign Calcifications



Skin



Vascular



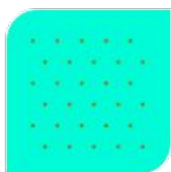
Rim



Popcorn



Rod-Like



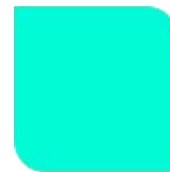
Punctate



Milk of calcium



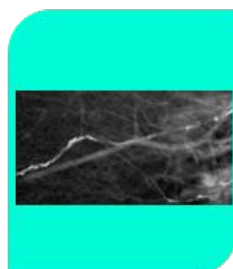
Suture



Dystrophic



Skin



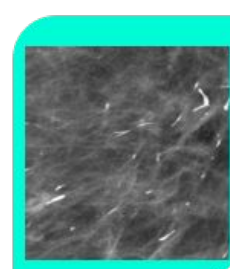
Vascular



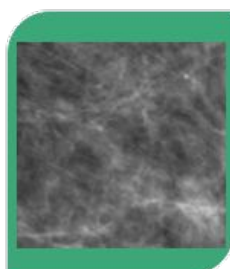
Rim



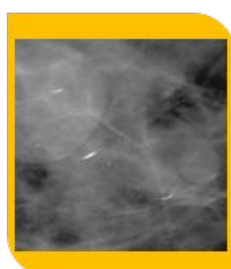
Popcorn



Rod-Like



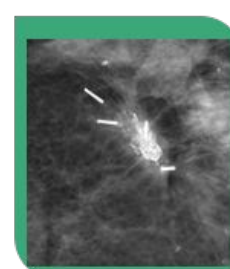
Punctate



Milk of calcium



Suture



Dystrophic

1- **Skin**: Multiple rim shaped skin/dermal calcification, ring-like with central lucency.

2- **Vascular**: Calcifications along the blood vessel.

3- **Rim**: Remember fat necrosis case? With The rim calcification and internal dystrophic calcification. **DDx**: Fat necrosis/Oil cyst.

4- **Popcorn**: Typical for calcified fibroadenoma (involved fibroadenoma).

5- **Rod-like**: Sharply demarcated.

6- **Punctate**: Tiny dots.

7- **Milk of calcium**: Small layering calcification within the cyst.

8- **Suture**: Post surgery along suturing line.

9- **Dystrophic**: Fat necrosis post surgery/trauma (and breast trauma is not a risk factor for breast cancer).

Suspicious Calcification more with malignant



**Amorphous**

The dots here are smaller than in the punctate calcification.



**Coarse heterogenous**

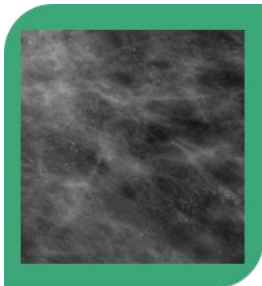
looks like the popcorn but smaller in size, irregular in shape.



**Fine Pleomorphic**  
different in size, shape, density.



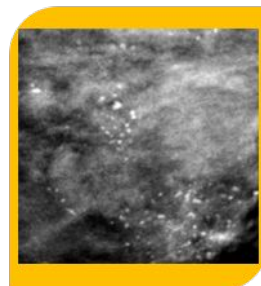
**Fine Branching and linear branching**  
**Most suspicious!**  
differentiate between this and milk and rod-like benign calcification.



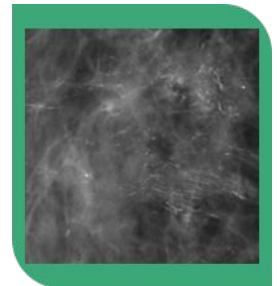
**Amorphous**



**Coarse Heterogeneous**



**Fine Pleomorphic**

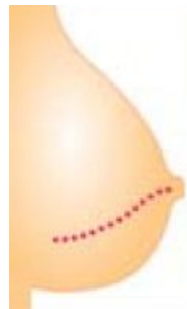


**Fine Branching and linear branching**

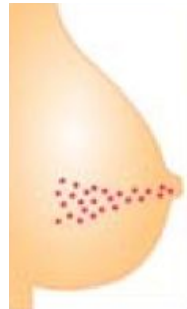
Distribution



**Grouped**  
< 2cm (must be 5 calcifications to consider it group)



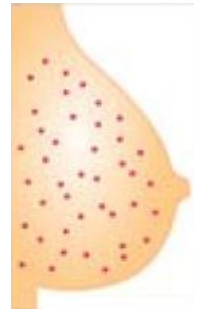
**linear Suspicious**  
Arranged in lines within ductules



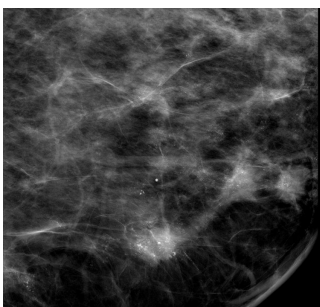
**Segmental Suspicious**  
Multiple lines towards the nipple



**Regional**  
> 2cm



**Diffused**  
Entire breast



**Grouped Calcifications**  
7 different groups

**Size:**

- Micro calcifications are associated with malignant processes; Macro calcifications are associated with benign processes. 0.5 mm or less to have a high probability of association with cancer, 2.0 mm or larger are typical of a benign process.

**Morphology:**

- Round and oval shaped calcifications that are also uniform in shape and size are likely benign.

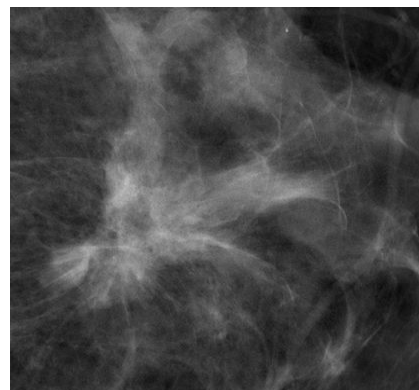
- Irregular in shape and size calcifications fall closer to the malignant end of the spectrum.

## Architectural Distortion

- Lines radiating from a point.
- Focal retraction/distortion of parenchymal edge.
- Main findings or associated findings, a patient with distortion only or with suspicious mass in addition to distortion.

### Differential diagnosis:

1. Breast cancer.
  2. Radial Scar (complex sclerosing lesion).
  3. Surgical Scar.
- How to differentiate between architecture distortion & spiculated mass?
- In architecture distortion the lines are radiating from a LUCENT center. If you see architectural distortion ask the pt if she has ever had a surgery, because if she has it will be not necessary to do further investigation or biopsy, the surgery might be the cause of the distortion.



## BI-RADS

### Breast Imaging Reporting And Data System

The system is Made from the American College Of Radiology to standardize the reports.

0 = **Incomplete** exam, Additional imaging/view is recommended.

1 = **Negative** no abnormalities at all, Routine screening recommended.

2 = **Benign** like cyst, fibroadenoma, hamartoma and fat necrosis, Routine screening recommended.

3 = **Probably Benign** (< 2% malignant); six-month short interval follow-up.

4 = **Suspicious of Malignancy** (≥ 2 to 95%); biopsy should be considered.

5 = **Highly Suspicious of Malignancy** (> 95%); take appropriate action.

6 = **Known Biopsy-Proven Malignancy** known malignancy (example: a patient diagnosed with breast cancer and is on chemotherapy, imaging was done to assess response to chemotherapy; the cancer is still there but is bigger/smaller/or stable).

However, if the patient had breast cancer in the past and her status post treatment and surgery and current imaging only has post surgical changes with no suspicious findings then this is BIRADS 2 (she's already diagnosed with cancer and just come to follow up).



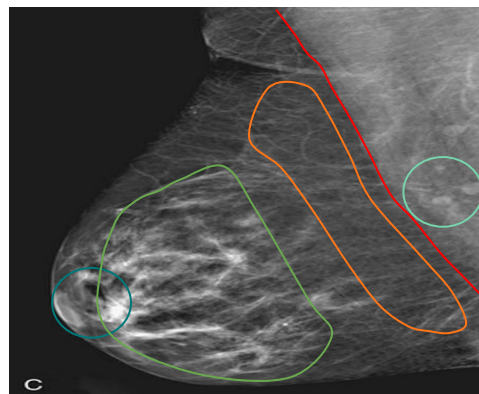
# Summary

<p><b>Anatomy of breast</b></p>	<ol style="list-style-type: none"> <li>1. <b>External anatomy:</b> <ul style="list-style-type: none"> <li>- Nipple.</li> <li>- Areola.</li> <li>- Glands of Montgomery.</li> </ul> </li> <li>2. <b>Internal anatomy:</b> <ul style="list-style-type: none"> <li>- Glandular tissue.</li> <li>- Fibrous (supporting): cooper's ligaments.</li> <li>- Fatty tissue.</li> </ul> </li> </ol>
<p><b>Modality and Age</b></p>	<ul style="list-style-type: none"> <li>● &lt; 30: Ultrasound.</li> <li>● 30-39: if no complain do US, complain do mammogram then US.</li> <li>● &gt; 40: mammogram, if +ve do US.</li> </ul>
<p><b>Mammogram Indications</b></p>	<ol style="list-style-type: none"> <li>1. Screening (The patient has no complaints).</li> <li>2. Diagnostic (The patient has a complaint).</li> </ol>
<p><b>Breast abnormality</b></p>	<ol style="list-style-type: none"> <li>1. Mass.</li> <li>2. Architectural Distortion.</li> <li>3. Calcification.</li> <li>4. Skin thickening.</li> <li>5. Nipple retraction.</li> <li>6. Axillary lymph nodes.</li> </ol>
<p><b>Mass Margins</b></p>	<ol style="list-style-type: none"> <li>1. Circumscribed.</li> <li>2. Obscured.</li> <li>3. Microlobulated (suspicious).</li> <li>4. Indistinct (more suspicious).</li> <li>5. Spiculated (<b>most suspicious</b>).</li> </ol>
<p><b>Mass density</b></p>	<ol style="list-style-type: none"> <li>1. Fat only.</li> <li>2. Mixed density.</li> <li>3. Low dense.</li> <li>4. Equal dense.</li> <li>5. High dense (suspicious).</li> </ol>
<p><b>Benign Calcification</b></p>	<ol style="list-style-type: none"> <li>1. <b>Skin:</b> ring-like.</li> <li>2. <b>Rim.</b></li> <li>3. <b>Popcorn:</b> involuted fibroadenoma</li> <li>4. <b>Rod-like:</b> sharply demarcated</li> <li>5. <b>Punctate:</b> tiny dots.</li> <li>6. <b>Milk of calcium:</b> layering.</li> <li>7. <b>Suture:</b> post surgery.</li> <li>8. <b>Dystrophic:</b> fat necrosis.</li> </ol>
<p><b>Suspicious calcification</b></p>	<ol style="list-style-type: none"> <li>1. Amorphous.</li> <li>2. Coarse heterogeneous.</li> <li>3. Fine pleomorphic.</li> <li>4. Fine branching and linear branching.</li> </ol>

# Questions

**Q1: What is the structure in orange in the following mammogram image of the breast?**

- Nipple.
- Pectoralis muscle.
- Fibroglandular tissue.
- Retromammary fat.



**Q2: A 34-year-old women came to your clinic complaining of greenish breast discharge started a month ago. Which of the following will be used to investigate the problem?**

- Ultrasound.
- MRI.
- Mammogram then Ultrasound.
- Mammogram.

**Q3: All of the following is a malignant feature of breast mass except for:**

- Thin echogenic pseudocapsule.
- Spiculation.
- Duct extension.
- Shadowing.

**Q4: An important feature to distinguish lipoma from fat necrosis is:**

- The location of the glandular tissue.
- The circumscribed margins.
- The dystrophic calcification.
- The heterogeneity

**Q5: All of the following is an example of benign calcification except:**

- Popcorn.
- Skin.
- Rim.
- Fine pleomorphic.

Answers:  
1-d.  
2-c.  
3-a.  
4-c.  
5-d.

WE NEED  
**YOUR**  
**FEEDBACK**