BREAST
CHAPTER 21

ROLE OF IMAGING IN BREAST EXAMS, ANATOMY & PHYSIOLOGY

ROLE OF IMAGING

- One in eight American women will develop breast cancer
  - Lifetime risk ~12%
  - Most common type of CA among women
- Early detection is vital
- Mammography = gold standard
  - Detects microcalcifications
  - 3D (tomosynthesis) images layer by layer
  - Difficult to image into dense breast tissue

ROLE OF IMAGING

- **Mammography:**
  - **Screening mammograms should begin yearly ~ 40 years old**
  - **Diagnostic mammograms are performed on patients who had abnormal findings on CBE, BSE, or who had an abnormal screening mammogram**
    - **Involves specialized detailed views**

ROLE OF ULTRASOUND

- **Ultrasound incredibly useful**
  - **Younger women with dense breast tissue**
  - **Adjunct to abnormal mammo or palpable lump**
  - **Allows imaging deep to the chest wall with minimal pain**
  - **Differentiates between cystic and solid**
  - **Doppler allows for blood flow detection**
  - **US-guided procedures (biopsy, needle loc, etc.)**
- **Limitations:**
  - **Operator and equipment dependent**
  - **Microcalcifications not easily imaged**
  - **Some masses have similar characteristics whether benign or malignant**

ROLE OF ULTRASOUND

- **Patient history is critical:**
  - **Age**
  - **Location of any lumps**
  - **History of trauma to the breast**
  - **Previous surgery**
- **Physician's clinical impression also helpful**
  - **Fibrocystic, suspicion of CA, abscess**

RISK FACTORS FOR BREAST CA

- Female
- Increasing age
- Fx of breast CA
- Personal hx of breast CA (or associated CA's)
- Biopsy proven atypical proliferative lesions
- Prolong estrogen effect (early menarche)
- Late menopause
- Nulliparity
- Late first pregnancy

INDICATIONS FOR ULTRASOUND

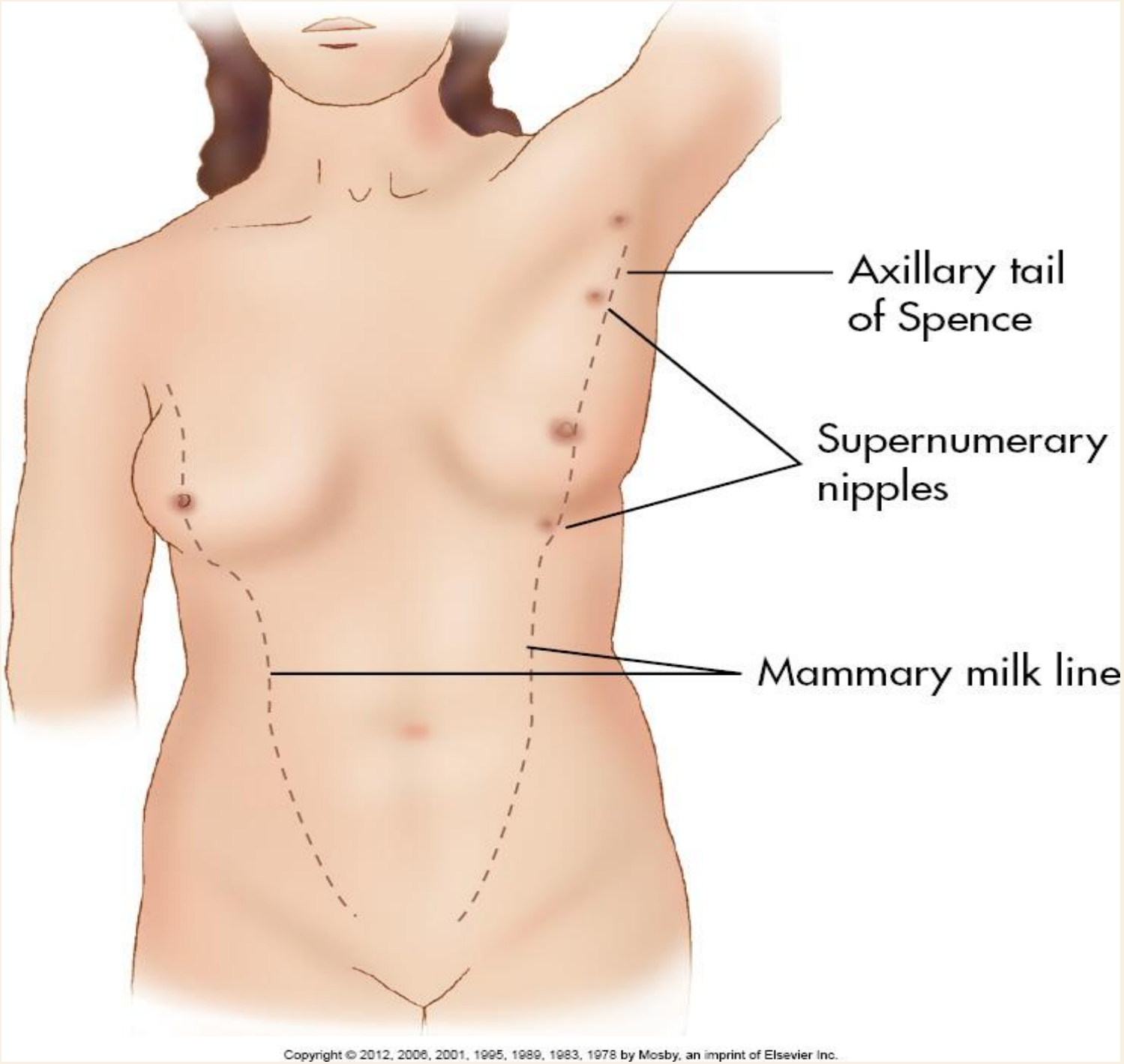
1. Evaluate a palpable mass in women <30 y.o. or women who are pregnant/lactating
2. Evaluate areas of breast pain, skin redness, or nipple changes
3. Correlate with questionable findings on a mammogram
4. Evaluate breast implants
5. Evaluated the radiographically dense breast
6. Serial monitoring of benign mass
7. Evaluate axillary lymph nodes

INDICATIONS FOR ULTRASOUND

8. Guidance during interventional procedures or when planning radiation therapy
9. Evaluate post-surgical or post-irradiated breast
10. Evaluate the male breast
11. Evaluate the breast when mammo is contraindicated

DEVELOPMENT

- **Early mammary gland begins development during the 4th week of embryonic life**
- **"Milk line" – breast develop along a line extending from the axilla to the inguinal region bilaterally**
  - **Accessory or supernumerary breasts are found along this line**
- **Breast enlargement in the newborn may be seen due to the placental and maternal hormonal stimulation**
  - **Estrogen influenced by mom**



DEVELOPMENTAL ANOMALIES

- **Unilateral early ripening:**
  - **Glandular tissue may start to develop in one breast before the other breast**
  - **Do not mistake this for a mass**
- **Precocious puberty:**
  - **Early bilateral breast development**
  - **Causes:**
    - **Estrogen secreting ovarian tumor**
    - **Adrenal tumor**
    - **Changes within the hypothalamus or pituitary glands**

DEVELOPMENTAL ANOMALIES

- **Congenital Nipple Flattening/Inversion:**
  - **Can be congenital if bilaterally**
  - **New findings are suspicious for pathology**
- **Polythelia:**
  - **Accessory nipple**
  - **Most common breast anomaly**
  - **More common in men than women**
- **Polymastia:**
  - **Accessory breast or more than two breasts**
  - **Most commonly found in the axilla**

DEVELOPMENTAL ANOMALIES

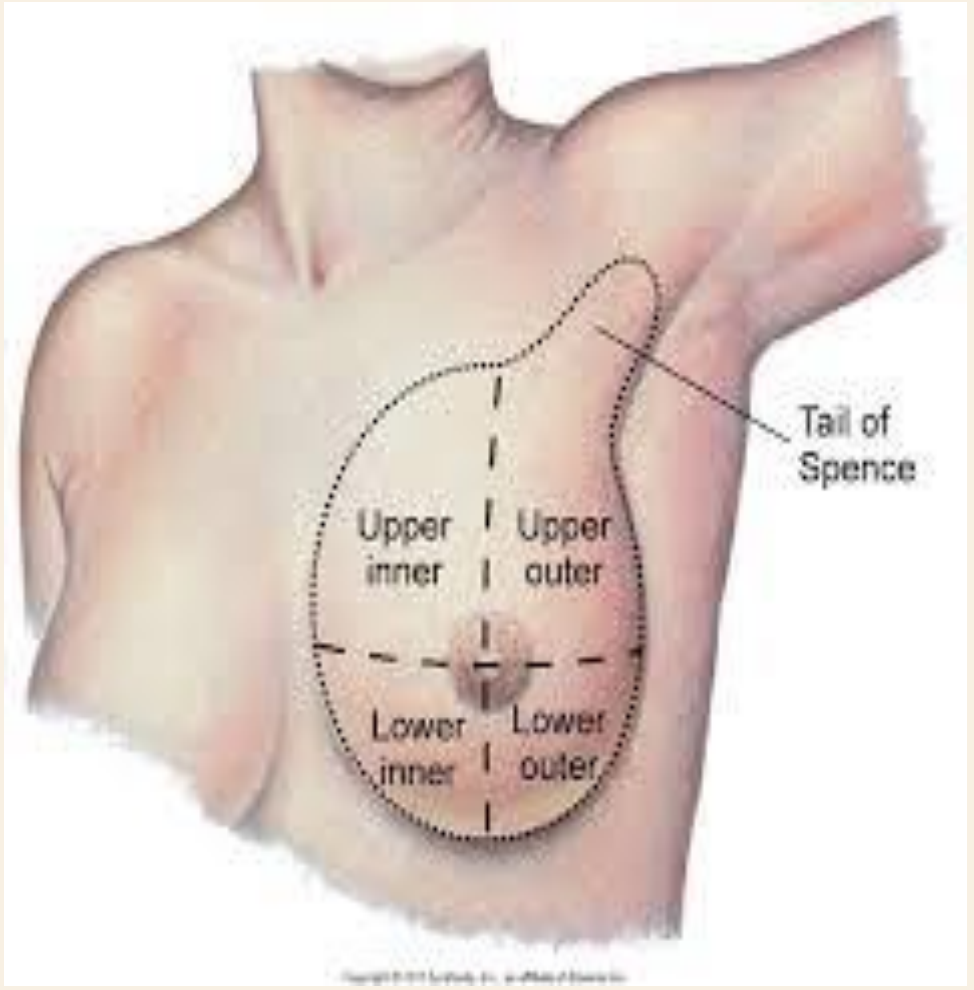
- **Athelia:**
  - **Absence of the nipple**
- **Amastia:**
  - **Absence of one or both breasts**
- **Amazia:**
  - **Absence of the breast tissue with development of the nipple**
  - **Can occur secondary to radiation exposure or surgical excision**

ANATOMY OF THE BREAST

- **Modified sweat gland in the superficial fascia of the anterior chest wall**
- **Major portion situated between:**
  - **2nd and 3rd rib superiorly**
  - **6th and 7th costal cartilage inferiorly**
  - **Axillary line laterally**
  - **Sternum medially**

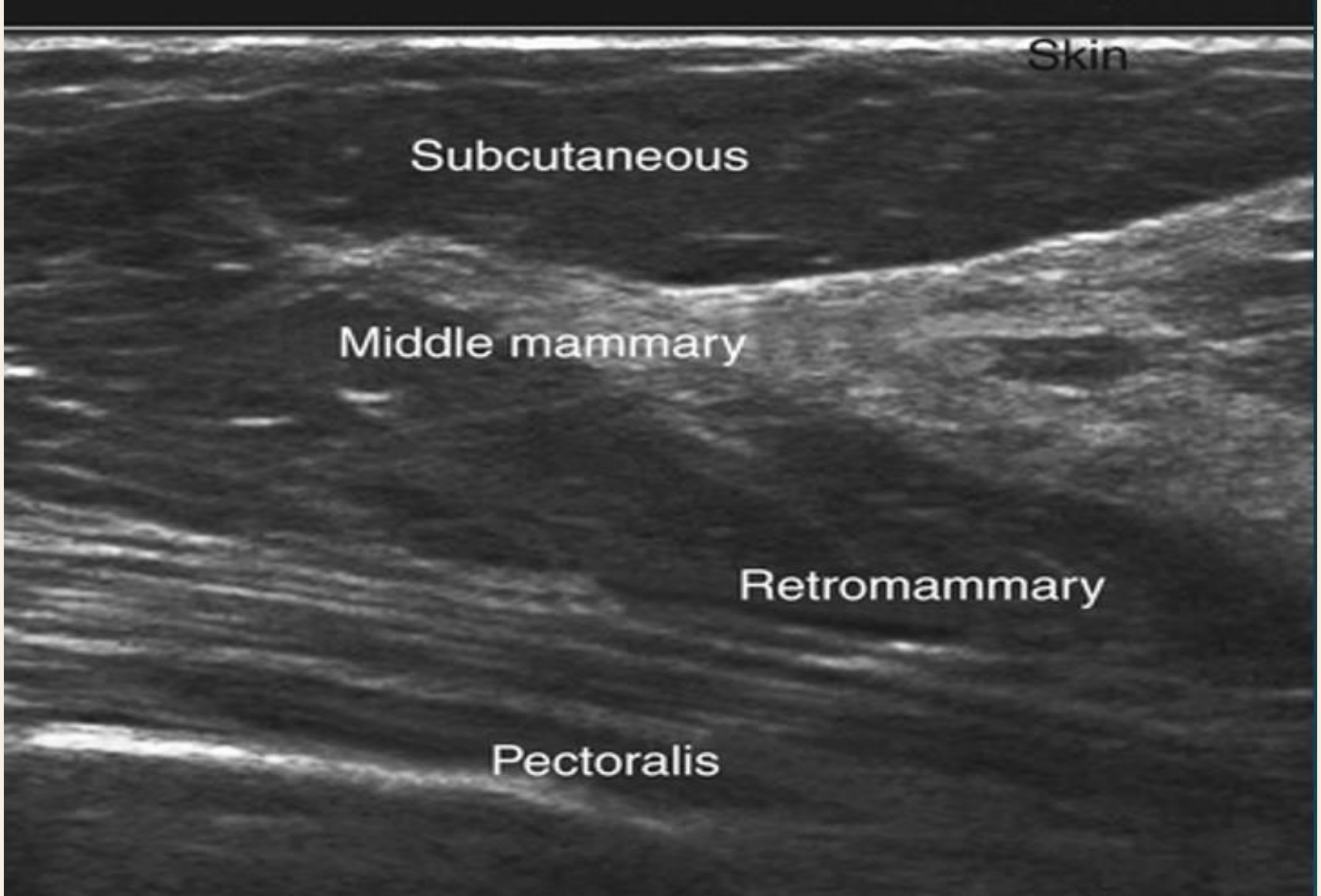
ANATOMY OF THE BREAST

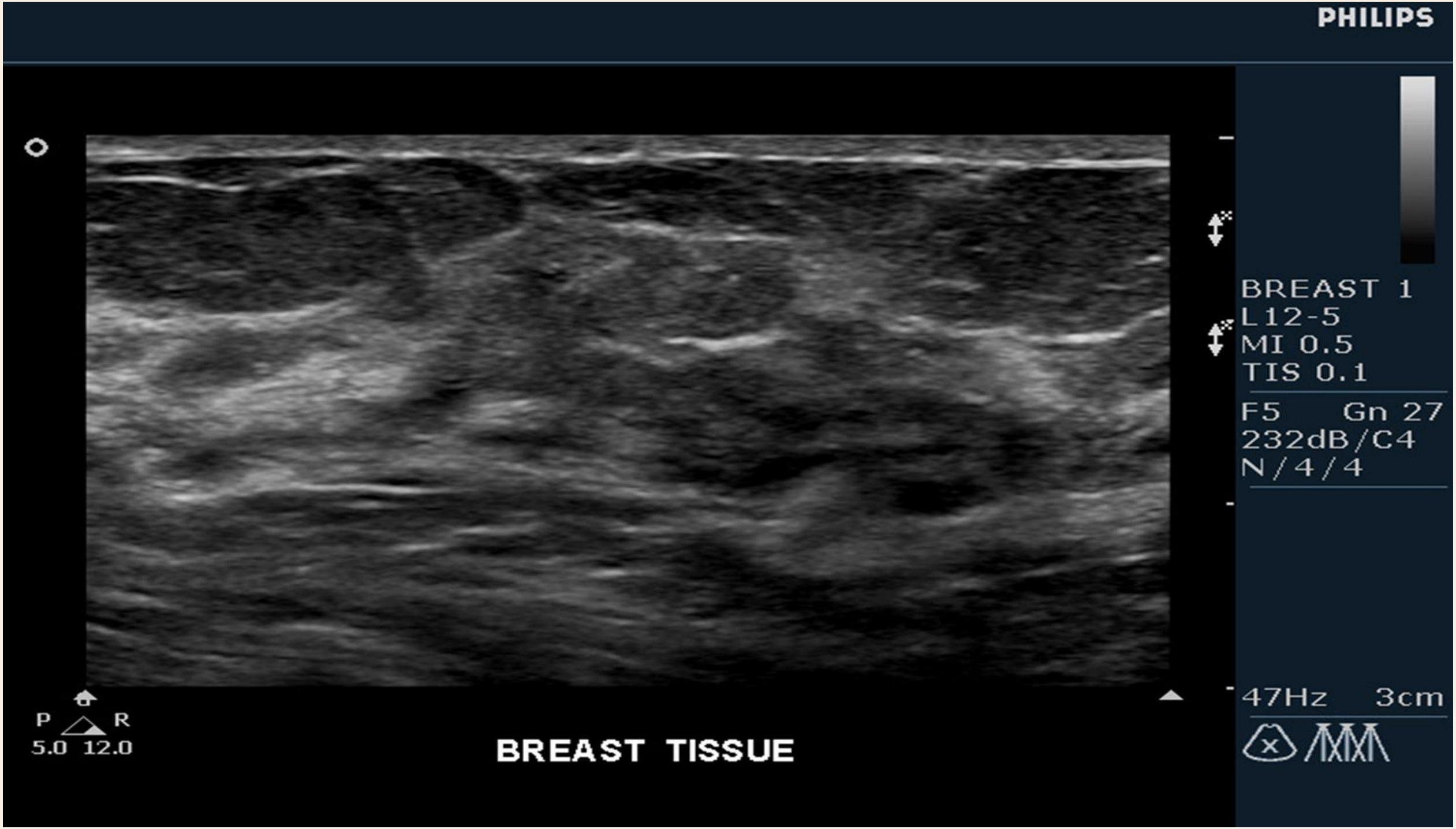
- **Breast tissue extends toward the lateral upper margin of the chest into the axilla**
  - ***Tail of Spence***
- **Surface of the breast contains the nipple and surrounding areola**

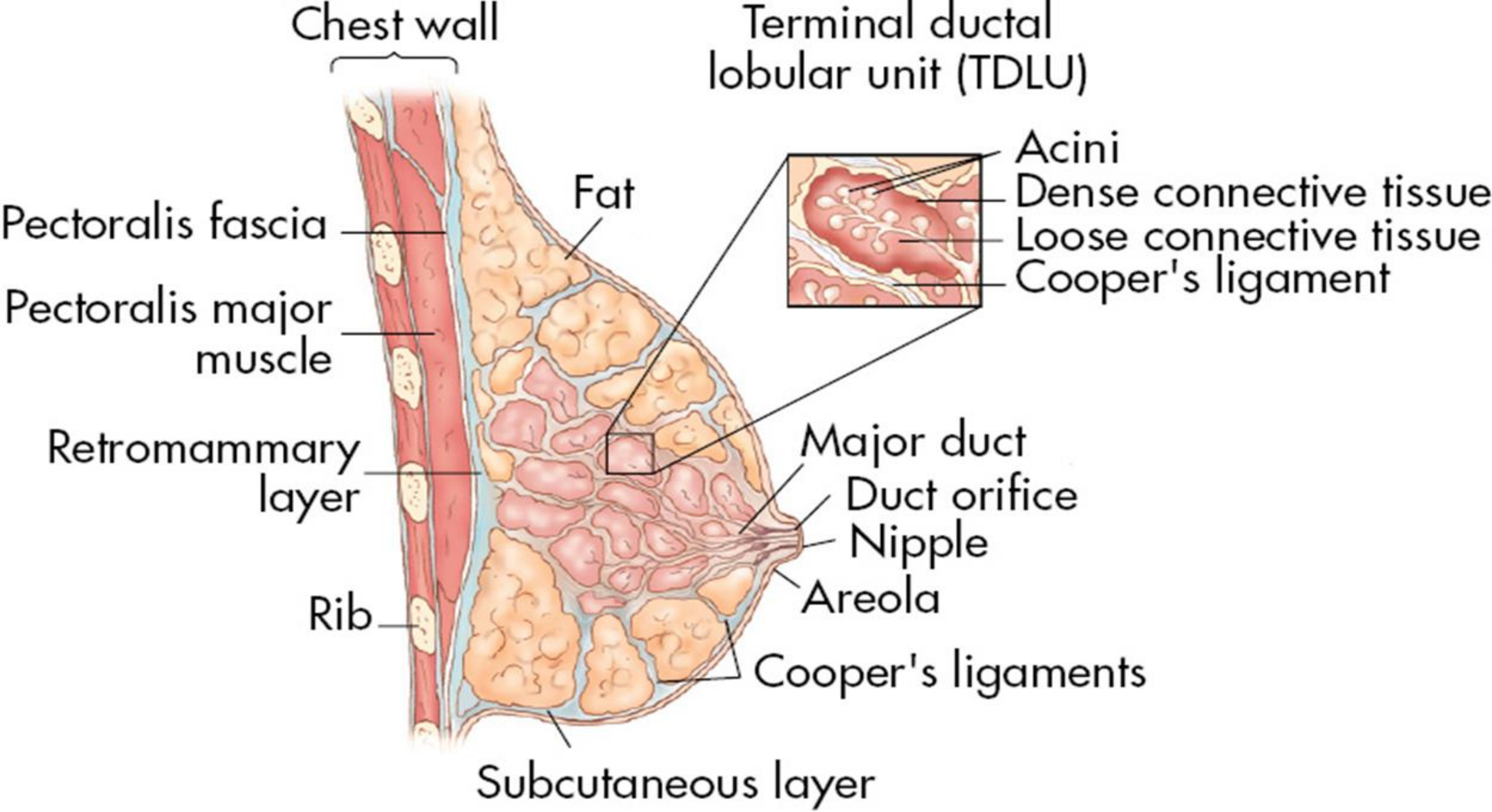


ANATOMY OF THE BREAST

- **The layers of the breast:**
  1. **Skin**
  2. **Subcutaneous layer (pre-mammary layer)**
  3. **Mammary layer**
  4. **Retromammary layer**
  5. **Muscle Layers**
     - **Pectoralis Major**
     - **Pectoralis Minor**
  6. **Chest Wall (Intercostal muscles & ribs)**


Skin
Subcutaneous
Middle mammary
Retromammary
Pectoralis


PHILIPS
BREAST 1
L12-5
MI 0.5
TIS 0.1
F5 Gn 27
232dB/C4
N/4/4
47Hz 3cm
P R
5.0 12.0
BREAST TISSUE



EXTERNAL ANATOMY

Skin

- Composed of:
  - Epidermis
  - Dermis
- Thickness is 0.5 – 2 mm
  - Thickest at the base of the breast
- Pores along the surface indicate locations of:
  - Sweat glands
  - Sebaceous glands
  - Hair follicles

EXTERNAL ANATOMY

Nipple

- Consists of dense connective tissue and erectile muscle
- Contains many sensory nerve endings
- 15-20 lactiferous ducts openings may be seen

Areola

- Smooth muscle, circular, & darker pigmentation of skin that encircles the nipple
- Contains numerous sebaceous gland
  - Montgomery's glands
    - Appears as small bumps in the areola
    - Release fatty substance that protects the nipple during lactation

SUBCUTANEOUS LAYER

- Beneath the skin to the mammary layer
- Contains Cooper's ligaments (Provides support)
- Consists mostly of fat
  - Fat will not be seen posterior to the nipple
- The amount of fat will increase with:
  - Age
  - Obesity
  - Pregnancy

MAMMARY LAYER

- Known as the:
  - Parenchymal Layer

    Or
  - Glandular Layer

- Axillary Tail of Spence
  - Portion of glandular tissue that extends into the axilla
- Composed to two types of tissue:
- Stroma and Epithelium

MAMMARY LAYER

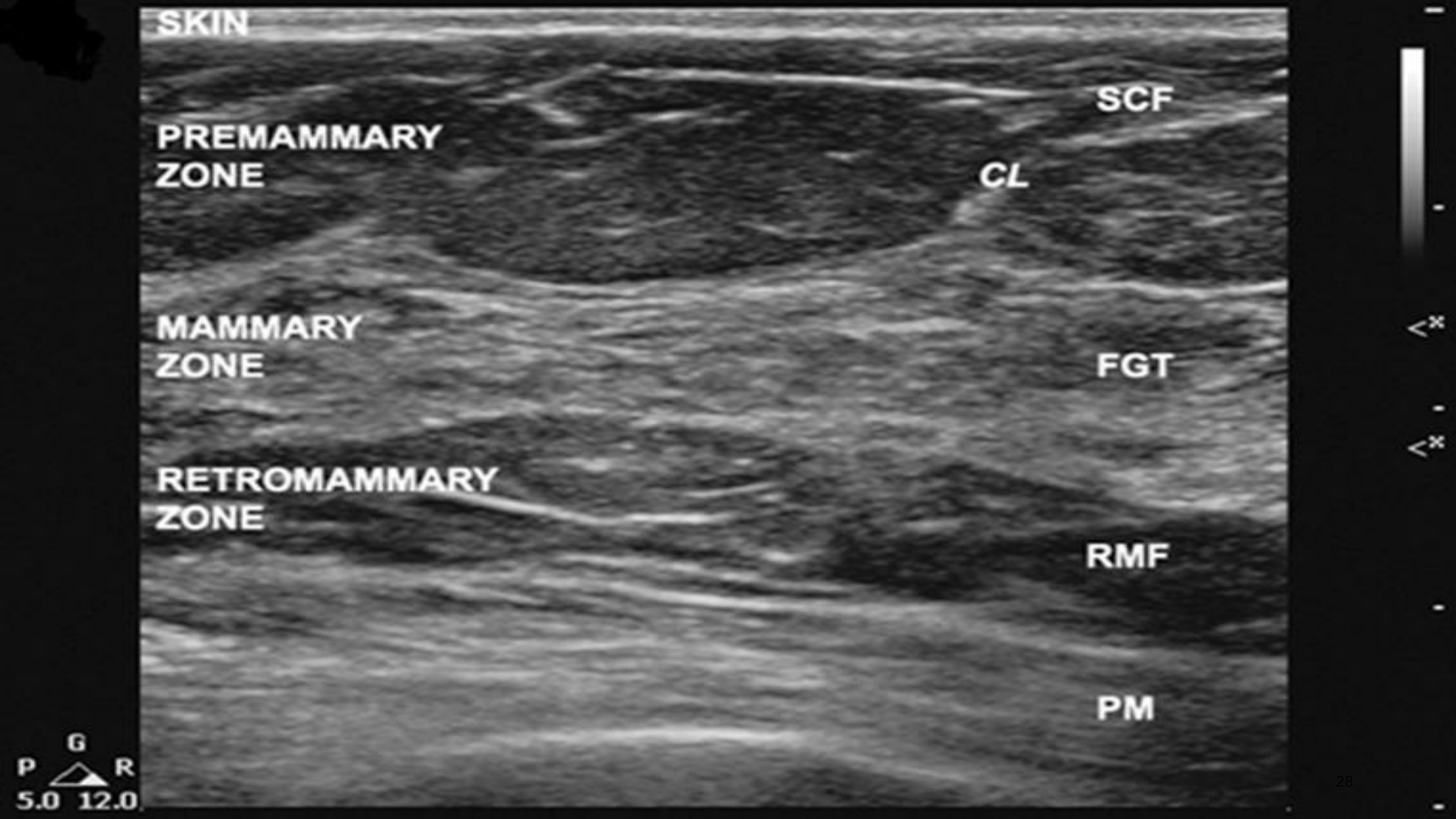
- **Stroma**
  - **Supportive tissue of the breast**
  - **Consists of:**
    - **Interlobular fat**
    - **Connective tissue**
      - **Cooper's ligaments**
      - **Loose connective tissue**
      - **Dense connective tissue**

MAMMARY LAYER

- **Epithelium**
  - **Functional tissue**
  - **Consists of:**
    - **Acini**
    - **Lobules**
    - **TDLU's**
    - **Lobes**
    - **Lactiferous ducts**

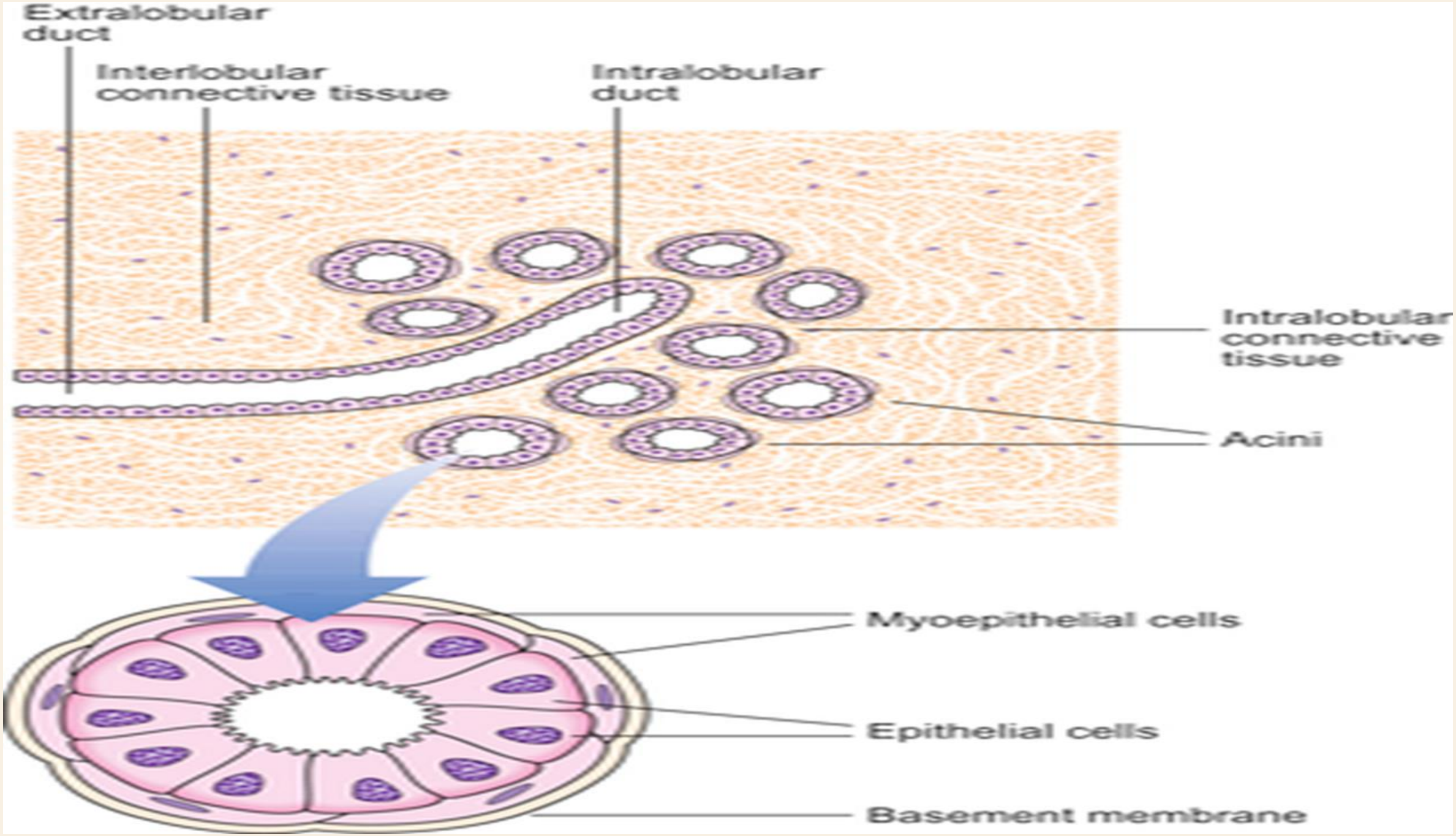
COOPER'S LIGAMENTS

- ***Suspensory ligaments*** **extending from the deep layer of the superficial fascia to the skin**
- **Separate fat lobules and lobes**
- **Provides the "framework"**
- **Seen from retro-mammary through the mammary to the pre-mammary layers**


SKIN
SCF
PREMAMMARY
ZONE
CL
MAMMARY
ZONE
FGT
RETROMAMMARY
ZONE
RMF
PM
G
P
R
5.0 12.0

ACINI

- Referred to as acinar cell or acinus
- Smallest functional unit of the breast
  - Hundreds found in each breast
- Each acini gives rise to a terminal duct
  - ***Terminal duct*** – beginning of a lactiferous duct
- This is the milk producing portion of the gland

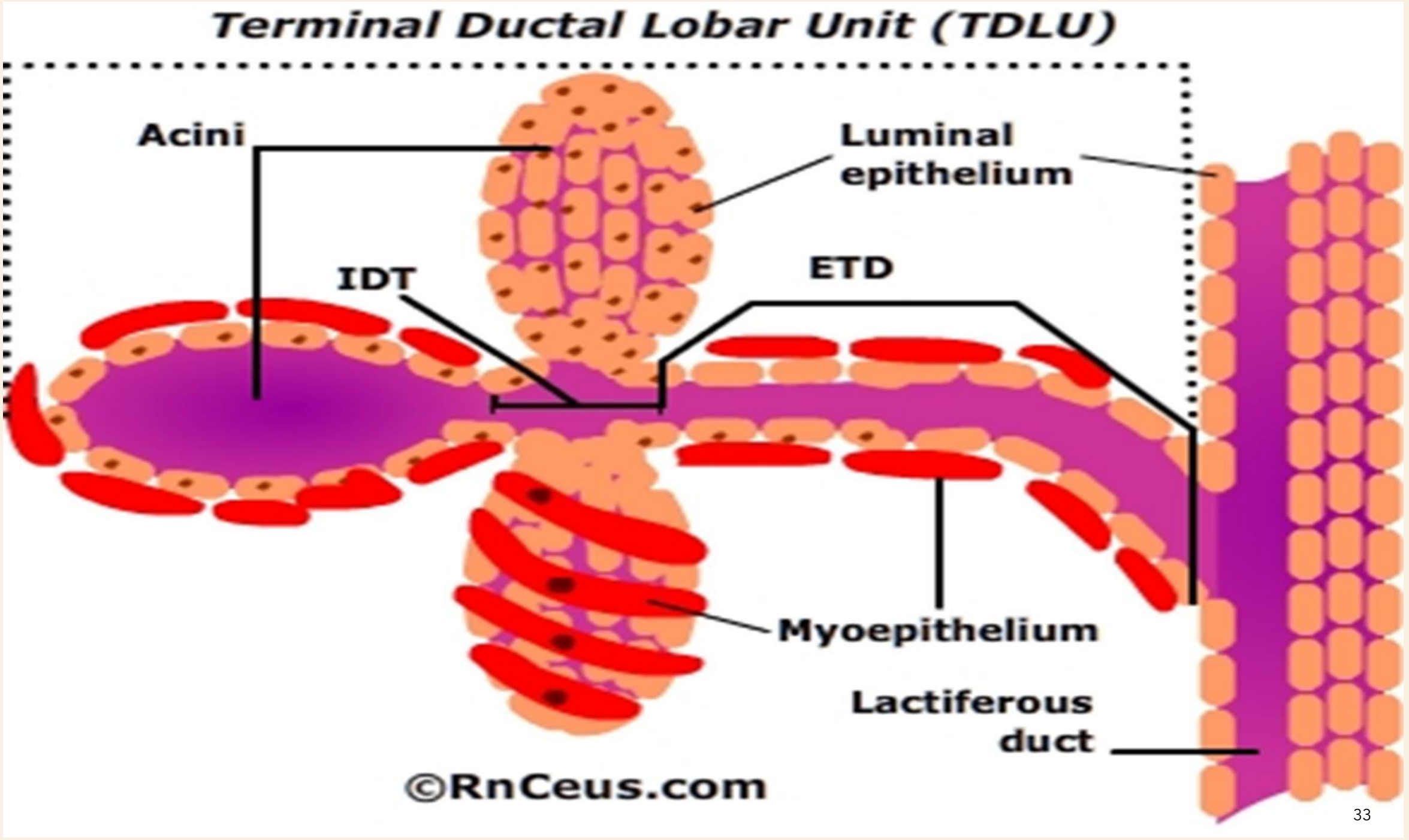

Extralobular duct
Interlobular connective tissue
Intralobular duct
Intralobular connective tissue
Acini
Myoepithelial cells
Epithelial cells
Basement membrane

LOBULE

- Composed of:
  - 30-50 acini
  - Intralobular terminal ducts
  - Intralobular stromal tissue
    - Loose connective tissue

TDLU

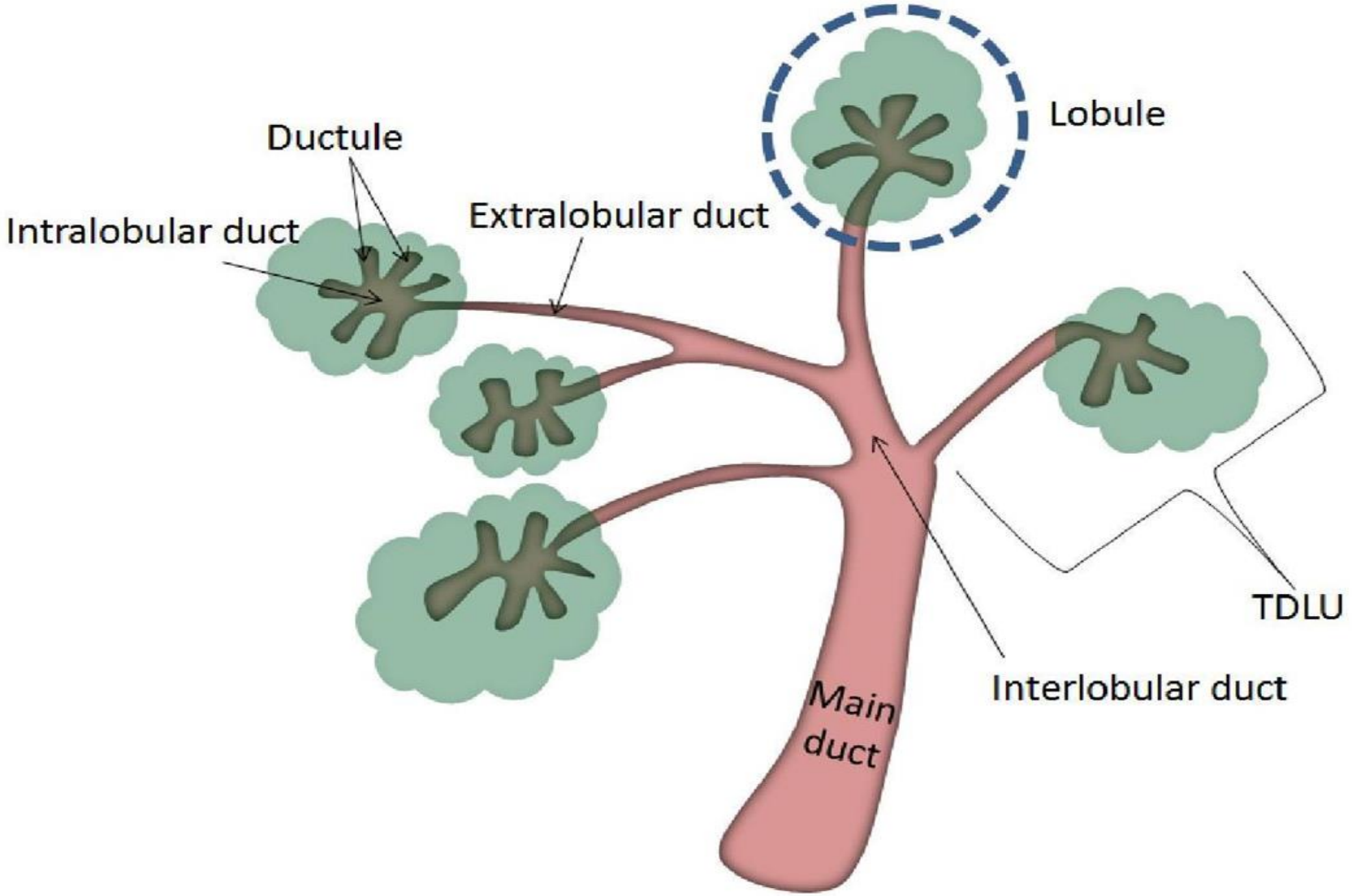
- Terminal Duct Lobular Unit
  - Functional unit of the breast
  - Measures 1-2 mm and not differentiated sonographically
- Consists of:
  - Lobule
  - Intralobular terminal ducts
  - Extralobular terminal ducts
- ***Nearly all breast pathology originates here***
  - Exception:
    - Lipoma (subcutaneous layer)
    - Phyllodes (stroma)


Terminal Ductal Lobar Unit (TDLU)
Acini
Luminal epithelium
IDT
ETD
Myoepithelium
Lactiferous duct
©RnCeus.com

LOBE

- Made up of several lobules (TDLU)
- There are approximately 15-20 lobes in each breast
- One lactiferous duct emerges from each lobe
  - Approximately 15-20 lactiferous ducts that travel towards the nipple

Ductal Anatomy



LACTIFEROUS DUCTS

- Lined with specialized cells
- Bound by the basement membrane
- Inner lining composed of:
  - Epithelial cells (inner layer)
  - Myoepithelial cell (outer layer)
    - Lie by the basement membrane (fibrous outer coating of the duct)
    - Contain contractive fibers that help transport milk from the acini and ducts towards the nipple
- Non-lactating breast
  - Lumen of ducts contain fluid, protein, and cellular debris

LACTIFEROUS DUCTS

- Begin with the ductule or Terminal Duct
- Intralobular Terminal Duct
  - Located within the lobule
- Extralobular Terminal Duct
  - Located outside the lobule
- Interloubular Duct
  - Travels between lobes
- Duct slightly enlarges beneath the areola
  - Area of lactiferous sinus

LACTIFEROUS DUCTS

- Can be seen as fluid filled “tubes”
- Best seen on radial scans
- Increase in size as they approach the nipple
- Normal size $\leq$ 2 mm
  - Can be larger:
    - At the sinus area
    - During pregnancy
    - During lactation

DEEP FASCIA

- **Deep layer of the superficial fascia is often referred to as “deep fascia”**
- **Located in the retro-mammary space**
- **Can deter cancer spreading to the chest wall**

RETRO-MAMMARY LAYER

- Separates the mammary layer from the pectoralis muscles
- Contains:
  - Thin layer of fat
    - Fat increases with age, obesity, and pregnancy
  - Connective tissue
  - Deep layer of the superficial fascia
- Allows free movement of the breast over the chest wall

MUSCLE LAYER

- **Pectoralis Major**
  - **Arises from the clavicle and costal cartilage of the sternum and attaches to the proximal humerus**
- **Pectoralis Minor**
  - **Arises from the 3rd, 4th, and 5th rib attaching to the scapula**
- **Pectoralis Major is anterior to the Pectoralis Minor**
- **Both are immediately posterior to the breast tissue**
- **Muscle will appear hypoechoic with hyperechoic linear striations**

CHEST WALL

- Ribs are located posterior to the pectoralis muscles
- Intercostal muscles are located within the rib spaces
- Posterior to the chest wall is the lung
  - Lung is high reflective and produces a hyperechogenic band of echoes
- When performing an ultrasound, you need to adjust your depth so the lung is the most posterior structure on the image (this ensures that you have scanned all the way to the chest wall)

THE MALE BREAST

- Normally retains some ductal elements beneath the nipple
  - Does not develop the milk-producing lobular and acinar tissue
- Gynecomastia:
  - Ductal elements can hypertrophy due to hormonal fluctuations, disease processes, or medications
  - Patient complains of breast tenderness and subareolar breast lump
  - Ultrasound used to rule out breast cancer as a cause of enlargement
    - Palpable area appears similar to female breast tissue
    - Ducts visualized radiating from the nipple

PHYSIOLOGY OF THE BREAST

- Function – produce milk
- Hormones active in breast physiology
  - Estrogen stimulates changes of the stromal tissues
    - Elongation of the mammary ducts
    - Growth of connective tissue
    - Increase in adipose tissue
    - Increased vascularity
  - Progesterone stimulates growth of the glandular tissue
    - TDLU

MENSTRUAL CHANGES

- **Early Proliferative Phase - Initially estrogen stimulates epithelial proliferation and enlargement of the ducts**

- **Late Secretory Phase - With ovulation progesterone stimulates growth of the lobules and terminal ductules (TDLU)**
  - **Increased blood flow and fluid retention**
    - **Breast tenderness, fullness, and nodularity**
- **Onset of menses progesterone levels decrease**
  - **TDLU's regress and involute**

PREGNANCY

- There are considerable changes in the breast tissue
  - TDLU's increase in size
    - Epithelium swells
  - Acinar cells enlarge in response to a variety of hormones
    - Estrogen
    - Progesterone
    - Lactogen
    - Prolactin
    - Chorionic gonadotropin from placenta

LACTATION

- After birth (Breast feeding begins)
  - Estrogen and progesterone diminish rapidly
  - Prolactin then dominates
    - Prolactin causes the acinar cells to secrete milk
- After termination of breast feeding
  - Ducts and lobules return to their normal size in approximately 3-6 months

MENOPAUSE

- Peri-menopausal
  - Lobules involute
    - Roll inward, invert, or shrivel
  - Loose connective tissue turns into dense connective tissue – converts to stroma
    - Stroma – replaced by fat
- Involution may begin before menopause as a gradual decrease in glandular tissue with fatty replacement
  - After menopause, glandular tissue atrophies

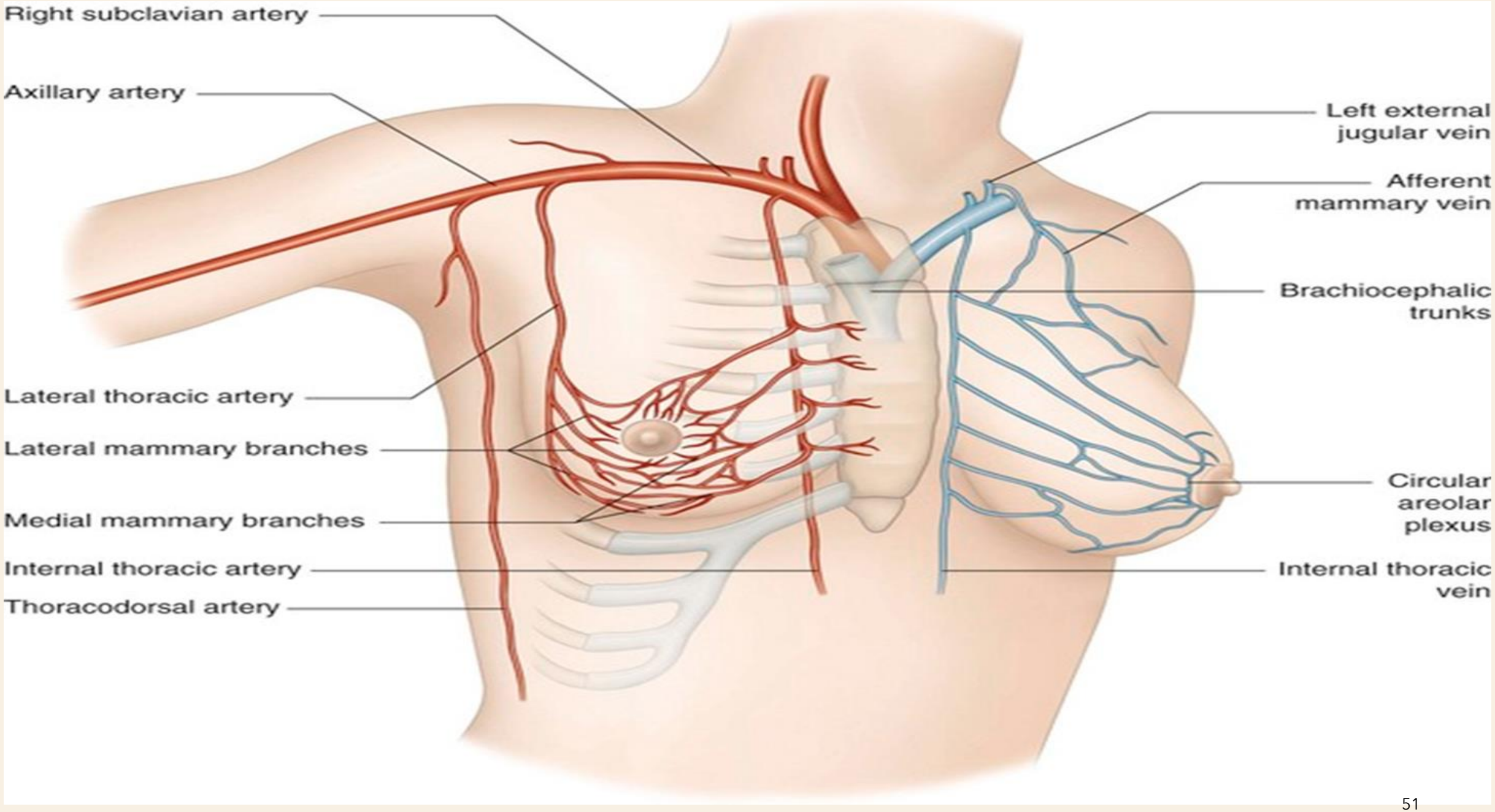
- Hormone replace therapy (HRT) can slow down the involutional changes

VASCULAR SUPPLY

- **Arterial supply:**
  - **Lateral Thoracic Artery**
    - **Arises from the axillary artery**
  - **Internal Mammary Artery**
    - **Also known as Internal Thoracic artery**
    - **Arises from the subclavian**
    - **Often used in CABG procedures**

VASCULAR SUPPLY

- **Venous drainage:**
  - **<u>Superficial Veins</u>**
    - **Located just deep to the superficial layer of the superficial fascia**
    - **Allows venous communication between both breasts**
      - **Could be potential route for cancer metastasizing to opposite breast**
  - **<u>Deep Veins</u>**
    - **Multiple small branches that drain into the internal mammary, lateral thoracic, axillary, subclavian, and intercostal veins**


Right subclavian artery
Axillary artery
Left external jugular vein
Afferent mammary vein
Brachiocephalic trunks
Lateral thoracic artery
Lateral mammary branches
Medial mammary branches
Circular areolar plexus
Internal thoracic artery
Internal thoracic vein
Thoracodorsal artery

LYMPHATIC SYSTEM

- Lymph flow begins deep within the breast tissues
- Originates in the stroma and lactiferous ducts
- Flow directions if from the deep system towards the areola into the peri-areolar plexus and continues into the subdermal lymphatic vessels
  - From there it travels outward to the outer lymphatic chains that drain the breast

LYMPHATIC SYSTEM

- **Intramammary Lymph Nodes**
  - **Seen throughout the breast parenchyma as part of the deep system**
  - **Approximately 75% of lymph drainage is to the axilla**
    - **This is why the axillary lymph node chain is so important in predicting the spread of breast cancer**

AXILLARY LYMPH NODE CHAIN

- External Mammary group
  - Located along lateral thoracic vessels
- Scapular group
  - Run with the subscapular vessels
- Axillary group
  - Run with the lateral axillary vessels
- Central group
  - Run with the medial axillary vessels
- Subclavicular group
  - Run with the subclavian vessels
- Interpectoral (ROTTER'S) nodes
  - Found between pectoralis major and minor

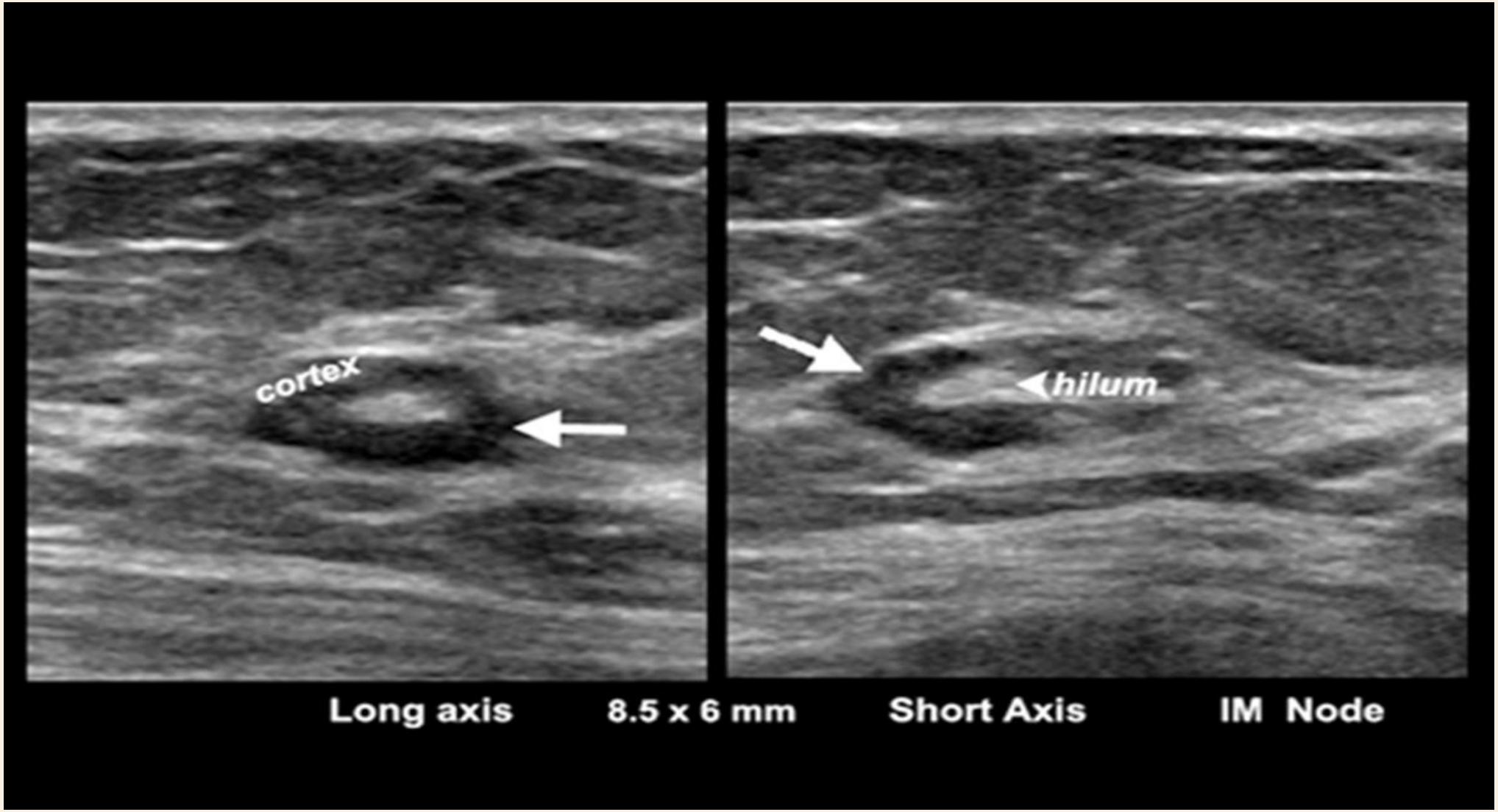
LYMPHATIC SYSTEM

- Remaining 25% of lymph drainage includes:
  - Internal Mammary lymph nodes
  - Intercostal lymph nodes
  - Flow to the opposite breast
  - Diaphragmatic lymph nodes
    - Allows drainage to the abdomen
  - Supraclavicular lymph nodes
    - Stage 5 breast cancer – distant mets

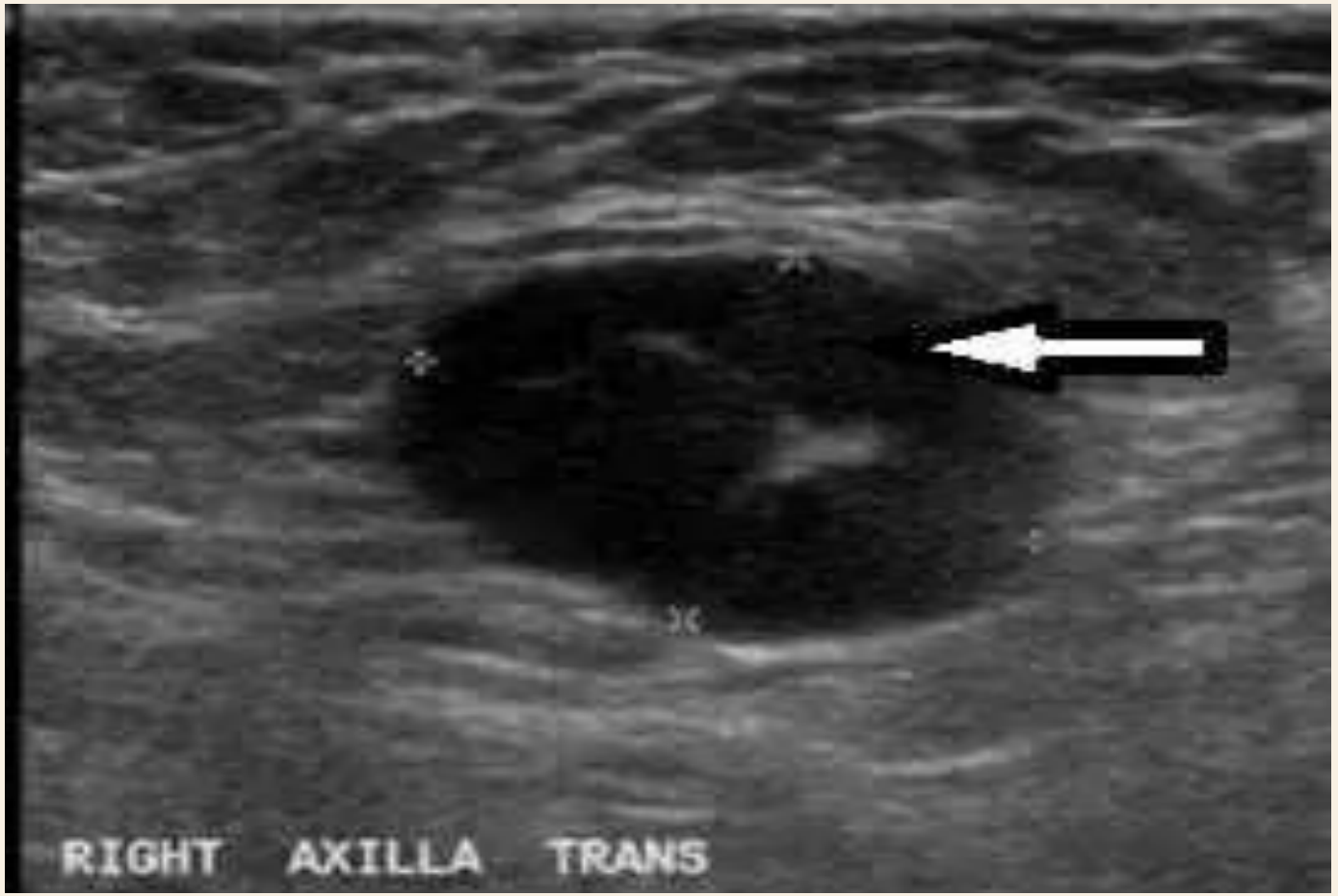
LYMPH NODES

- Lymph nodes are reniform (kidney-like)
  - Outer cortex and medial hilum where an artery, vein, and lymph vessels enter and exit the node
- As lymph nodes become more fatty
  - Cortex thins
  - Hilum is more prominent on sonography
- Cancerous lymph node
  - Cortex thickens
  - Loss of echogenicity of hilum

NORMAL LYMPH NODE



ABNORMAL LYMPH NODE



SURGICAL AND STAGING

- **Axillary lymph nodes are divided into 3 levels depending on their relationship with the Pectoralis Minor Muscle**
  - **Level 1 – nodes lie lateral to the pectoralis minor muscle**
  - **Level 2 – nodes lie posterior to the pectoralis minor muscle**
  - **Level 3 – nodes lie medial to pectoralis minor muscle**

PERFORMING THE EXAM

PREPARATION

- Know the indication for the exam
- Know what was specifically requested
  - Targeted vs. whole breast exam
- Obtain pertinent prior exams
  - Mammogram, Sonogram, MRI
- Obtain pertinent history
- Explain the exam to the patient

TARGETED EXAM

- **Sonography is used to evaluate a specific area of the breast only**
  - **Palpable lump**
  - **Pain**
- **Usually performed as a follow-up to mammography to answer a specific question**
- **Entire breast is not evaluated**

WHOLE BREAST EXAM

- **Ultrasound is used to survey the entire breast for the presence of pathology/disease**
- **May have attention directed to a specific area**
- **Not used as a replacement for screening mammography**

WHOLE BREAST EXAM

- **Indications:**
  - **Secretions**
  - **High-risk patients with dense breast**
  - **Search for lesions in known cancer patients**
  - **Implant rupture**
  - **Search for primary lesion**
  - **Follow-up to multiple known masses**
  - **Patients who refuse mammography**

PATIENT HISTORY

- **Obtain as much history that the patient can provide:**
  - **Age**
  - **Personal history of breast disease**
  - **Personal history of cancer**
  - **Family history of breast disease**
  - **Medications – especially hormones**
  - **Previous breast surgeries**
  - **Breast pain, location, and duration**
  - **Findings from monthly BSE and CBE**

VISUAL INSPECTION

- **Assess for**
  - **Size, shape, contour, and symmetry**
  - **Skin:**
    - **Thickness**
    - **Edema**
    - **Redness or discoloration**
    - **Retractions or protrusion**
  - **Nipple discharge or retraction**
  - **Surgical scars**

PALPABLE MASS

- Assess for:
  - Size of lump
  - Location of lump
    - Distance from nipple
  - Shape of lump
    - Round
    - Oval
    - Lobulated
    - Irregular
  - Consistency of lump
    - Soft, hard, firm, gritty or rubbery
  - Mobility of lump
  - Date when it was first noticed? Has it changed over time?

PATIENT POSITIONING

- Patient is examined in a supine or supine-oblique position with the ipsilateral arm raised above the head
  - Allows for even distribution of breast tissue
  - Minimizes thickness to ensure all tissue can be penetrated
- Medial aspect of the breast
  - Evaluated more effectively with the patient supine
- Lateral aspect of the breast and larger breasts
  - Steep oblique or decubitus position may be required
- Alternative position – upright or sitting

TRANSDUCER SELECTION & PRESSURE

- High frequency, linear array transducer
  - 10-18 MHz
  - Need to penetrate to chest wall for adequate exam
- Moderate transducer pressure should be utilized while scanning
  - Improves sound transmission
  - Decreases tissue depth for better penetration
  - Improves detail or resolution
  - May eliminate unwanted artifacts

ERGONOMICS

- **Adjust the stretcher so that your shoulder and arm are in a relaxed position**
- **Adjust the monitor to optimize viewing to reduce neck strain**
- **Hold transducer securely at its base – not high on the cord**
- **Rest forearm on patient for support**

GRAYSCALE SET-UP

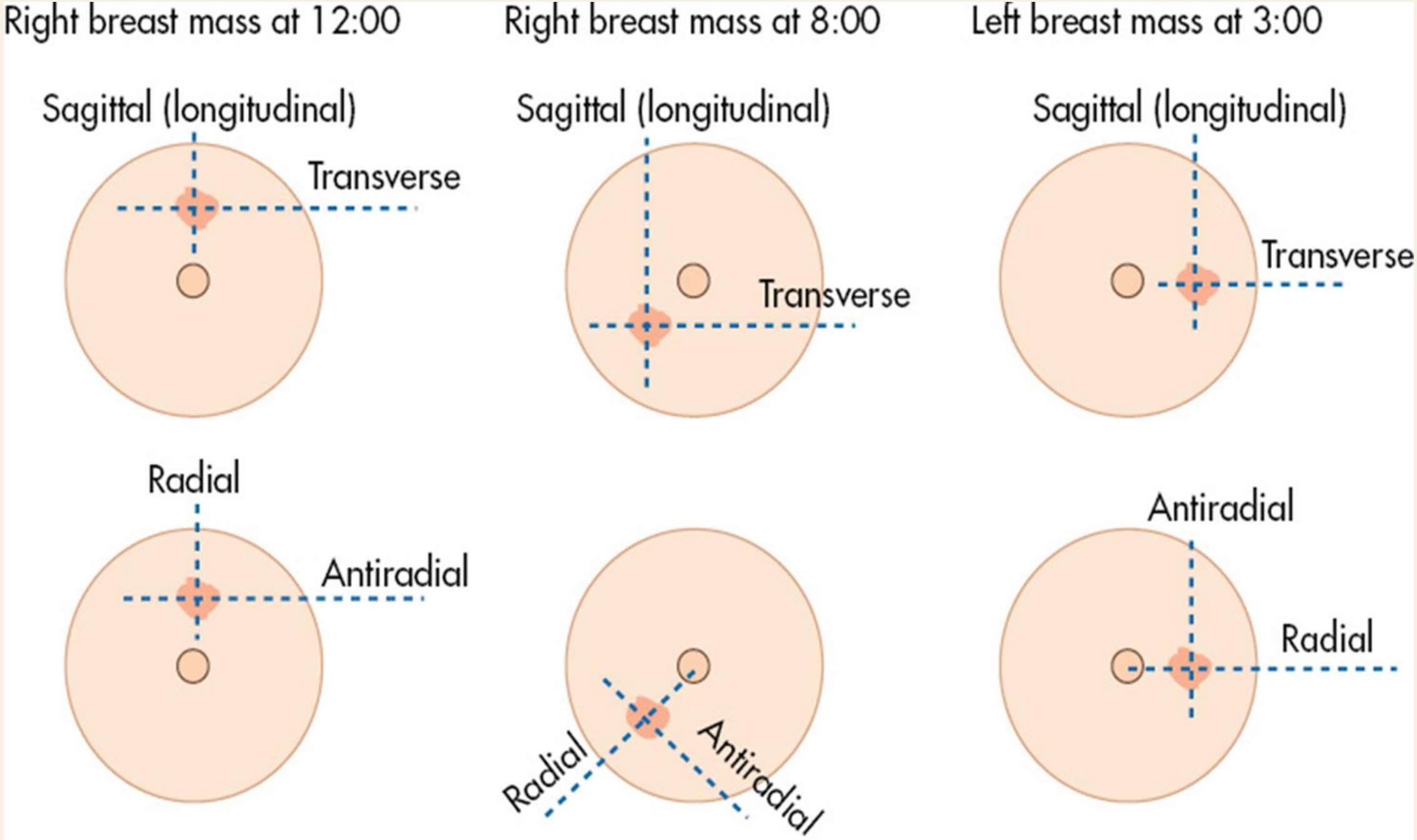
- Echogenicity of breast tissues and masses are described in comparison to normal breast fat
- Gain settings and dynamic range should be adjusted so the echogenicity of fat is medium (mid-level) gray
  - Anechoic/Hypoechoic:
    - Cyst, Duct, Blood, Milk, Nipple
  - Medium Gray Shade:
    - Fat, TDLU, Loose stromal fibrous tissue
  - Hyperechoic:
    - Skin, Cooper's ligaments, dense stromal fibrous tissue

SCAN PLANES

- **Scanning may be done in:**
  - **Longitudinal/Transverse planes**
    - **Corresponds to the conventional sagittal and transverse of the body**
  - **Radial/Anti-radial planes**
    - **Correlate with the direction of the ductal system of the breast**
    - **<u>Radial</u> – longitudinal or parallel with the ducts**
    - **<u>Anti-radial</u> – transverse or perpendicular to the ducts**

SCAN PLANES

- Mass or region should be scanned in orthogonal planes (90 degrees to each other)
  - Need to document anatomy in both planes
- Radial/Anti-radial planes are best scanning practices when investigating pathology
  - Allows visualization of tumor or ductal extensions branching towards/away from the nipple
    - These extensions could be missed if scanning sagittal/transverse



TRANSDUCER POSITIONING

- **https://www.youtube.com/watch?v=PCAnL9paucE**

ECHO PALPATION

- **Technique used to isolate a palpable mass**
- **Immobilize a palpable mass between two fingers while scanning over the mass using the opposite hand**
- **Assures visualization of the correct structure**
- **Also evaluate the mobility of a palpable mass**
  - **Benign mass – *tend* to move slightly within tissues**
  - **Malignant mass – *tend* to be rigidly fixed**

ROLLED NIPPLE TECHNIQUE

- **Breast ultrasound includes scanning of the mammary tissue and the areola, nipple, and skin line**
- **Following the ducts to the nipple can be difficult due to shadowing created by the contractile tissue**
  - **Rolled nipple technique - one finger is placed alongside the nipple and with the transducer, you roll the nipple over the finger, so you are scanning parallel to the duct**
  - **A thick dollop of gel or stand-off pad may also help visualization**

STAND OFF PAD

- Improves focusing and greater detail in the superficial layers of the breast
  - Optimizes near field focus
  - Reduces slice thickness artifacts
- Creates a distance between the skin surface and the transducer
  - Alters position of the fixed elevational plane – moves it more superficially

STAND OFF PAD

- Ideal thickness is 1.0 cm
  - This now places the elevational plane focus of a 10 MHz transducer at 0.5 cm
    - Normally it is 1.5 cm
- Types of stand off pads
  - Manufactured gel pads
  - Large glob of gel
  - Water bag
  - Transducer attachments

STAND OFF PAD

- **Improves imaging of superficial structures:**
  - **Tumors**
  - **Cysts**
  - **Vessels**
  - **Ducts**
  - **Surgical specimens**
  - **Skin lesions or thickening**

DYNAMIC COMPRESSION

- **Variable transducer compression can improve image quality and eliminate artifacts:**
  - **Cysts will change shape**
  - **Internal echoes within a benign mass may become more uniform**
  - **Soft, benign masses *tend* to change shape**
  - **Hard, malignant masses do not change shape**
  - **Debris within cysts can be better visualized**
  - **Ducts may be visualized better**
  - **Reduces false shadowing**

DYNAMIC COMPRESSION

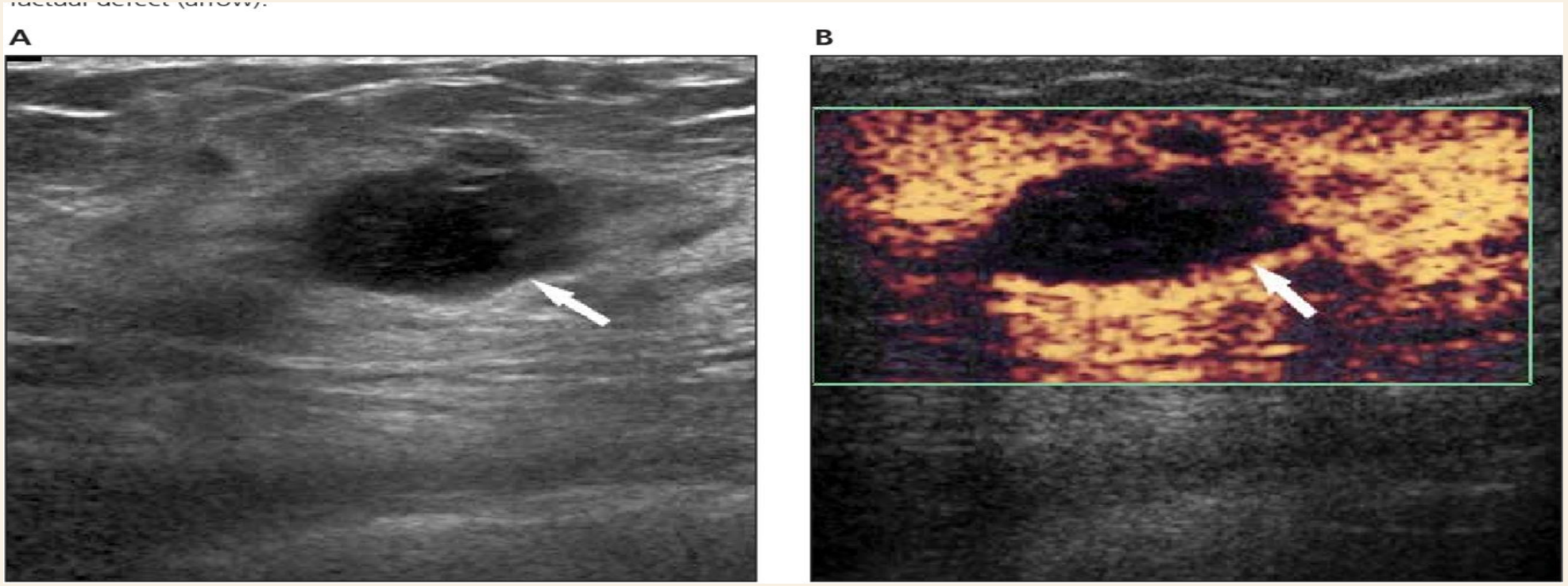
- **Pitfalls of excessive transducer pressure:**
  - **Reduce or ablate blood flow**
  - **Poor margin delineation due to adjacent tissue pressed against the mass**
  - **Poor superficial imaging due to near field artifacts and focusing**

TRANSDUCER ANGULATION

- **Permits better assessment of the mass**
  - **Margin characteristics are better delineated when the sound beam is perpendicular and the FOV is enlarged**
- **Vary the angulation by:**
  - **Rocking from end-to-end (heel/toe)**
  - **Rocking from side-to-side**
  - **Rotating the transducer**

FREMITUS MANEUVER

- **The vibration of tissues in the chest during speech**
- **Used to evaluate breast tissues during real-time scanning**
- **Foreign tissues will not vibrate, therefore no signal will be created**



FREMITUS MANEUVER

- Image the tissue in question
- Turn power Doppler on
  - Use a low-flow setting / decrease gains
- Have the patient hum or say “EEEEEEE”
- Normal breast tissue with demonstrate a strong Doppler signal due to chest wall vibrations
- Abnormal breast tissue (tumors) will not vibrate and will not demonstrate a Doppler signal

DOCUMENTATION

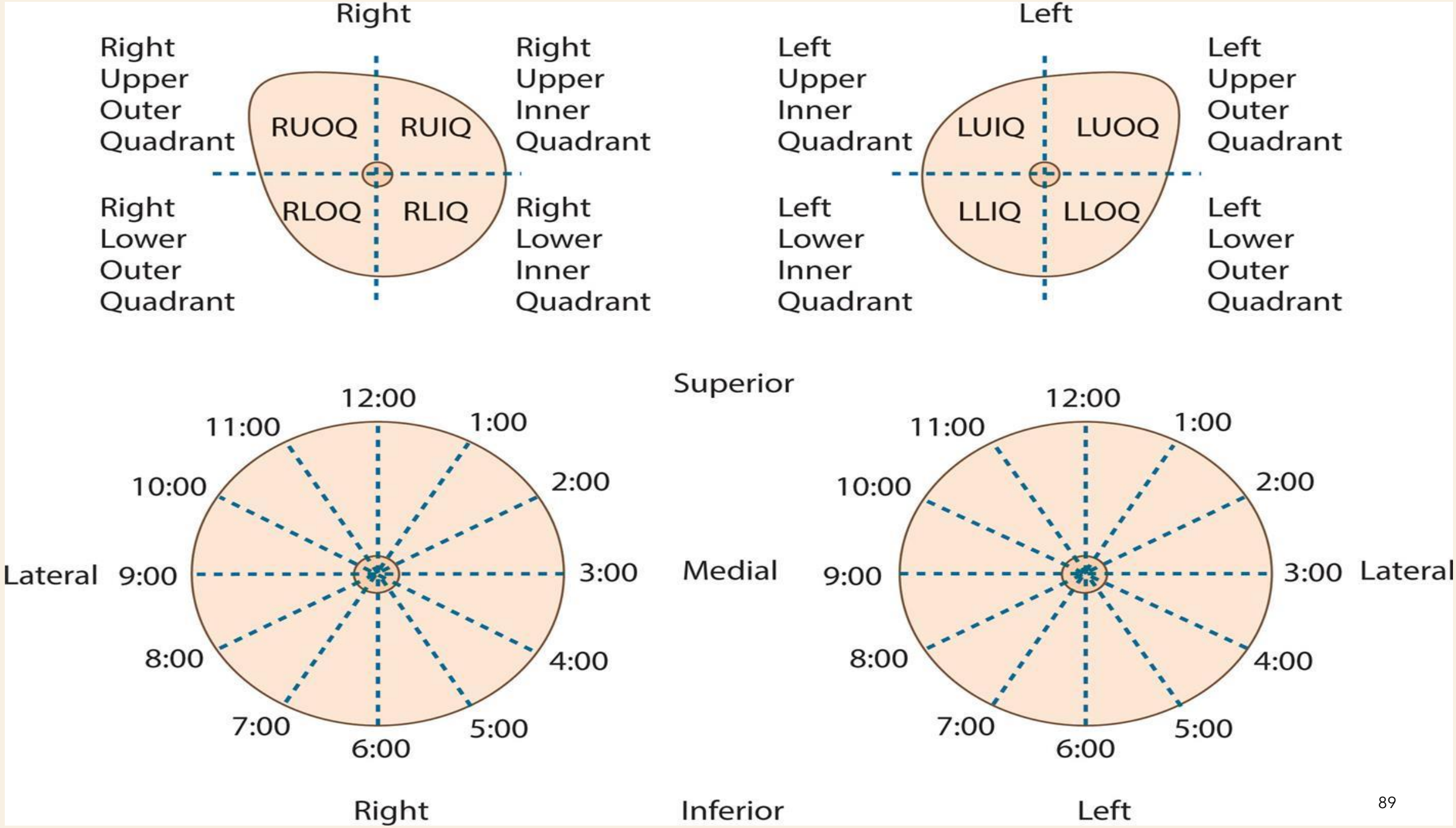
- AIUM Standards
  - Facility name and location
  - Examination date
  - Patient name; MRN and/or birthday
  - Anatomic location of mass or area scanning (proper annotation)
  - Mass measurements (three preferred)
    - Images include mass with and without measurements
  - Sonographer's initials

MEASUREMENTS

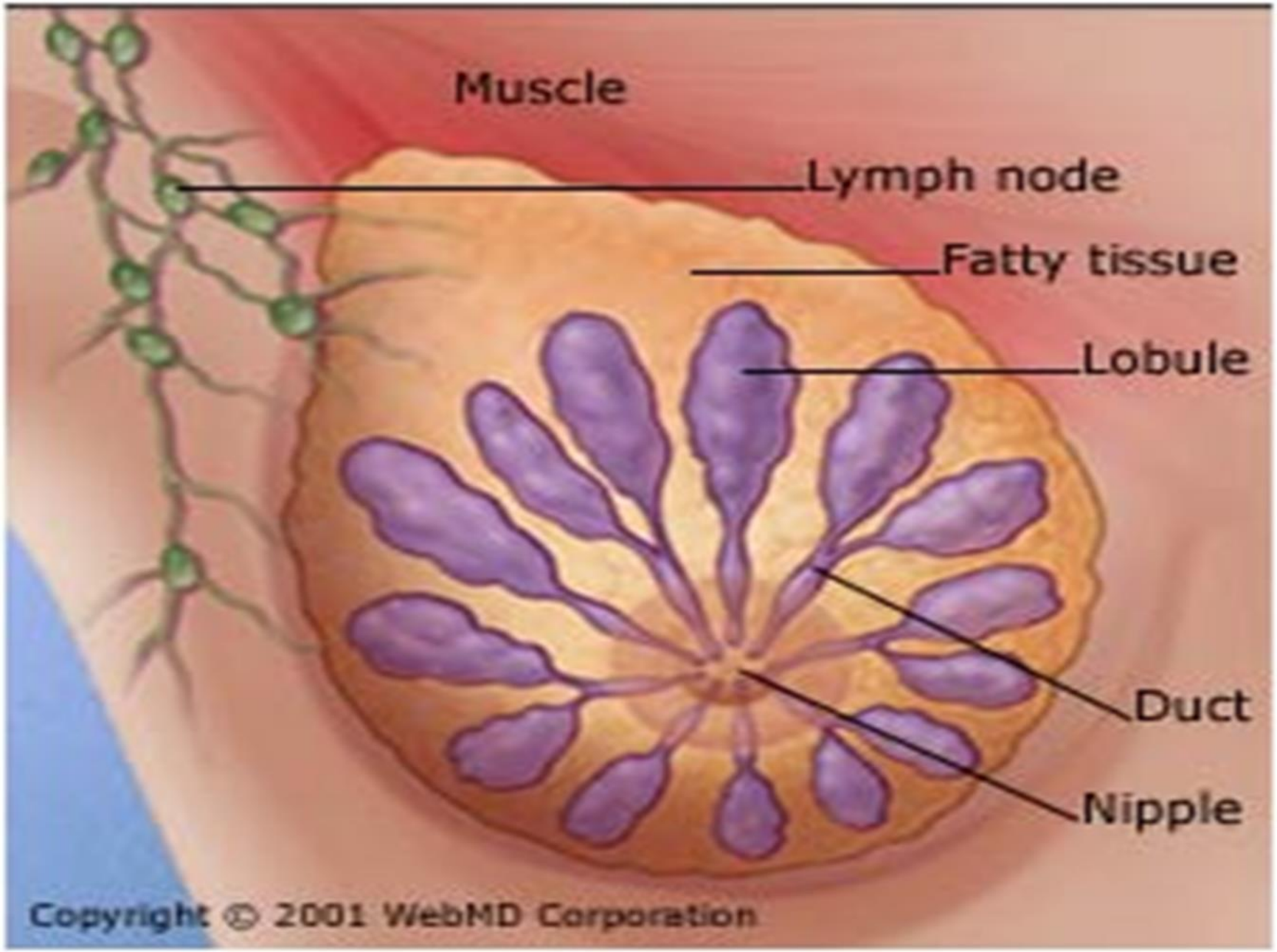
- Document in two orthogonal planes and obtain three measurements
  - Largest measurement defines the “long axis” or “length” of the mass
  - Height measurement (AP) is taken perpendicular to the length measurement
  - Then rotate the transducer 90-degrees to obtain the width measurement

ANNOTATION

- Labeling images can be time consuming but is very helpful for follow-up studies
- "Clock method" used as a standard
  - Provides a more detailed description than the quadrant method
  - SA denotes the subareolar region
  - AX refers to the axillary region

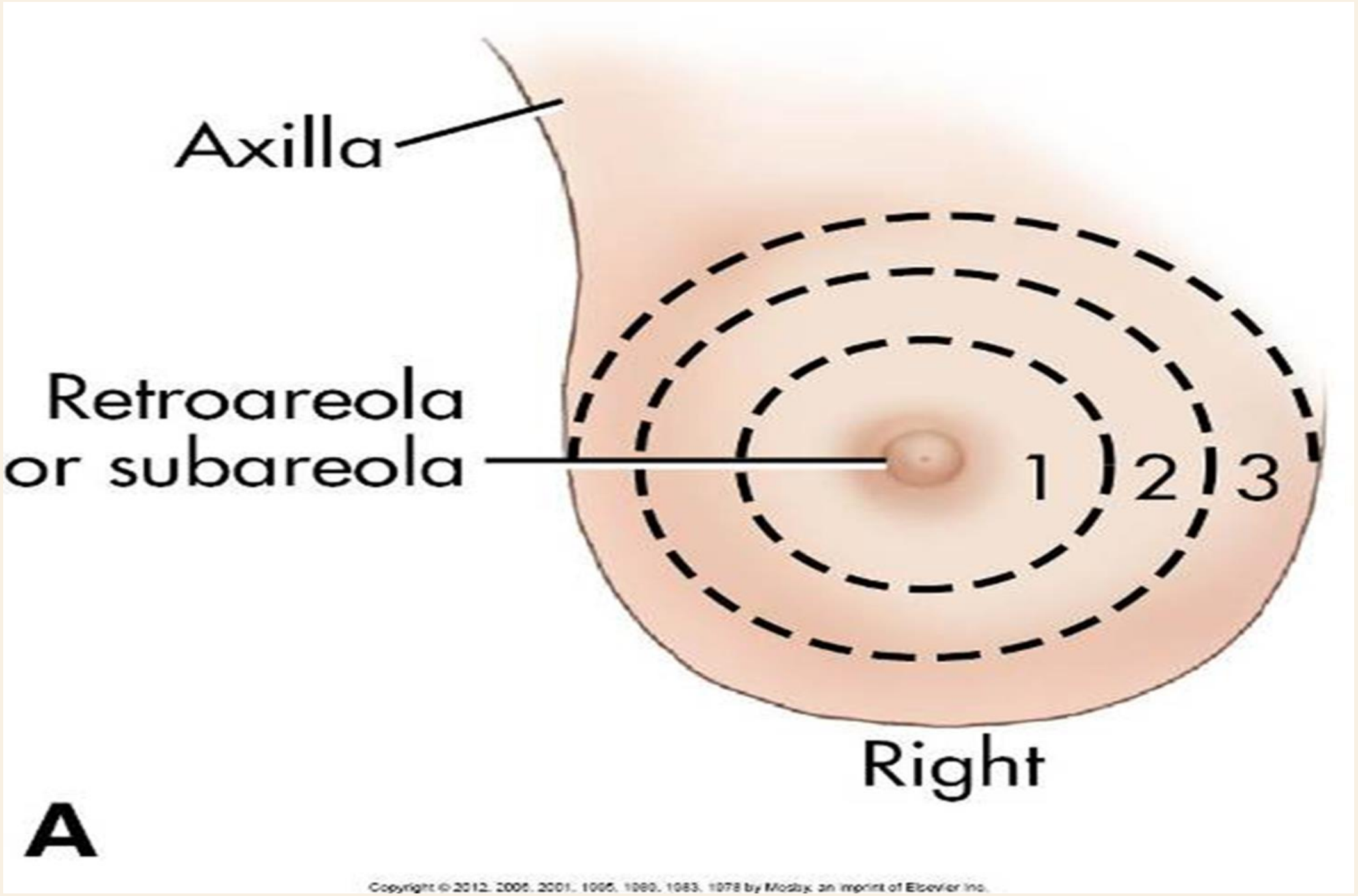

Right
Right Upper Outer Quadrant
Right Upper Inner Quadrant
RUOQ
RUIQ
RLOQ
RLIQ
Right Lower Outer Quadrant
Right Lower Inner Quadrant
Left
Left Upper Inner Quadrant
Left Upper Outer Quadrant
LUIQ
LUOQ
LLIQ
LLOQ
Left Lower Inner Quadrant
Left Lower Outer Quadrant
Superior
12:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
Lateral
Medial
Lateral
Right
Inferior
Left

Breast Anatomy



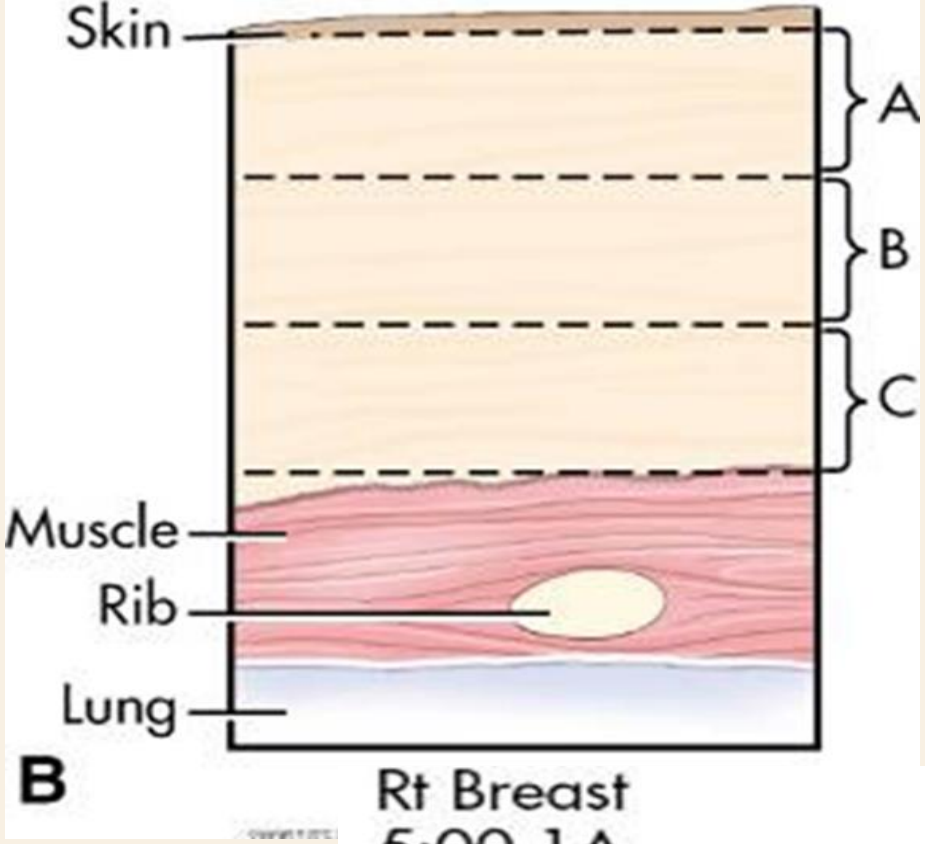
123 METHOD

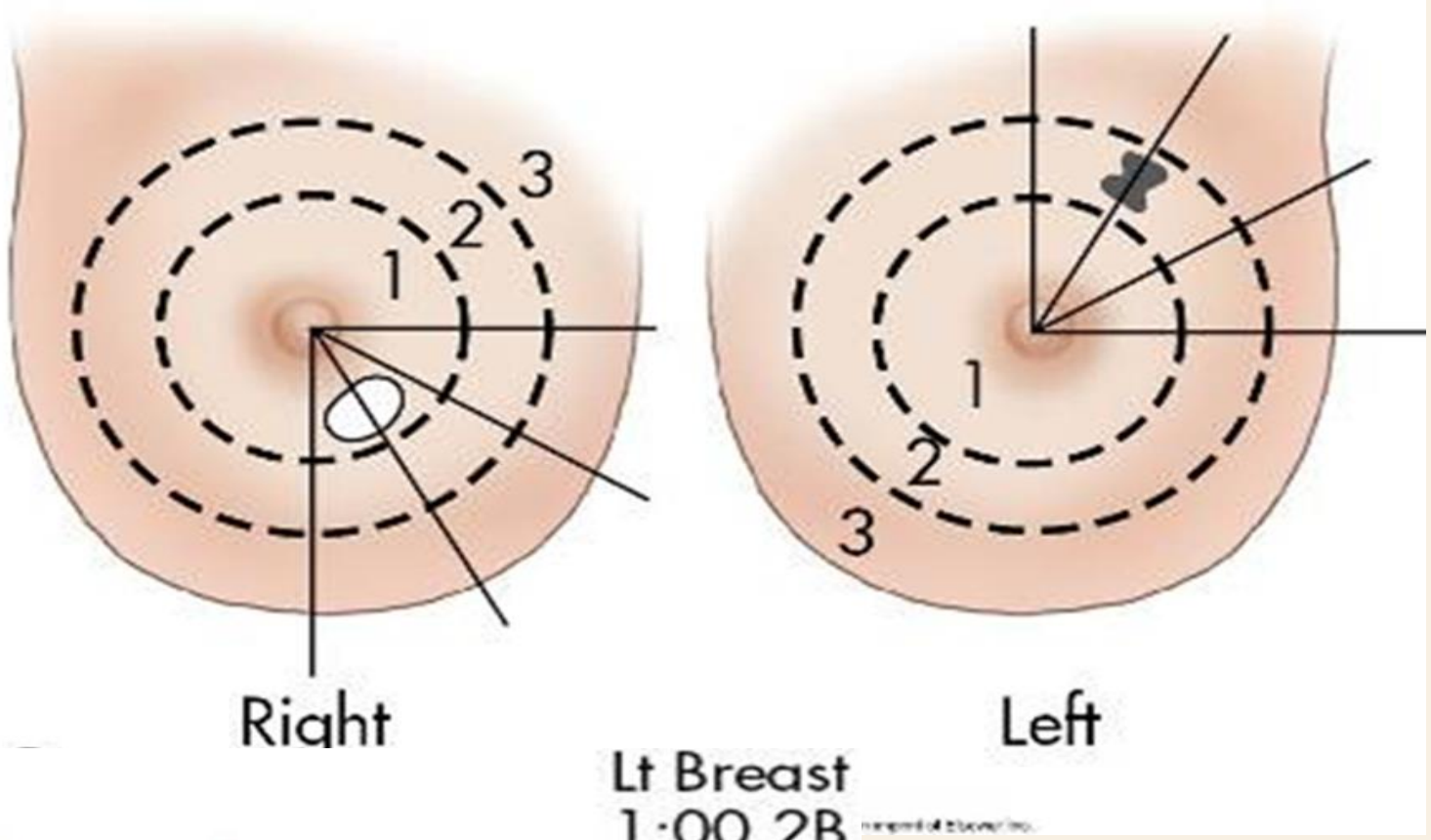
- **Describes the location of a lesion in comparison to its distance from the nipple**
  - **1 – near the nipple**
  - **2 – mid distance from the nipple**
  - **3 – periphery of the breast**

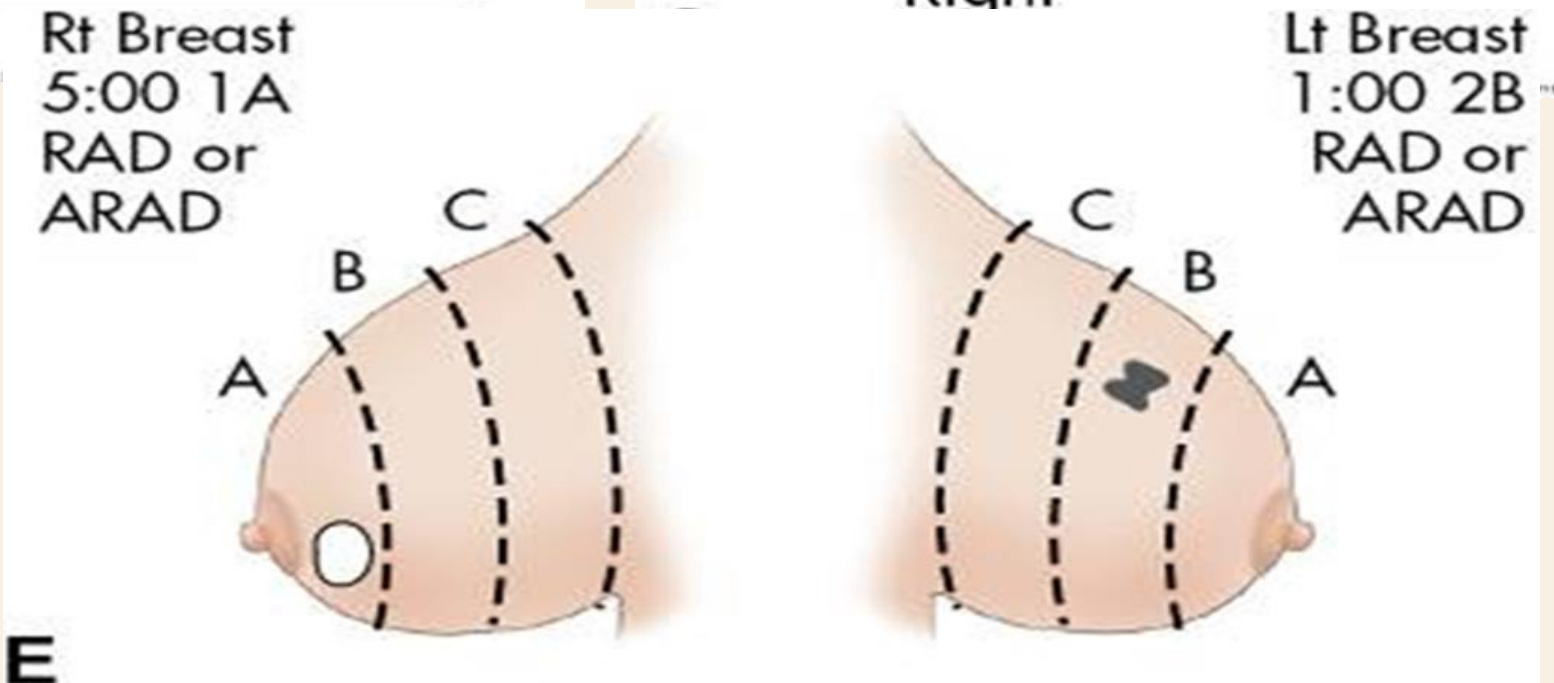


ABC METHOD

- **Describes the depth of a lesion**
  - **A – Superficial (Subcutaneous layer)**
  - **B – Within the mammary zone (mid-depth)**
  - **C – Near the chest wall (Retromammary zone)**


Skin
A
B
C
Muscle
Rib
Lung
B


1
2
3
Right
1
2
3
Left


Rt Breast
5:00 1A
RAD or
ARAD
A
B
C
Lt Breast
1:00 2B
RAD or
ARAD
C
B
A
E

WHAT IS THE CORRECT ANNOTATION?

- **A mass is seen in the right breast at the 8:00 area**
- **The mass is near the nipple**
- **The mass is near the chest wall**
- **You are scanning in a radial scan plane**

Right Breast 8:00 RAD 1C

BREAST IMAGE REPORTING

ACR BI-RADS ASSESSMENT FOR MAMMOGRAPHIC MASSES

Final Assessment Categories			
Category		Management	Likelihood of cancer
0	Need additional imaging or prior examinations	Recall for additional imaging and/or await prior examinations	n/a
1	Negative	Routine screening	Essentially 0%
2	Benign	Routine screening	Essentially 0%
3	Probably Benign	Short interval-follow-up (6 month) or continued	>0 % but ≤ 2%
4	Suspicious	Tissue diagnosis	4a. low suspicion for malignancy (>2% to ≤ 10%) 4b. moderate suspicion for malignancy (>10% to ≤ 50%) 4c. high suspicion for malignancy (>50% to <95%)
5	Highly suggestive of malignancy	Tissue diagnosis	≥95%
6	Known biopsy-proven	Surgical excision when clinical appropriate	n/a

ACR DESCRIPTIVE FORM FOR BREAST EVALUATION – ULTRASOUND LEXICON

Breast composition	**a. Homogeneous—fat** **b. Homogeneous—fibroglandular** **c. Heterogeneous**	
Mass	Shape:	Oval, round, irregular
	Margin:	Circumscribed or not circumscribed: indistinct, angular, microlobulated, spiculated
	Orientation:	Parallel, not parallel
	Echo pattern:	Anechoic, hyperechoic, complex cystic/solid hypoechoic, isoechoic, heterogeneous
	Posterior features:	No features, enhancement, shadowing, combined pattern
Calcifications	In mass, outside mass, intraductal	
Associated features	Architectural distortion, duct changes, skin thickening, skin retraction, edema, vascularity (absent, internal, rim), elasticity	
Special cases (cases with a unique diagnosis)	Simple cyst, clustered microcysts, complicated cyst, mass in or on skin, foreign body (including implants), intramammary lymph node, arteriovenous malformation, Mondor disease, postsurgical fluid collection, fat necrosis	

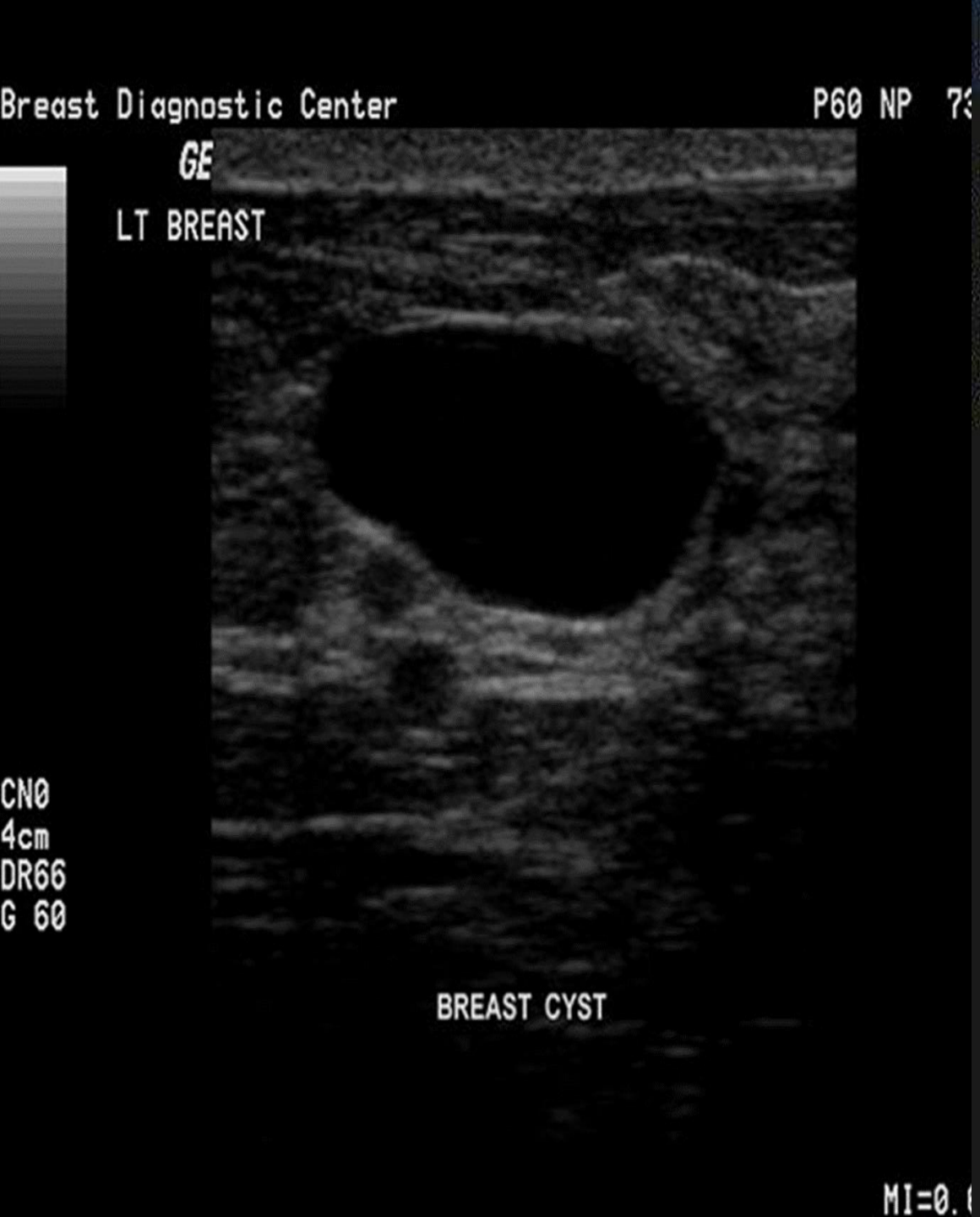
SONOGRAPHIC CHARACTERISTICS OF BREAST LESIONS

- Refer to Box 21.8
  - Simple cyst
  - Complicated cyst
  - Solid masses
    - Margins
    - Disruption of breast architecture
    - Shape
    - Orientation
    - Internal echo pattern
    - Attenuation effects
    - Mobility
    - Compressibility
    - Vascularity

BENIGN MASSES

CYST

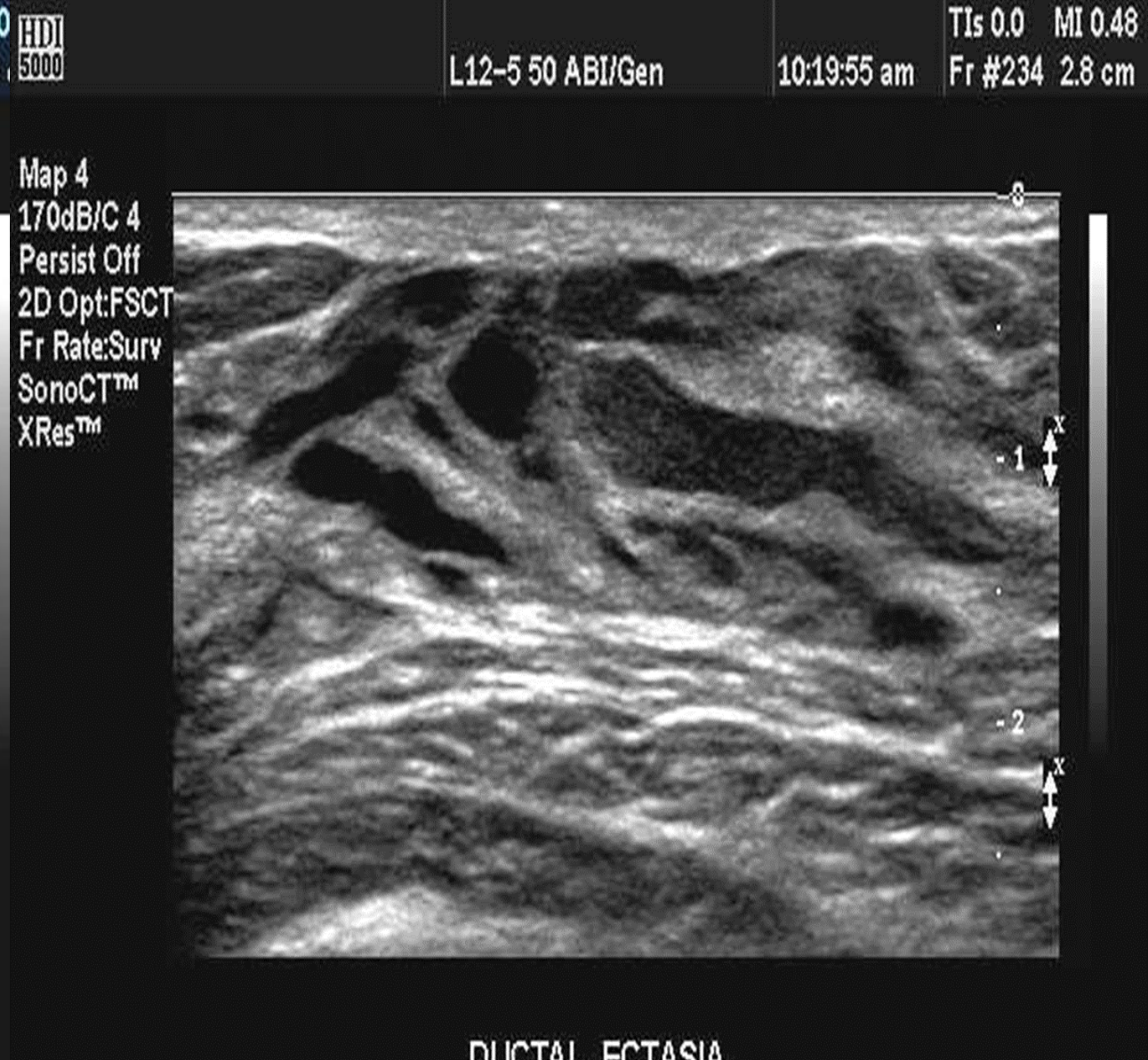
- Very common
- Unilateral or bilateral
- Patients may have hx of irregular menstrual cycle
- Symptoms:
  - Pain
  - Tenderness
- Sonographically:
  - Round or oval
  - Well defined borders
  - Anechoic with posterior enhancement
  - Absence of color flow


Breast Diagnostic Center
P60 NP
GE
LT BREAST
CN0
4cm
DR66
G 60
BREAST CYST
MI=0.


HDI 5000
SWCHSC SB
L12-5 50 ABI/Gen
2:54:45 pm
TIs 0.0 MI 0.57
Fr #113 3.0 cm
Map 4
170dB/C 3
Persist Off
2D Opt:FSCT
Fr Rate:Surv
SonoCT™
XRes™
-1
-2
-3
BREAST CYST / DUCTAL ECTASIA
SonoCT™ IMAGING WITH XRES™ TECHNOLOGY

BREAST CYSTS

SonoCT™ IMAGING WITH XRES™ TECHNOLOGY



DUCTAL ECTASIA

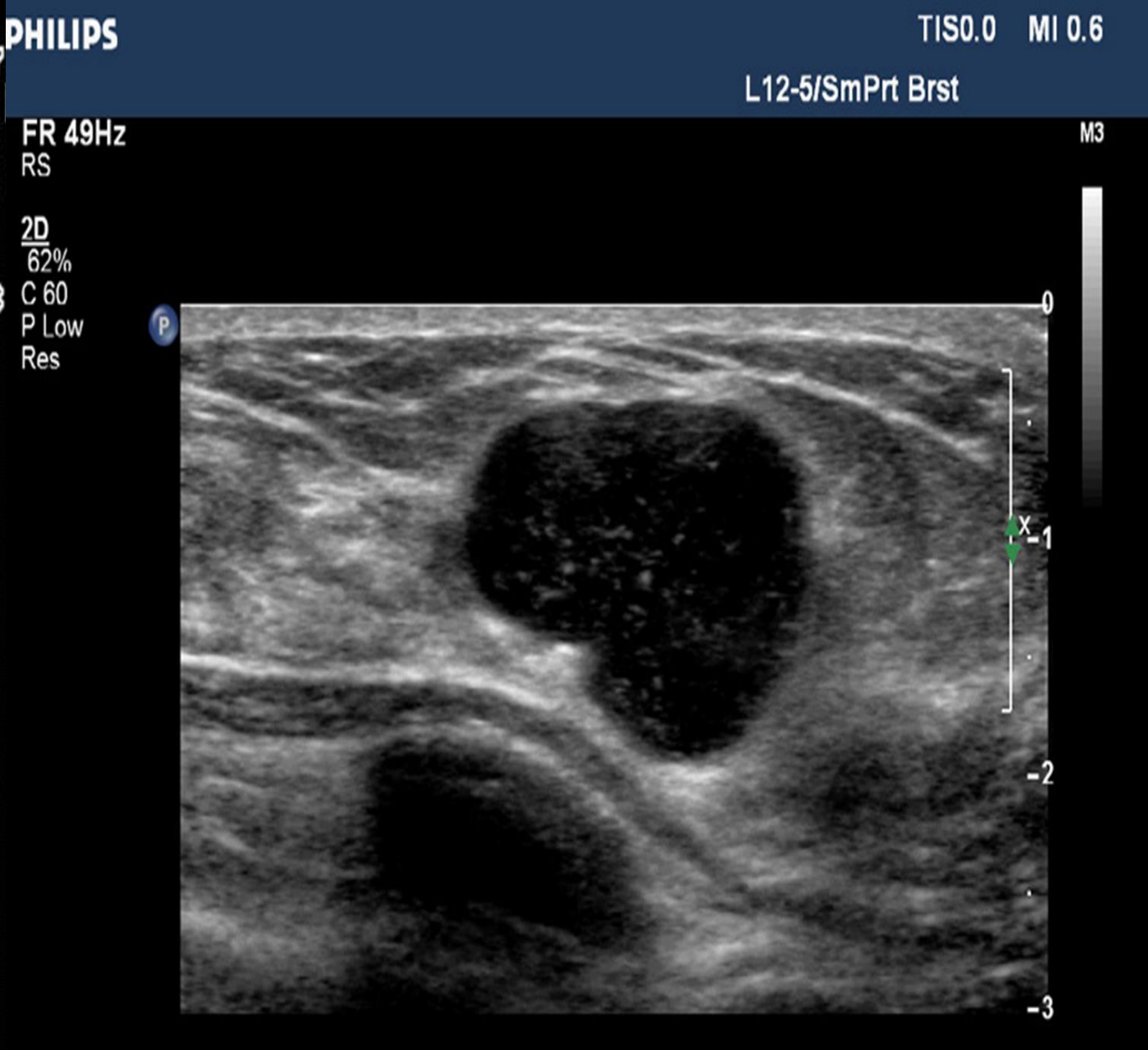
SonoCT™ IMAGING WITH XRES™ TECHNOLOGY

CYST

- Commonly resolve after menopause
- Some medications may cause cyst development
- Compression will cause the cyst to distort and should be slightly moveable

- <u>Complex cysts</u>:
  - Accumulation of cholesterol crystals, hemorrhage, infected debris, internal septations, or wall irregularities
  - Aspiration may be performed to confirm a benign etiology

COMPLEX BREAST NODULE



COMPLEX BREAST CYST

MI<0.4 A

Simple cyst

- Simple cyst
- Galactocele
- Hematoma
- Oil cyst.

Complicated cyst

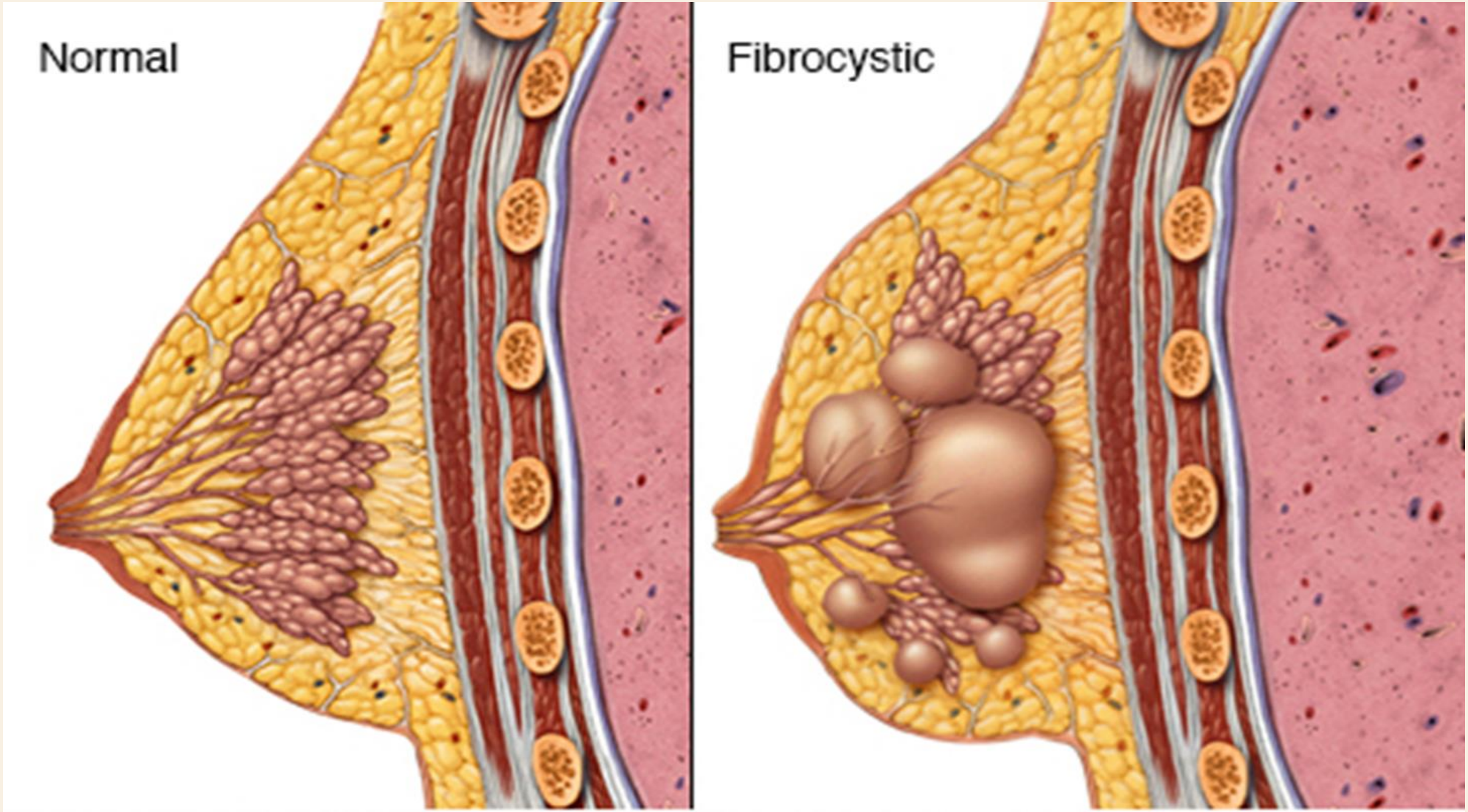
- Galactocele
- Hematoma
- Oil cyst.
- Abscess.

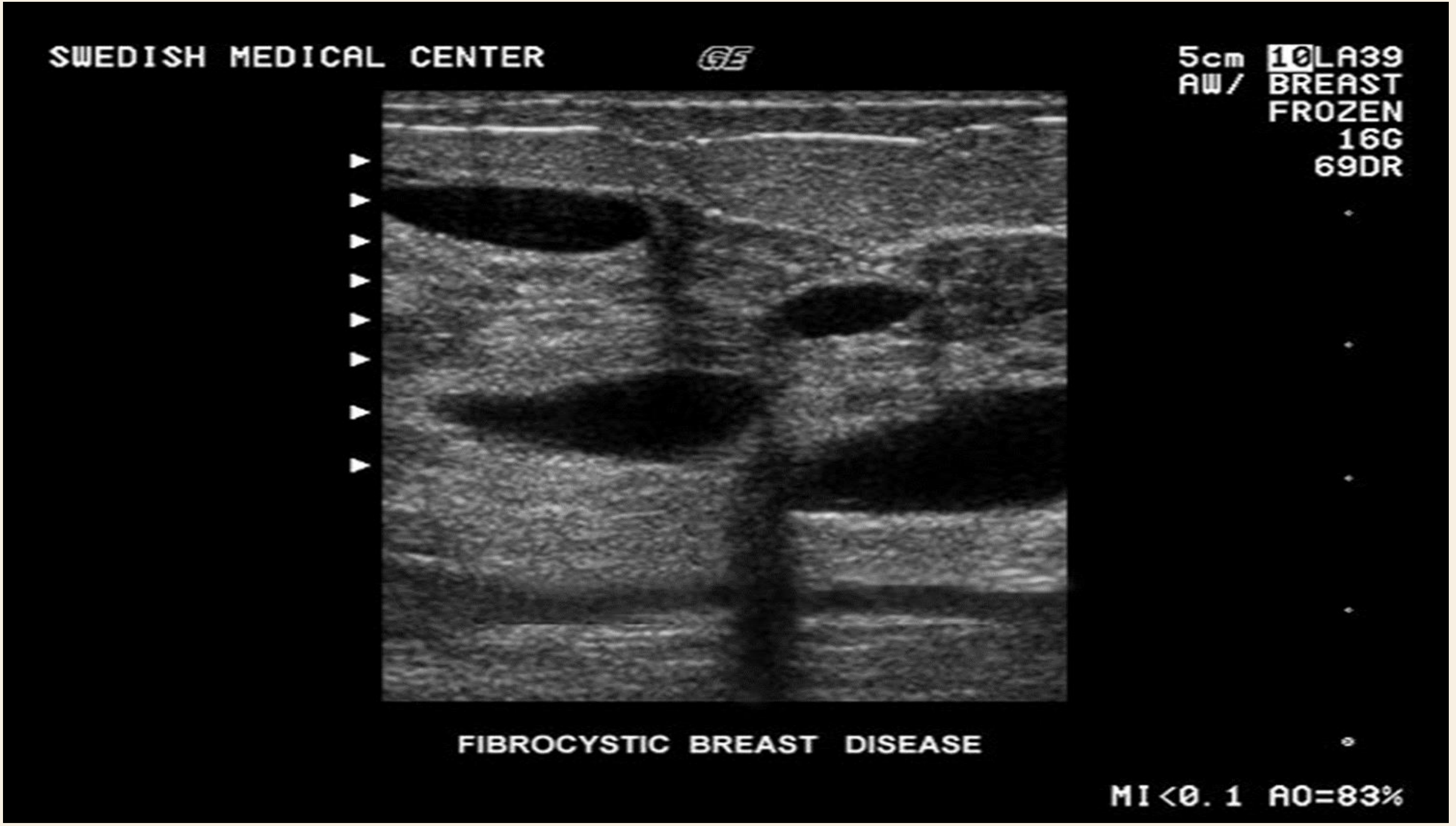
Complex cyst

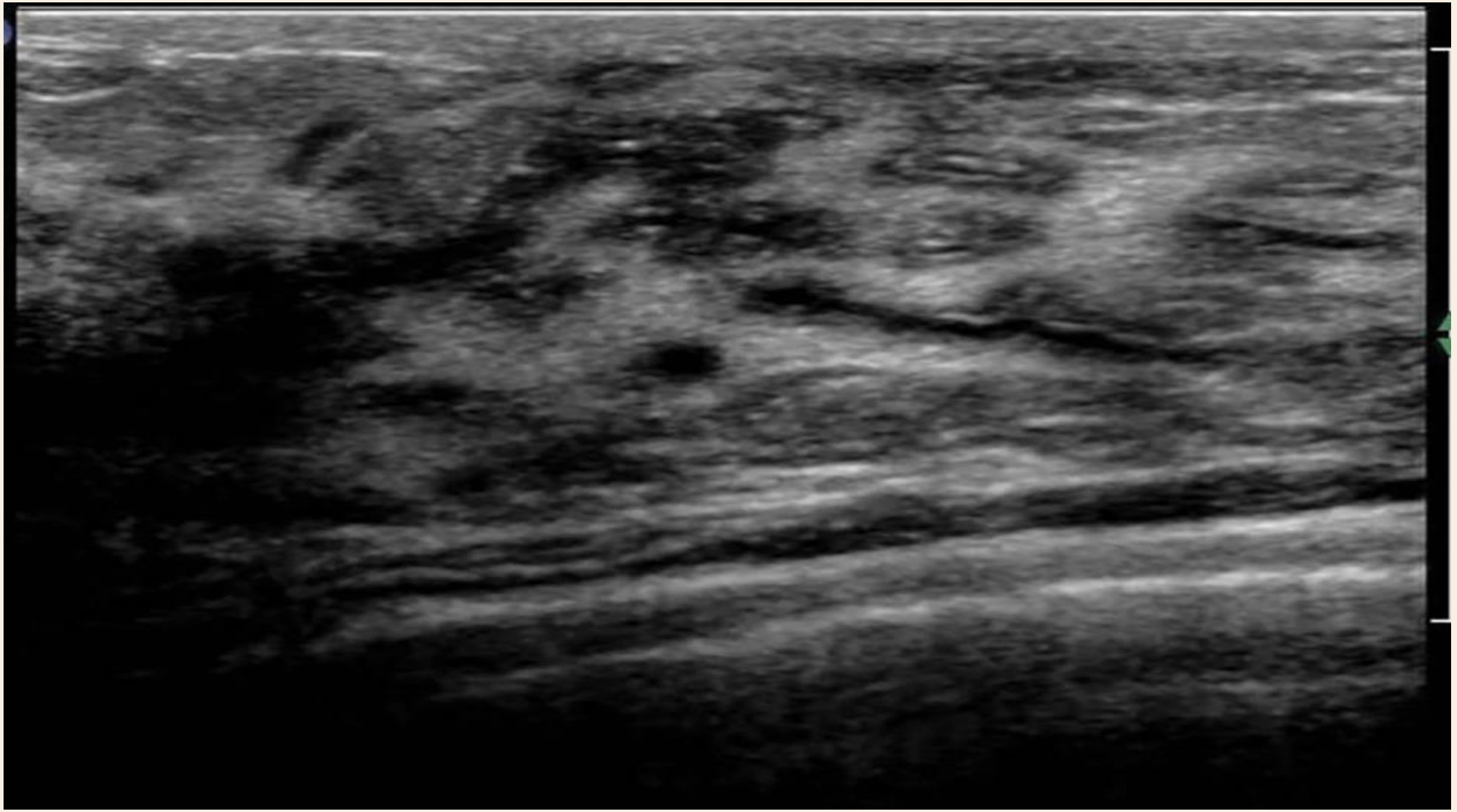
- Galactocele
- Hematoma
- Fat necrosis.
- Abscess.
- Necrotic tumor.
- Papillary tumor.
- Atypical ductal hyperplasia.
- DCIS

FIBROCYSTIC DISEASE

- Changes in the parenchyma
  - Terminal ducts and lobules
- Caused by disturbance in estrogen/progesterone balance
- Sonographically:
  - Multiple small cysts develop
  - Large sonolucent cysts
  - Areas of fibrous tissue (stroma) appears brighter
  - Ductal ectasia




SWEDISH MEDICAL CENTER
GE
5cm 10LA39
AW/ BREAST
FROZEN
16G
69DR
FIBROCYSTIC BREAST DISEASE
MI<0.1 AO=83%

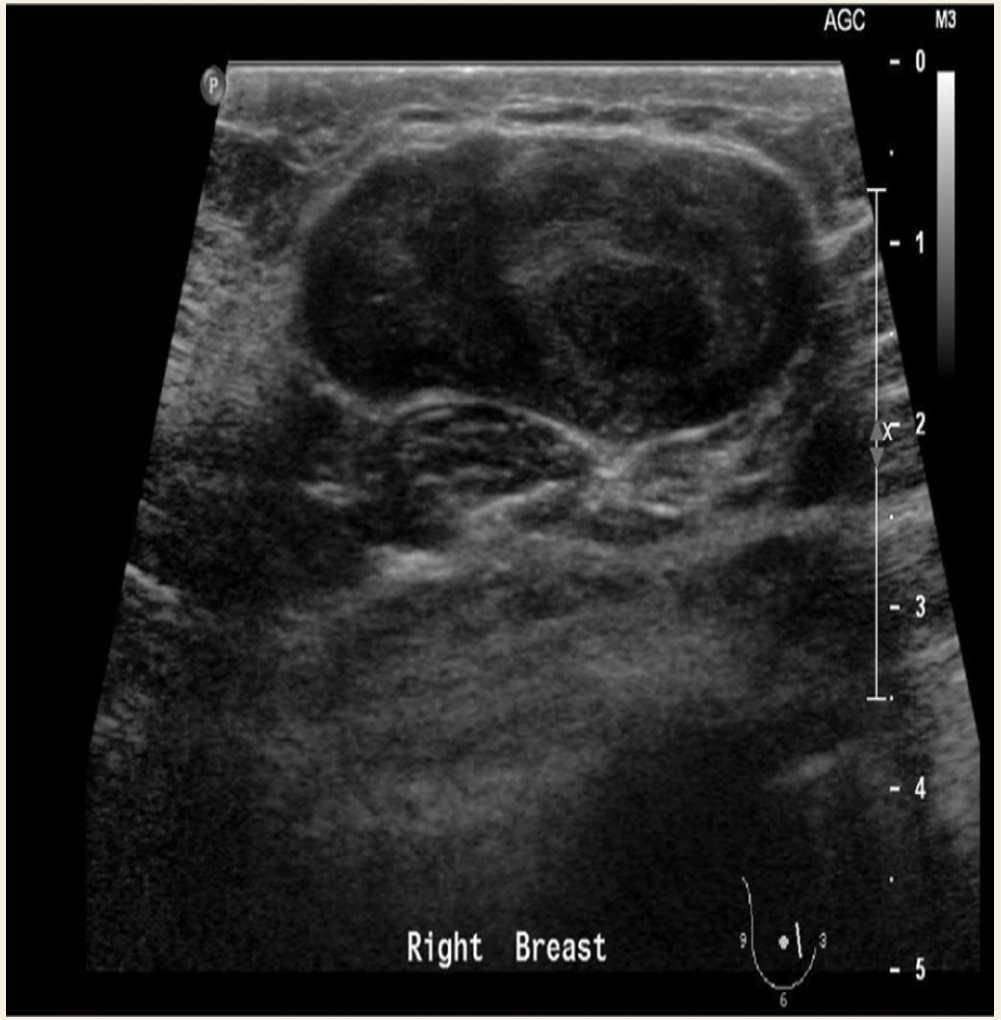


FIBROADENOMA

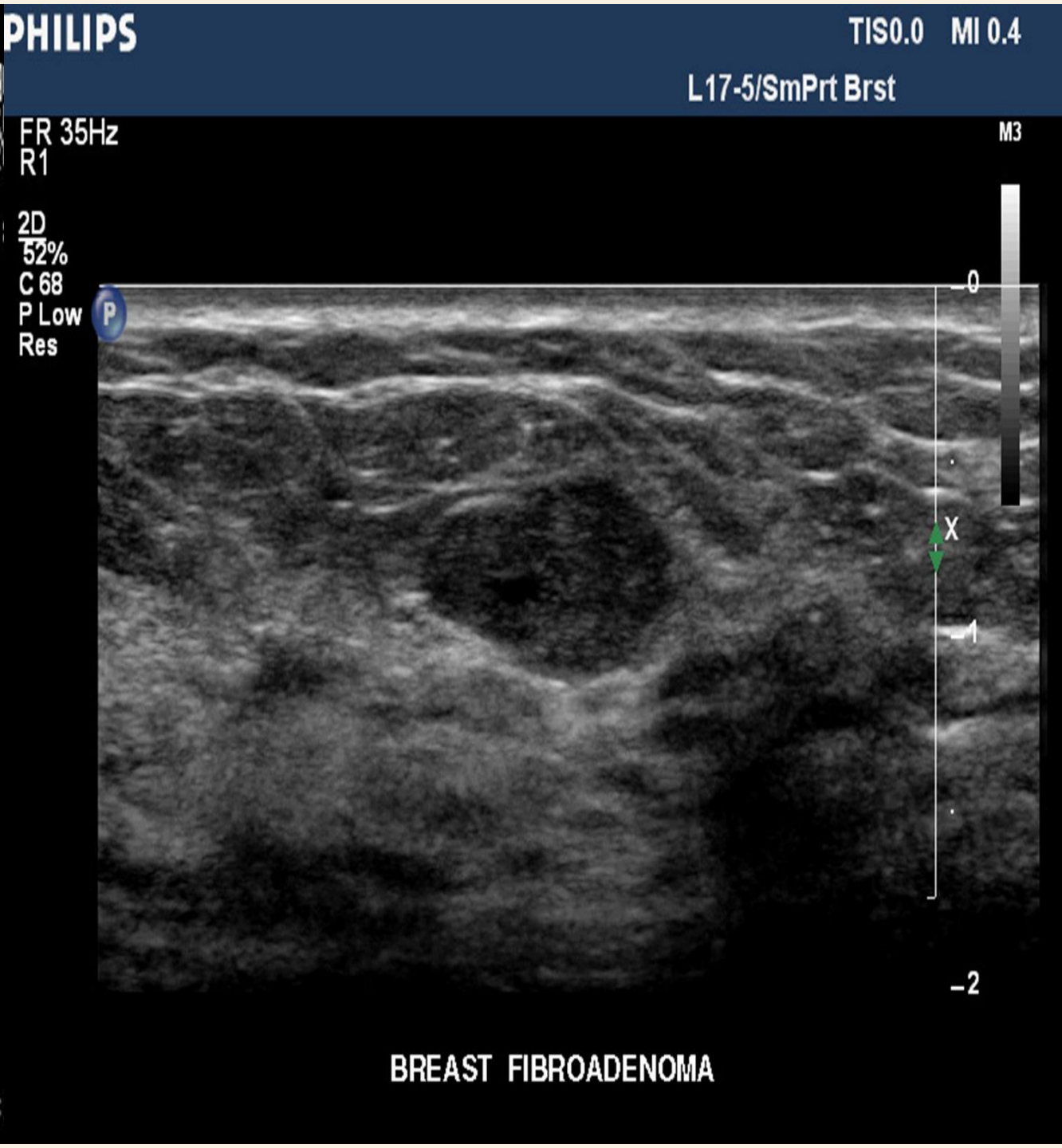
- **Most common benign breast tumor**
  - **Growth is stimulated by estrogen**
- **Primarily in young women ~15-40 years old**
- **<u>Clinically</u>:**
  - **Firm**
  - **Rubbery**
  - **Freely mobile**
  - **Slow-growing**

FIBROADENOMA

- **Sonographically:**
  - **Small, rounded margins**
  - **Clearly delineated from surrounding breast tissue**
  - **Low-level homogeneous internal echoes**
    - **Typically hypoechoic**
  - **Possible posterior enhancement**




SWEDISH MEDICAL CENTER
GE
4cm
12
BR
FR
FIBROADENOMA
MI<0.4 AO=


PHILIPS
TIS0.0 MI 0.4
L17-5/SmPrt Brst
FR 35Hz
R1
M3
2D
52%
C 68
P Low
Res
P
0
X
-1
-2
BREAST FIBROADENOMA

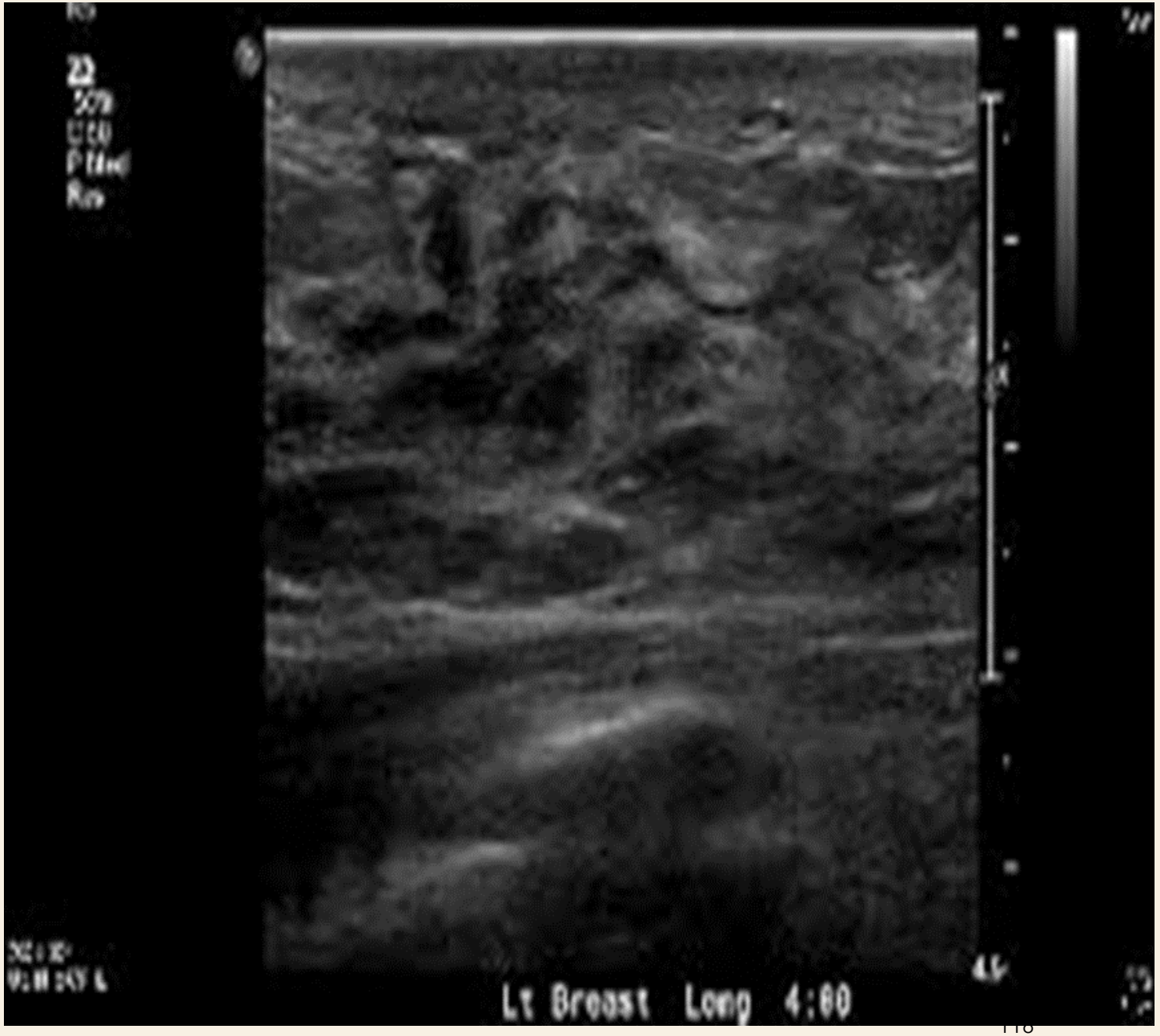
MASTITIS

- **Inflammation of the breast**
- **Usually during pregnancy and lactation but can affect women at any stage of life**
- **<u>Symptoms</u>:**
  - **Edema**
  - **Nipple discharge**
  - **Nipple retraction**
- **<u>Sonographic appearance</u>:**
  - **Tissue edema**
  - **Mild skin thickening**

MASTITIS

- **Three types of mastitis:**
  - **<u>Puerperal</u> – most common acute type of mastitis, occurs during lactation**
  - **<u>Periductal</u> – noninfectious form of mastitis see in perimenopausal or menopausal women**
  - **<u>Granulomatous</u> – results from traumatic injury, foreign body, fungal infection, parasitic disease, and autoimmune disorders**


Dr P Marazzi/SPL


Lt Breast Long 4:00

ABSCESS

- Localized area of purulent material
- Often develops with acute mastitis
- Clinically:
  - Pain
  - Swelling
  - Redness
  - Febrile
  - Enlarged axillary nodes
  - Purulent discharge

ABSCESS

- **Sonographically:**
  - **Ductal dilatation**
  - **Increased echogenicity of the breast**
  - **Irregular margins**
  - **Later – organized area of complex mass**
  - **Increased vascular flow**


SWEDISH MEDICAL CENTER
+1:38:12
4cm
12LA39
BREAST
FROZEN
14G
78DR
NIPPLE
SHADOW
BREAST ABSCESS
MI<0.4 AO=100%

POST - RADIATION BREAST ABSCESS

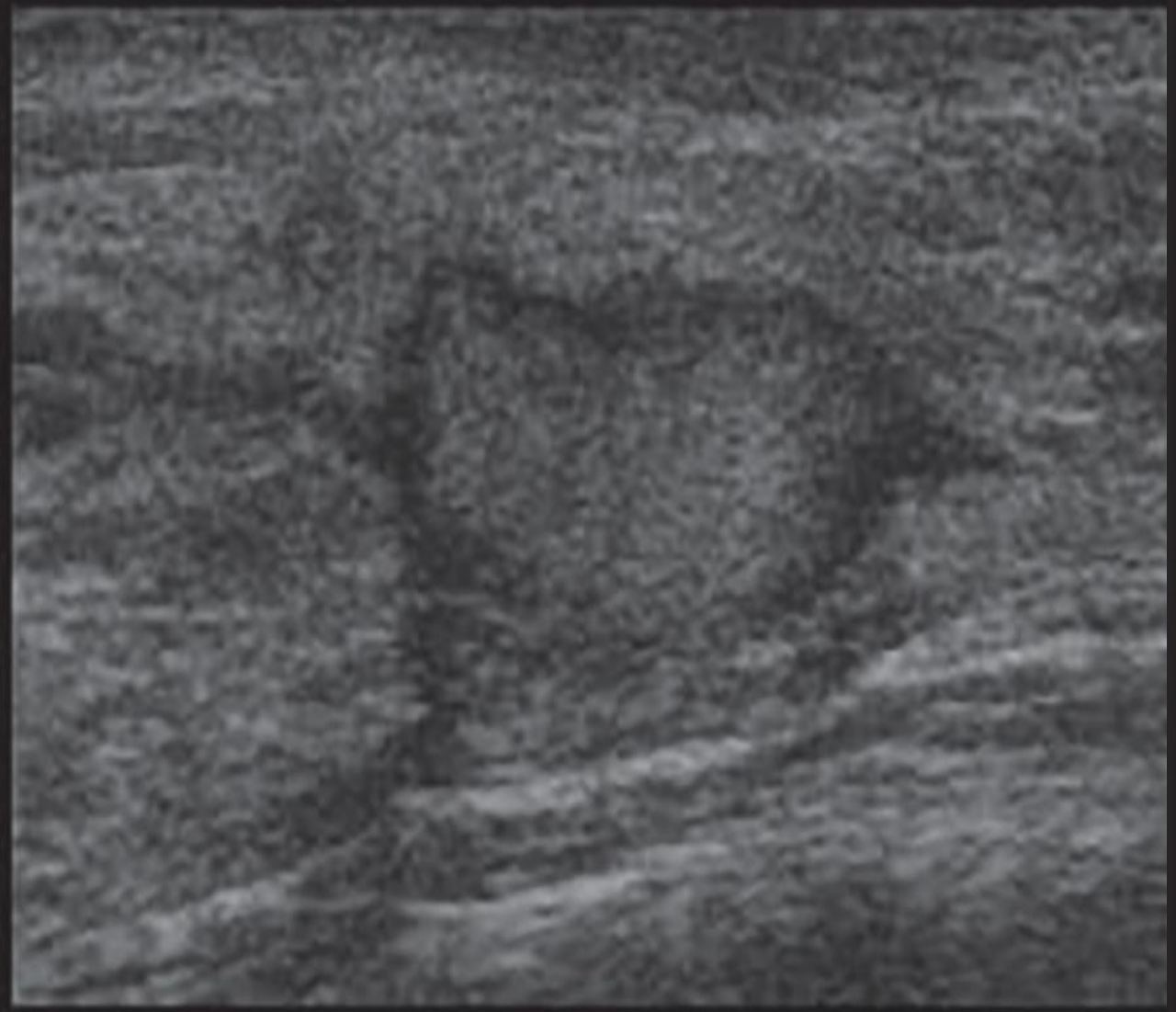
SonoCT™ IMAGING WITH XRES™ TECHNOLOGY

FAT NECROSIS

- Uncommon
- Usually found in older women
- Necrosis results from local trauma, surgery, radiation treatment or inflammation
- Occurs subareolar or subcutaneous
- Clinically:
  - Palpation reveals a spherical nodule that is superficial under a layer of calcified necrosis

FAT NECROSIS

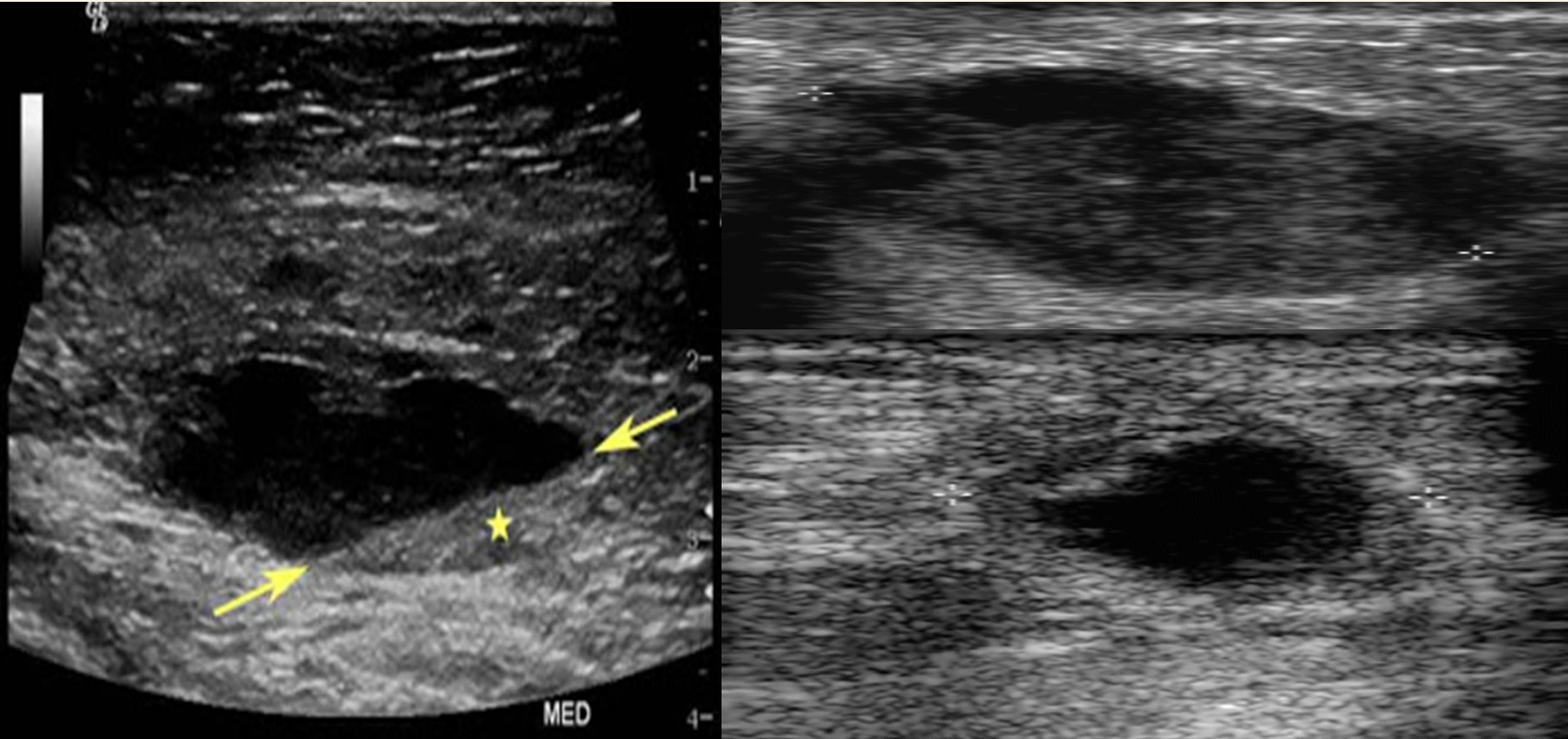
- **Sonographically:**
  - **May appear:**
  - **Solid**
  - **Complex with mural nodules or echogenic bands**
  - **Anechoic with posterior enhancement or shadowing**
  - **May mimic a malignant lesion**



HEMATOMA

- **Develop as a result of trauma or occur spontaneously in patients with bleeding disorders or due to anticoagulant use**
- **<u>Clinically</u>:**
  - **Bruising**
  - **Skin thickening**
  - **Tenderness**
- **<u>Sonographically</u>:**
  - **Varies depending on length of time (early – fluid mass, later – more complex with non-uniform internal echoes)**

HEMATOMAS

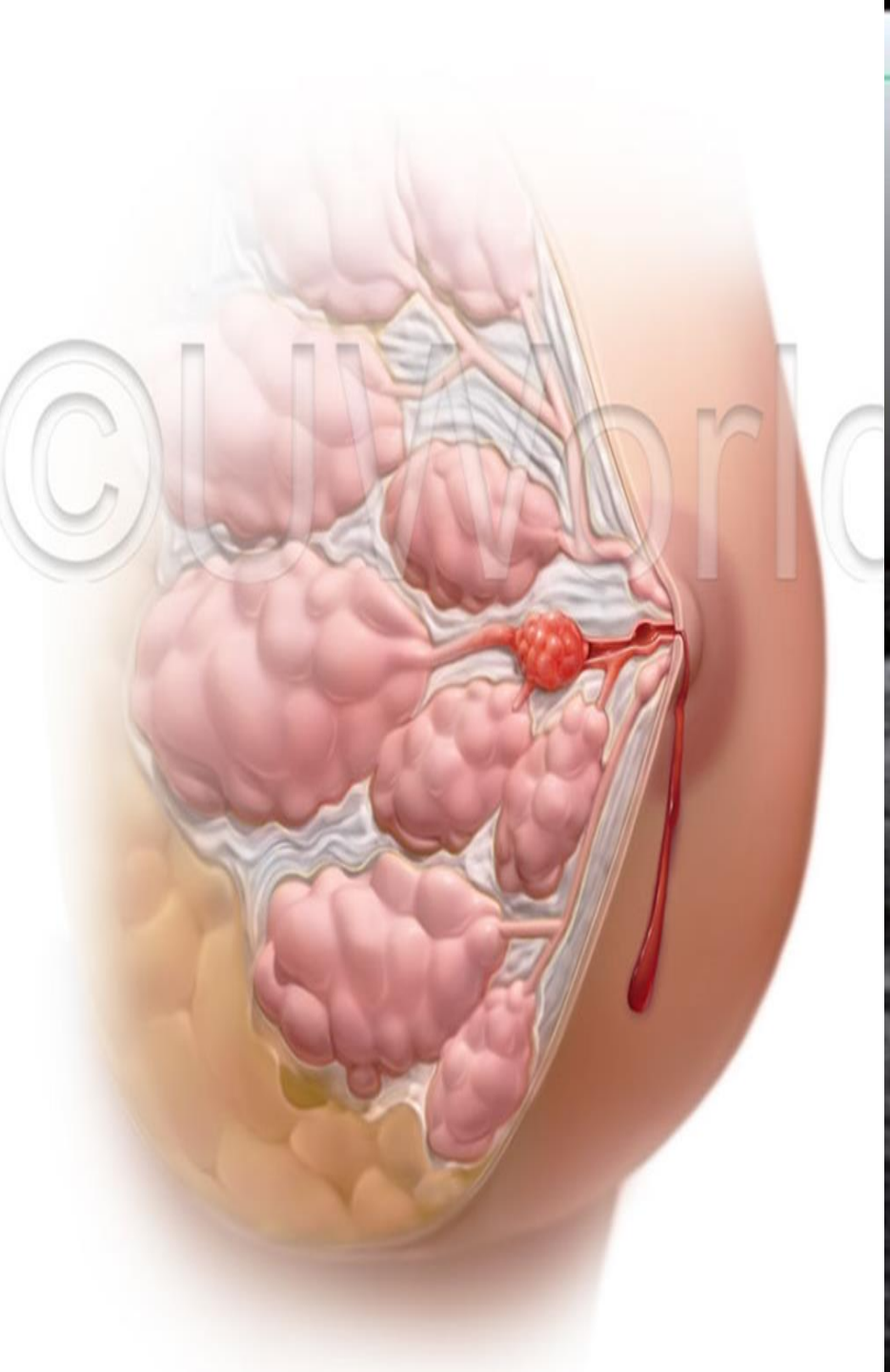


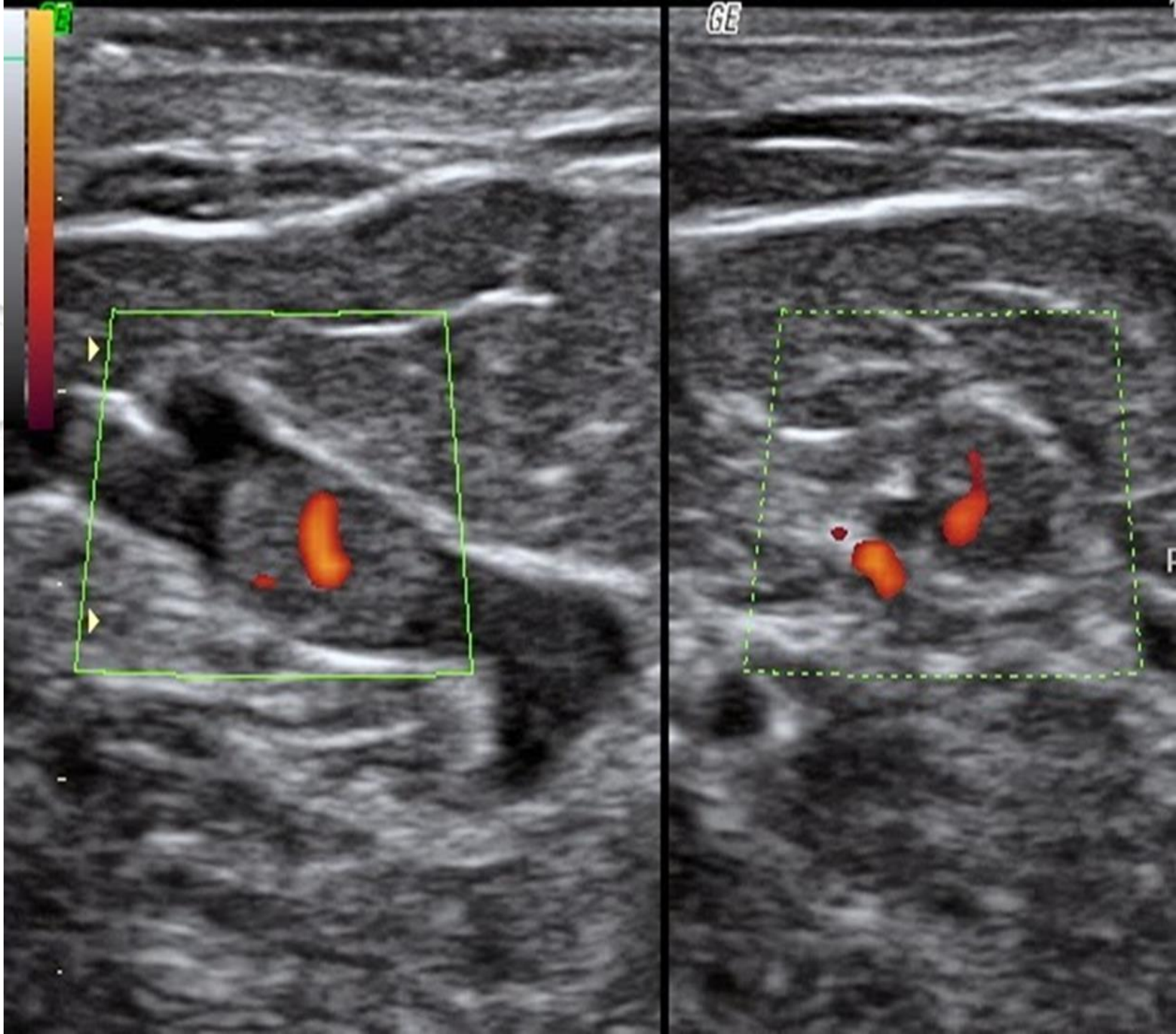
LIPOMA

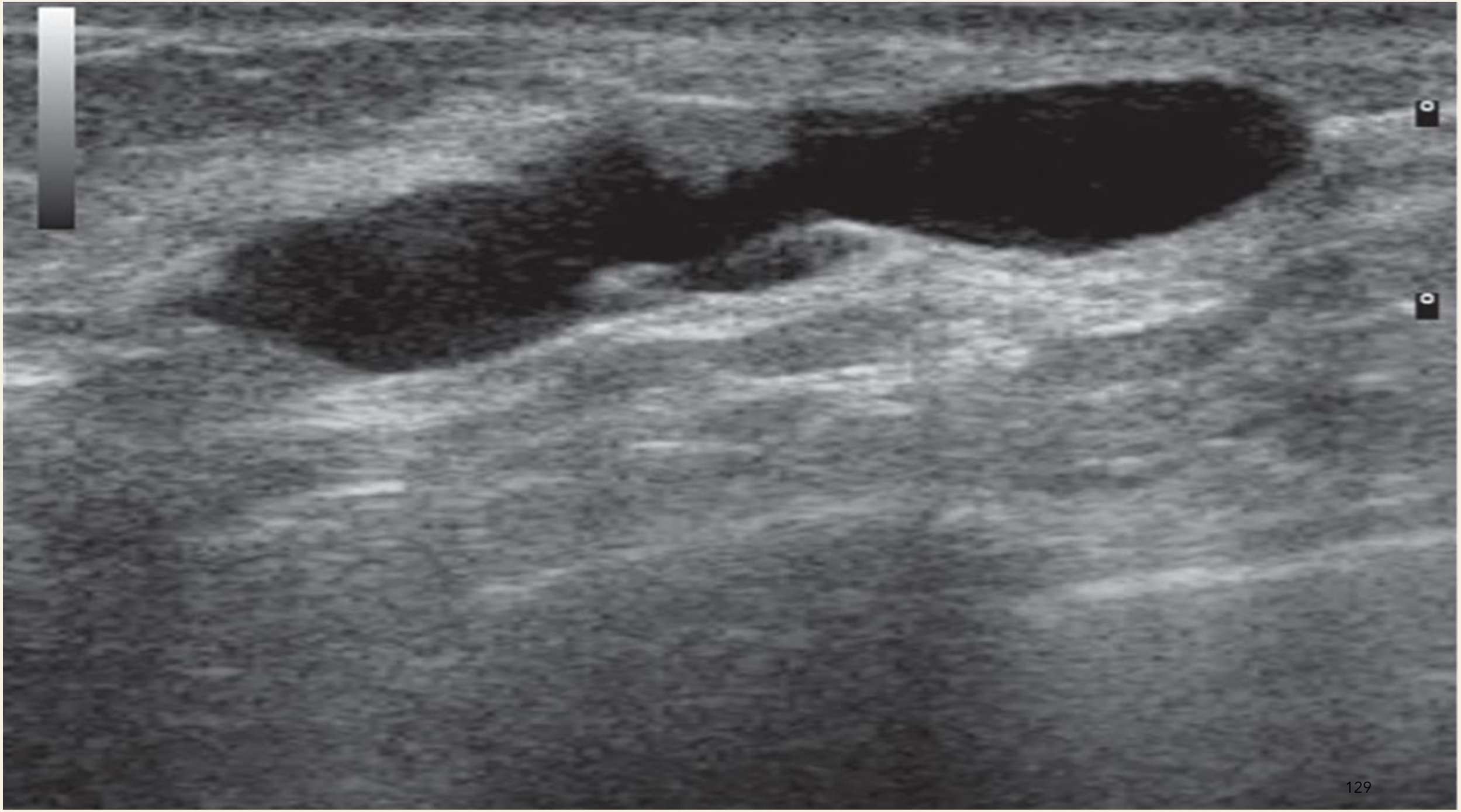
- Capsulated fatty tissue
- Can grow pretty large before it is detected clinically
- Found in middle-aged or menopausal women
- Clinically:
  - Large, soft, mass is felt
  - No thinning/fixation of overlying skin is noted
- Sonographically:
  - Difficult to distinguish from fatty breast tissue
  - Smooth walls
  - Hypoechoic with posterior enhancement
  - Easily compressible

INTRADUCTAL PAPILLOMAS

- Proliferation of the epithelial lining of the breast duct
- Usually develops beneath the areola
- Clinically:
  - Asymptomatic
  - Persistent bloody nipple discharge
- Sonographically:
  - Difficult to visualize
  - Only clue – presence of dilatation of solitary duct
    - Soft tissue mass within dilated duct

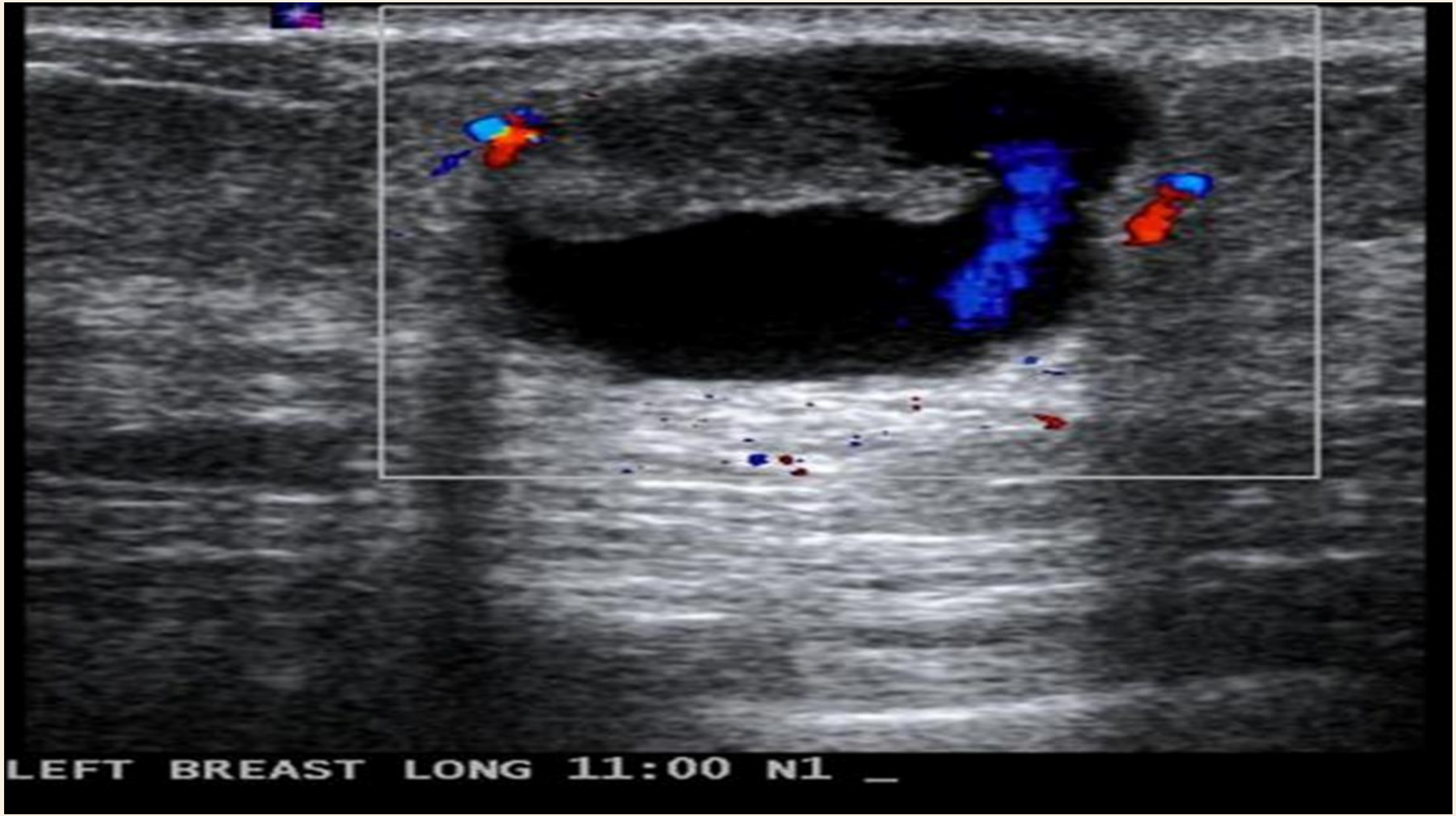



GE
GE



INTRACYSTIC PAPILLOMAS

- Uncommon
- Usually affects older women
- Clinically:
  - Bloody nipple discharge
  - Mildly tender breast lump
- Sonographically:
  - Discrete complex cystic mass
  - Broad-based soft tissue mass extending from the wall into the cyst
  - Posterior enhancement


LEFT BREAST LONG 11:00 N1 _

SEBACEOUS CYST

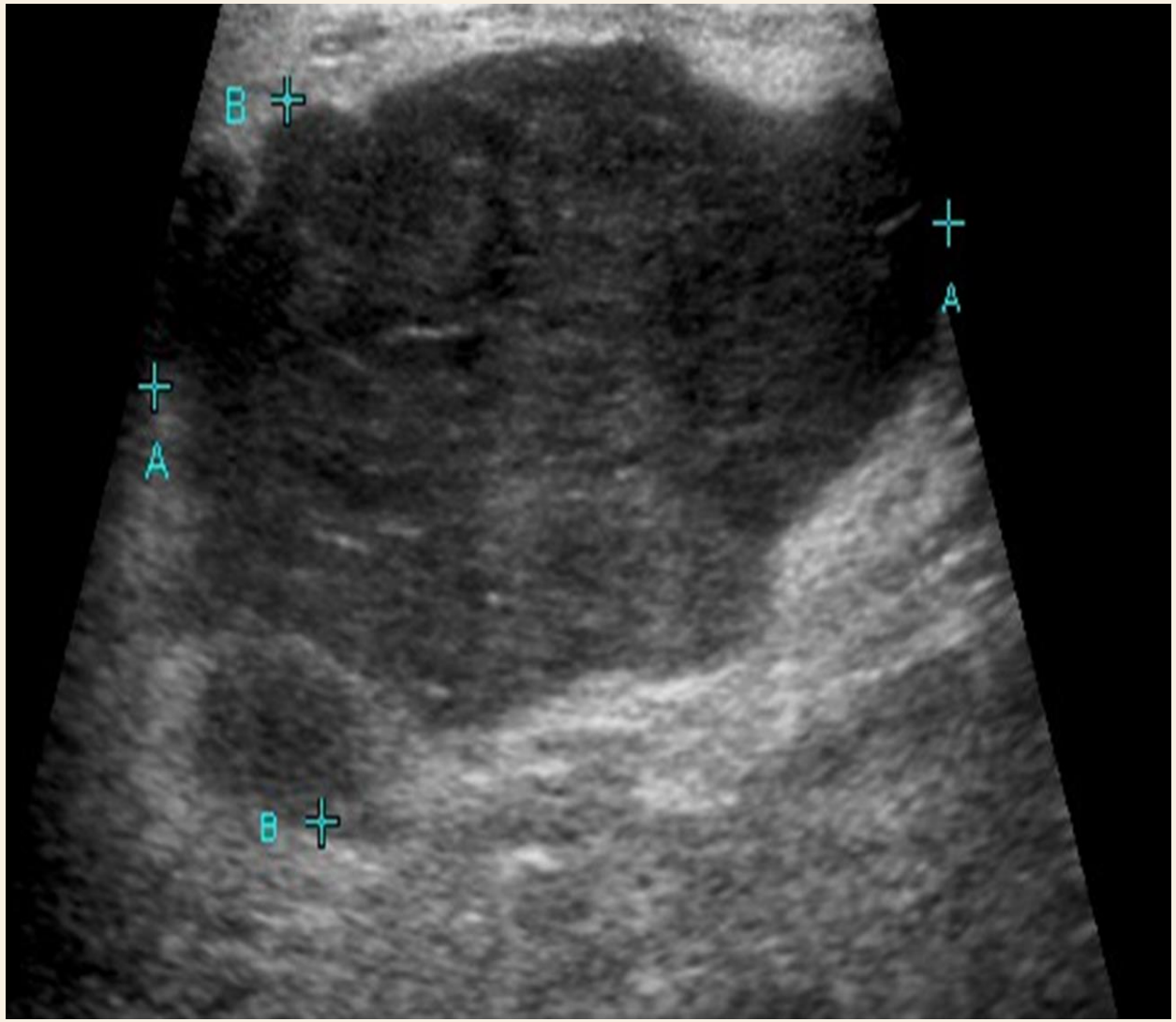
- **“Epidermal Inclusion Cyst”**
- **Results from obstructed sebaceous gland on the dermis of the breast**
- **Commonly associated with Montgomery glands of the areola or found along the inframammary fold**
- **<u>Sonographically</u>:**
  - **Rounded, well-defined mass with low to medium level echogenicity (oily sebum)**
  - **May demonstrate wall calcification**

PHYLLODES

- **Uncommon, 40–60-year-old prevalence**
- **Rare type of lesion arising from the stroma (connective tissue)**
- **Usually benign but may become malignant**
- **<u>Clinically</u>:**
  - **Mobile palpable mass**
  - **Non-tender**
  - **Skin bulging is possible**
  - **Can become quite large**

PHYLLODES

- **<u>Sonographically</u>:**
  - **Large, solid, well-circumscribed mass**
  - **Lobulated borders**
  - **Similar to a fibroadenoma but has cystic areas within**
  - **Malignant – more lobulated, fast growing**



PHYLLODES


A
B
C
D
KING GEORGE'S MEDICAL UNIVERSITY
THORAX ABDOMEN
SARVESH KUMAR

MALIGNANT MASSES

RISK FACTORS

- **<u>Two major risk factors</u>:**
  - **Personal or family history**
  - **Personal history of biopsy-proven atypical hyperplasia**

BREAST CANCER

- **Breast cancer is generally painless, lobular or irregular in shape, uneven surface contour (gritty), and fixed or poorly moveable**
- **Patients may present with:**
  - **Palpable lump**
  - **Nipple discharge**
  - **Skin dimpling**
  - **Ulceration**
  - **Nipple retraction**

Nearly always result from cancer

BREAST CANCER TERMS

- **Carcinoma – cancer that arises from the epithelium (in the ductal system)**
- **Sarcoma – cancer that arises from supportive or connective tissues**
- **In situ (noninvasive) – tumor is localized to its site of origin**
- **Infiltrating (invasive) – tumors grow past the site of origin and can gain access to the blood vessels and lymphatic channels**
  - **85% of breast cancers**

BREAST CANCER TERMS

- **Multifocality – presence of additional tumors within one breast quadrant or ductal system**
- **Multicentricity – presence of multiple tumors in different quadrants or tumors separated by 5 cm or more**

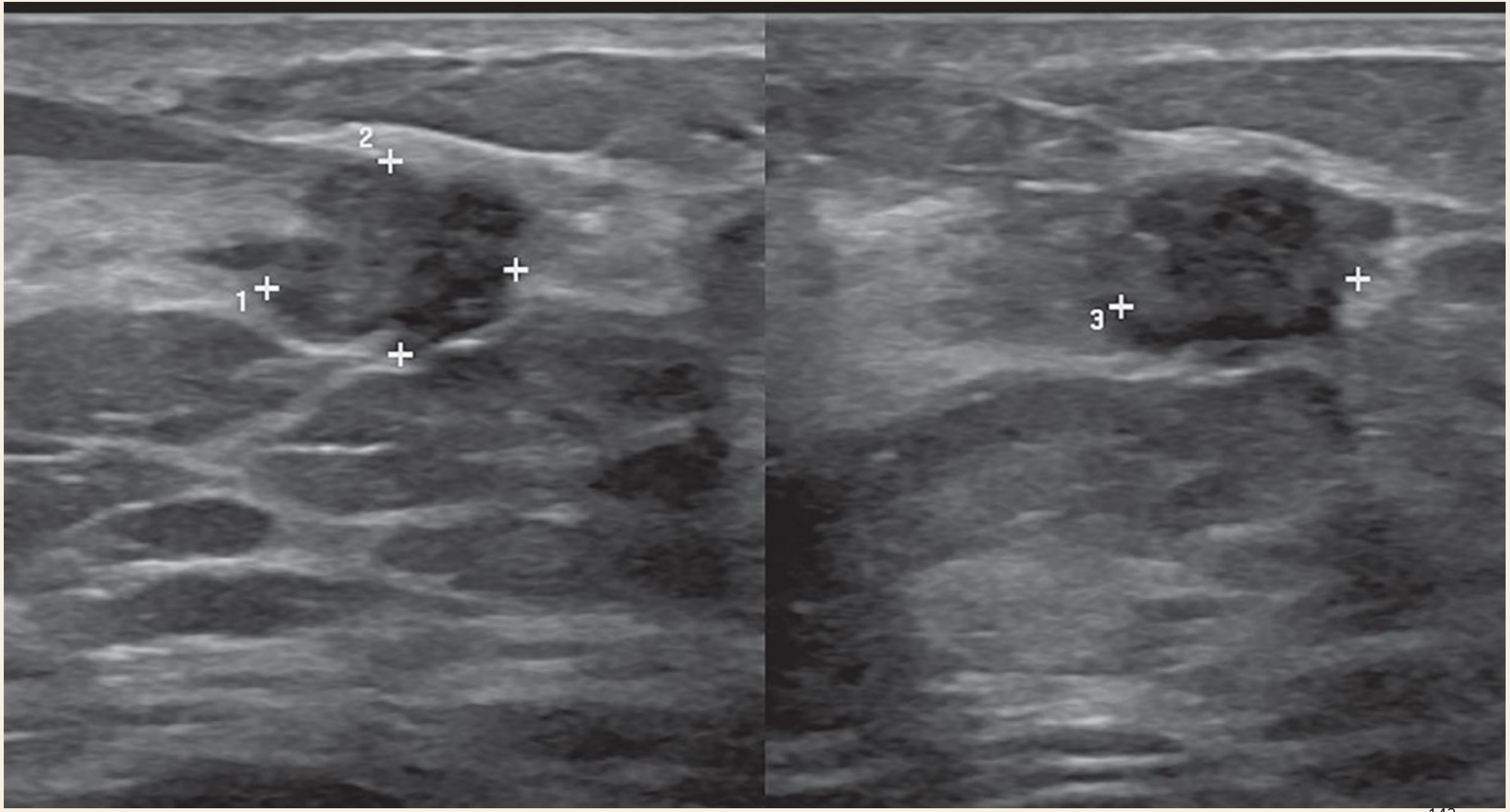
- **Both multifocal and multicentric tumors are more likely to recur and have a poor prognosis**

DUCTAL CARCINOMA IN SITU (DCIS)

- **“Intraductal carcinoma”**
- **Most common noninvasive breast malignancy**
- **Characterized by excessive growth of abnormal epithelial cells in the duct**
- **<u>Clinically</u>:**
  - **Asymptomatic**
  - **Palpable mass**
  - **Nipple discharge**

DUCTAL CARCINOMA IN SITU (DCIS)

- **Mammography findings:**
  - **Microcalcifications**
- **Sonographically:**
  - **Irregular ductal dilatation**
  - **Intraductal mass**
  - **Microcalcifications (may or may not be visualized)**
  - **Architectural distortion**


2
1
3

LOBULAR CARCINOMA IN SITU (LCIS)

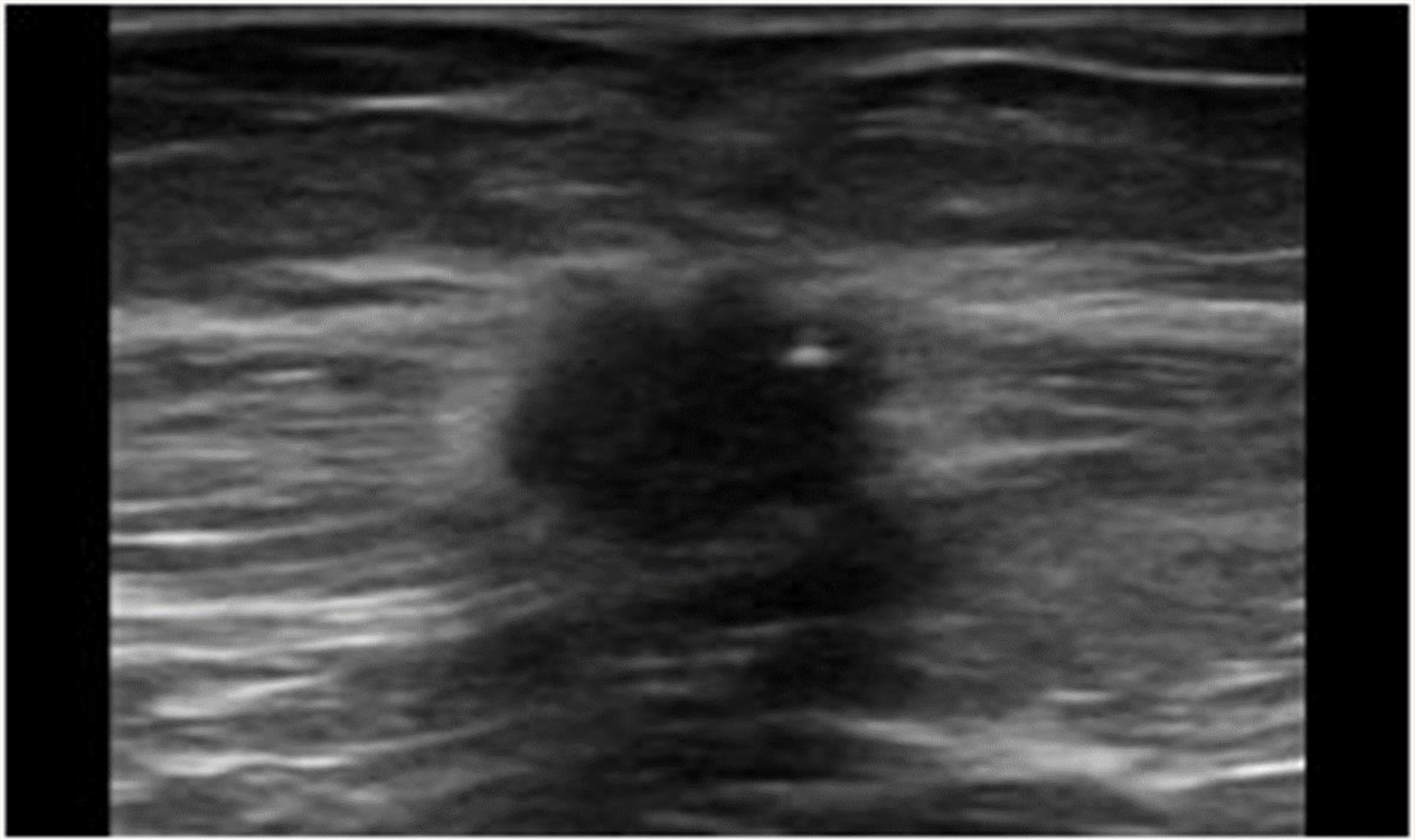
- Generally affects premenopausal women and has a very low malignant potential
- LCIS is often referred to as a lobular neoplasia and classified as a precancerous growth
- Sonographically:
  - Bilateral, multicentric tumor
  - Mimics Fibrocystic disease

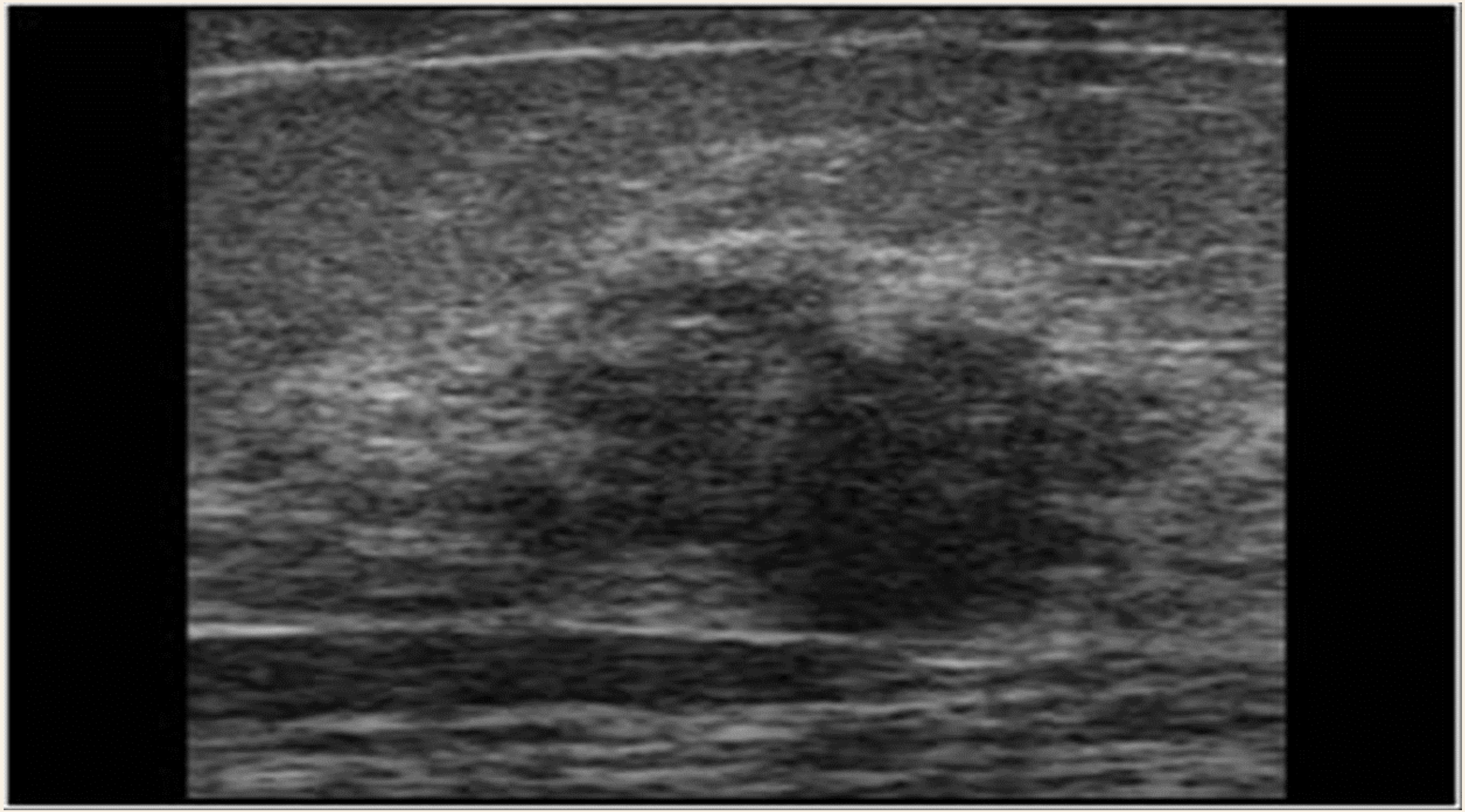
INVASIVE DUCTAL CARCINOMA (IDC)

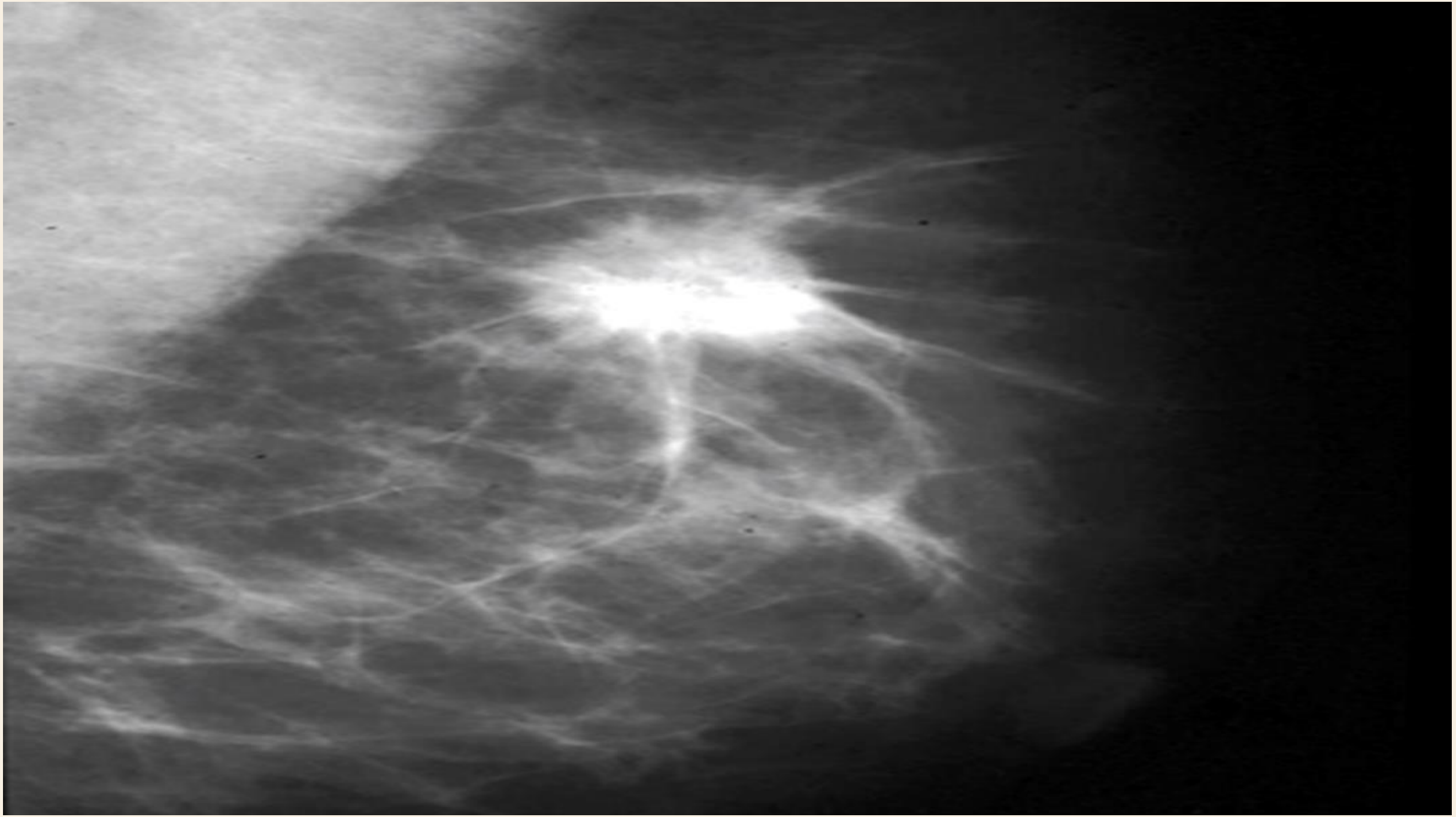
- Most common – 85% of breast cancers
- Invades neighboring tissues
- Clinically:
  - When palpable – hard, fixed mass that is painless
  - Commonly found in the UOQ
- Mammography findings:
  - Asymmetric
  - Radiopaque mass
  - Microcalcifications
  - Thickened and retracted Cooper's ligaments

INVASIVE DUCTAL CARCINOMA (IDC)

- **<u>Sonographically</u>:**
  - **Irregular and ill-defined**
  - **Borders become spiculated (needle-like)**
  - **Hypoechoic with anterior border being more echogenic than posterior**
  - **"Taller than wide" with branching**
  - **Shadowing posterior**
  - **May have possible microlobulation, microcalcifications, ductal extension, architectural disruption**

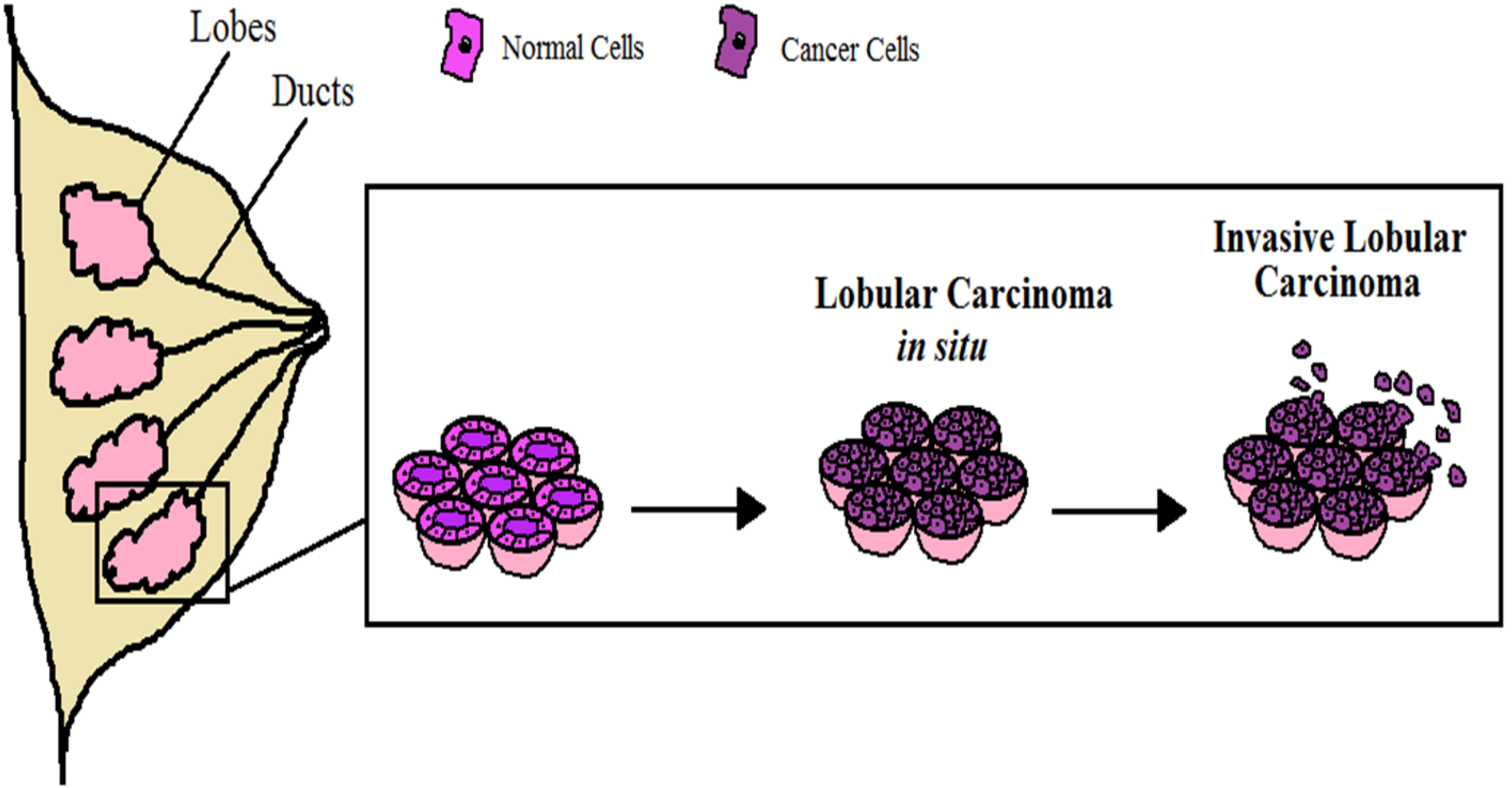


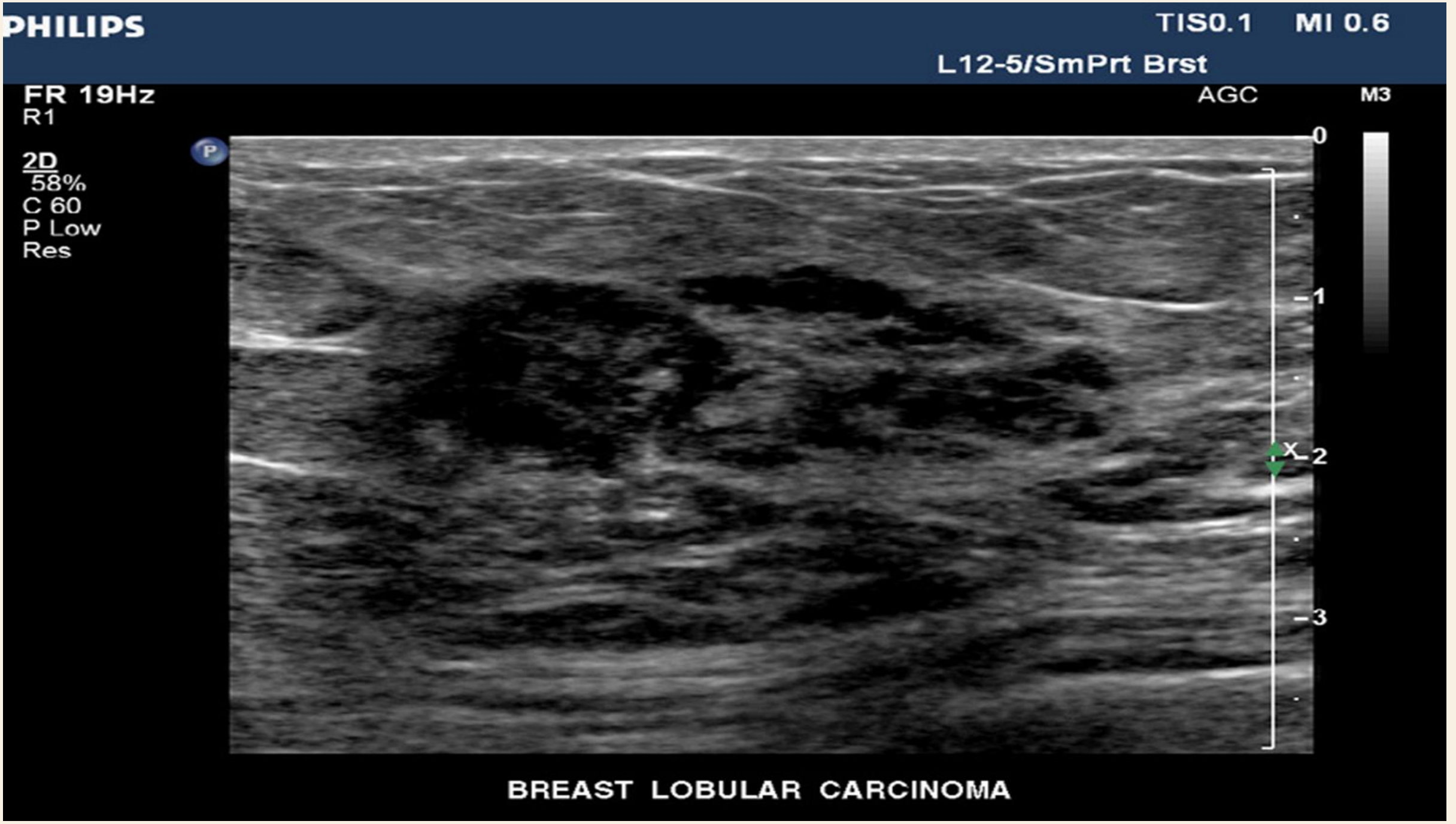




INVASIVE LOBULAR CARCINOMA (ILC)

- **Begins in the lobule where it extends into the fatty tissue of the breast**
- **Bilateral mass that is multicentric and/or multifocal (poor prognosis)**
- **Mammography may underestimate the extent of spread**
- **<u>Sonographically</u>:**
  - **Spiculated mass mimicking invasive ductal carcinoma**
  - **Architectural distortion**


Lobes
Ducts
Normal Cells
Cancer Cells
Lobular Carcinoma
in situ
Invasive Lobular
Carcinoma


PHILIPS
TIS0.1 MI 0.6
L12-5/SmPrt Brst
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C 60
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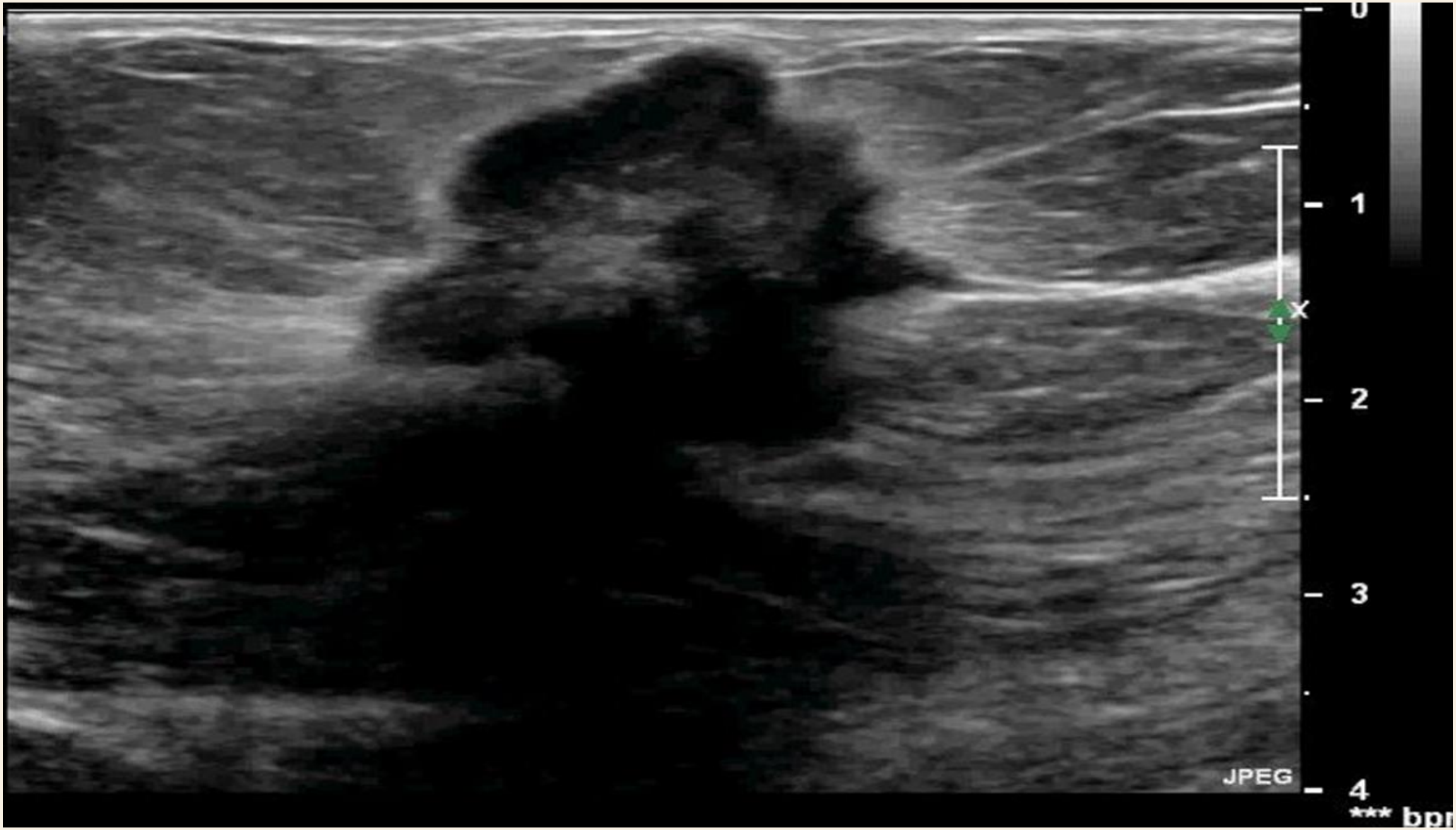
BREAST LOBULAR CARCINOMA


0
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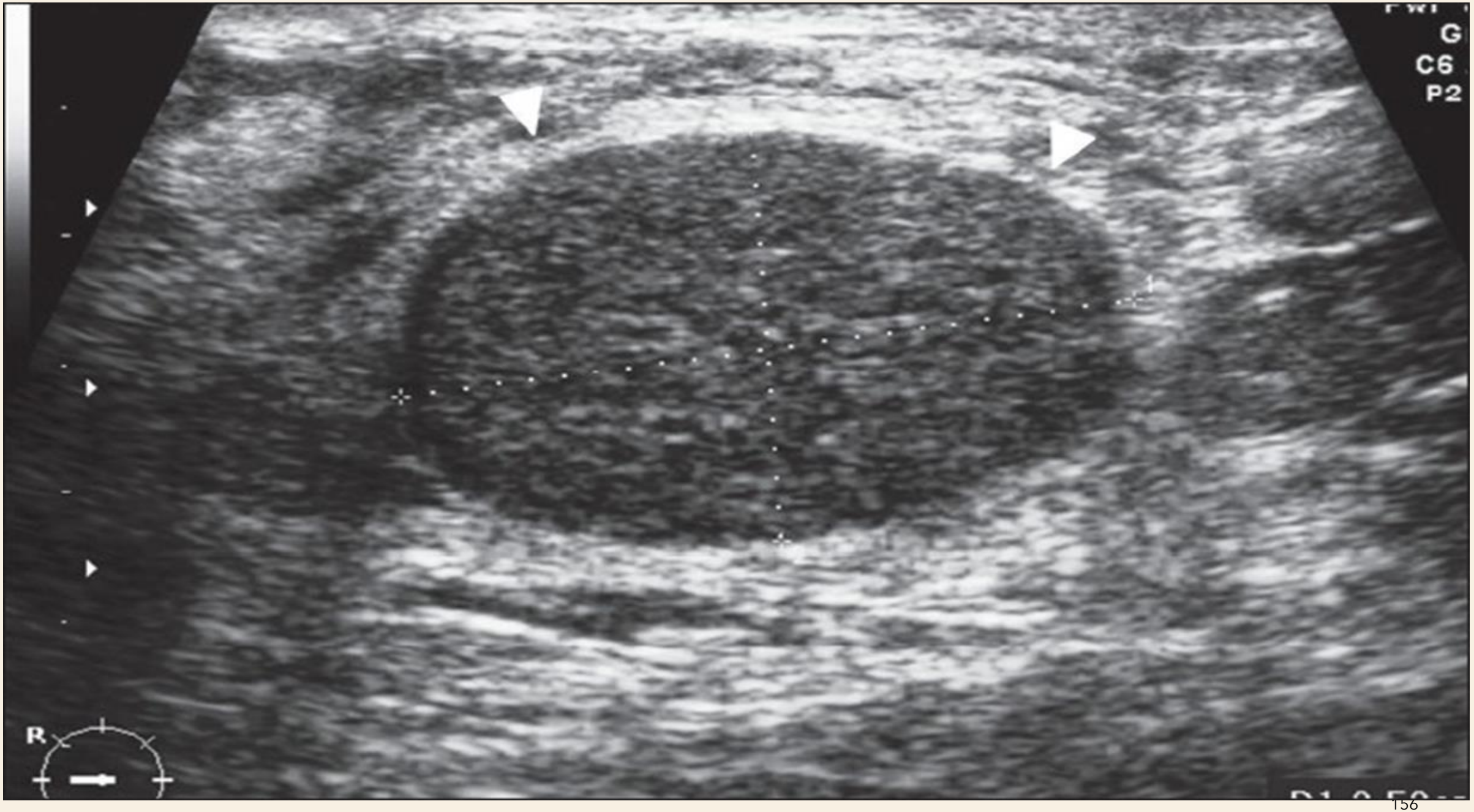
4
JPEG

MEDULLARY CARCINOMA

- Rare, but fast growing
- Prevalence in younger females
- Clinically:
  - Discrete, palpable mass
  - Large mass may cause skin bulging
  - Discoloration of skin
  - Mildly compressible

MEDULLARY CARCINOMA

- **<u>Sonographically</u>:**
  - **Homogenous/mildly heterogenous mass**
  - **May have posterior enhancement**
  - **Round, oval**
  - **Surface irregularities/lobulations may be visualized**
  - **Hemorrhage or cystic degeneration may be noted**
  - ***May be confused with a benign tumor***


G
C6
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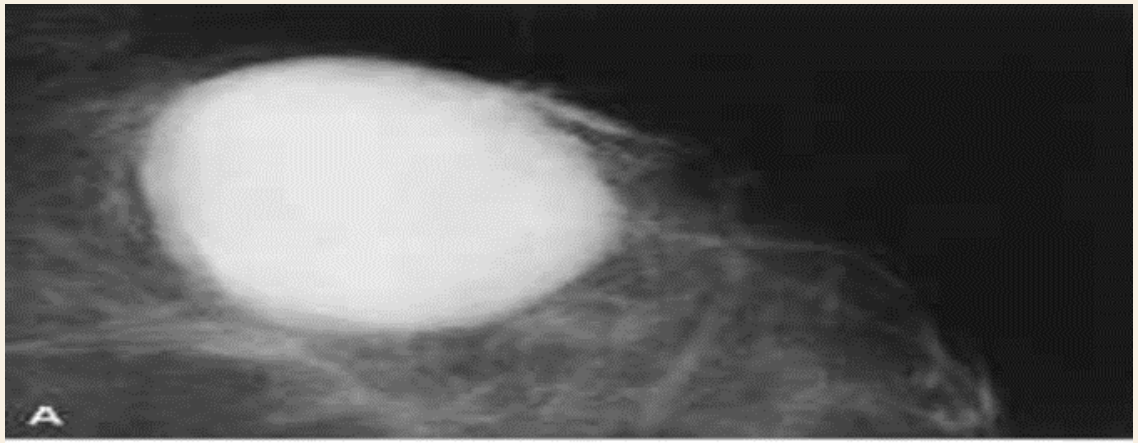
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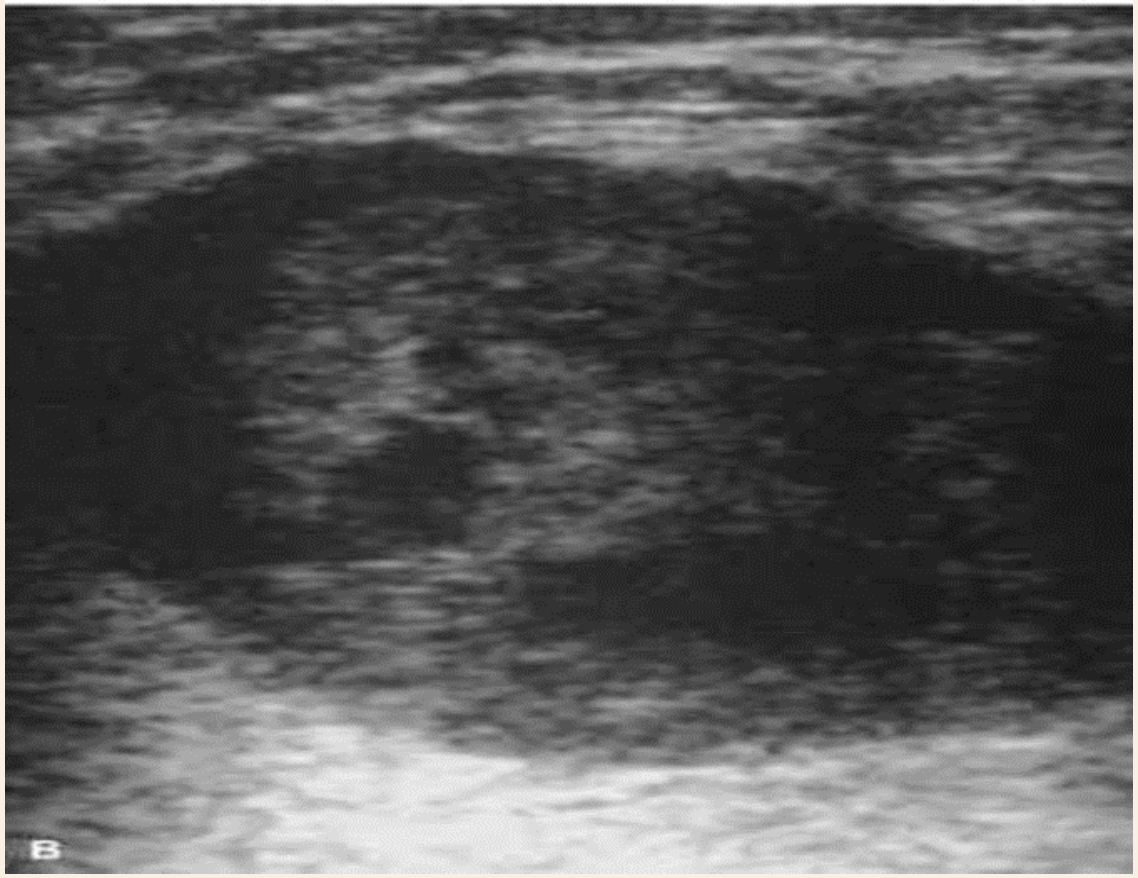
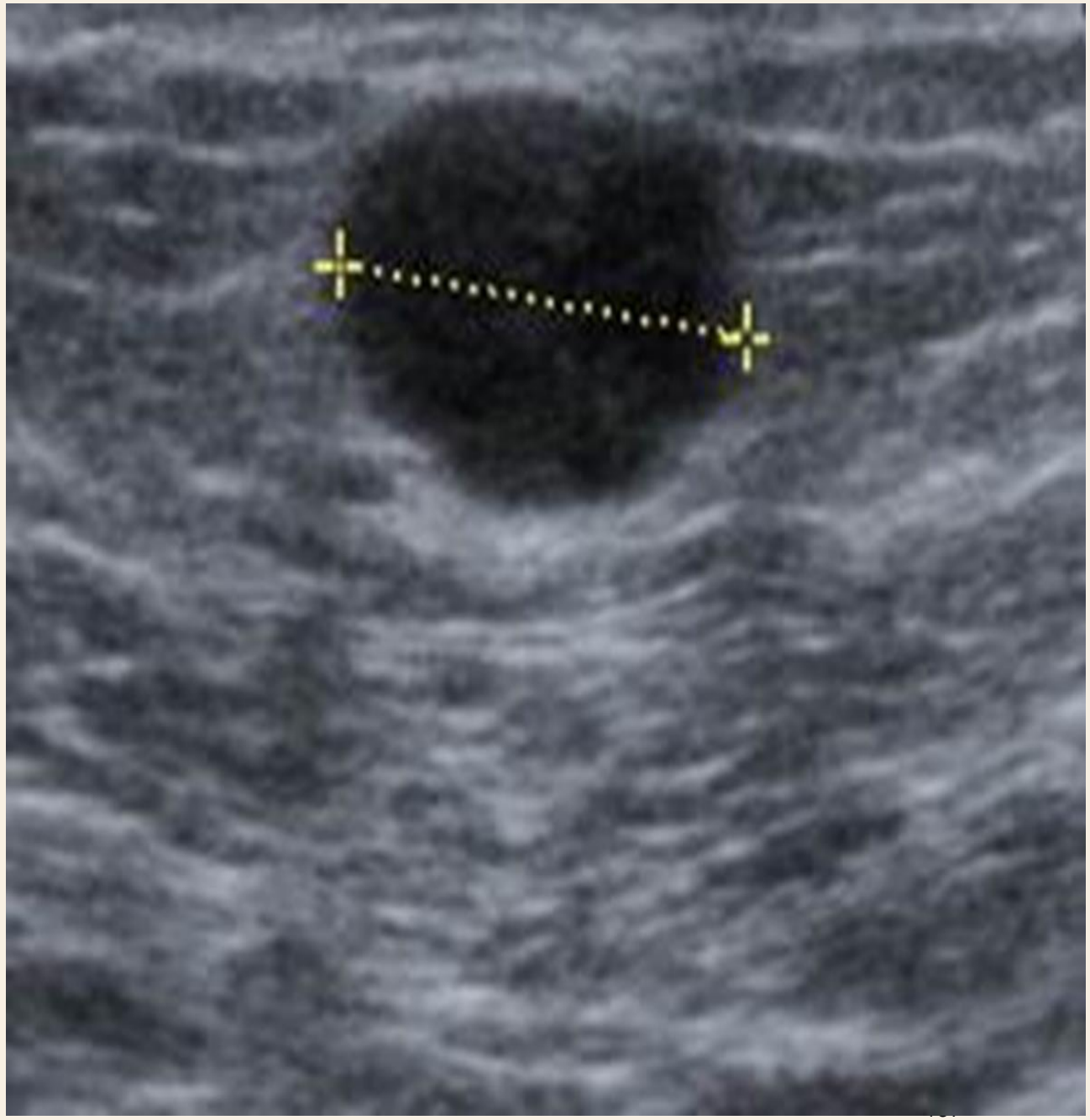
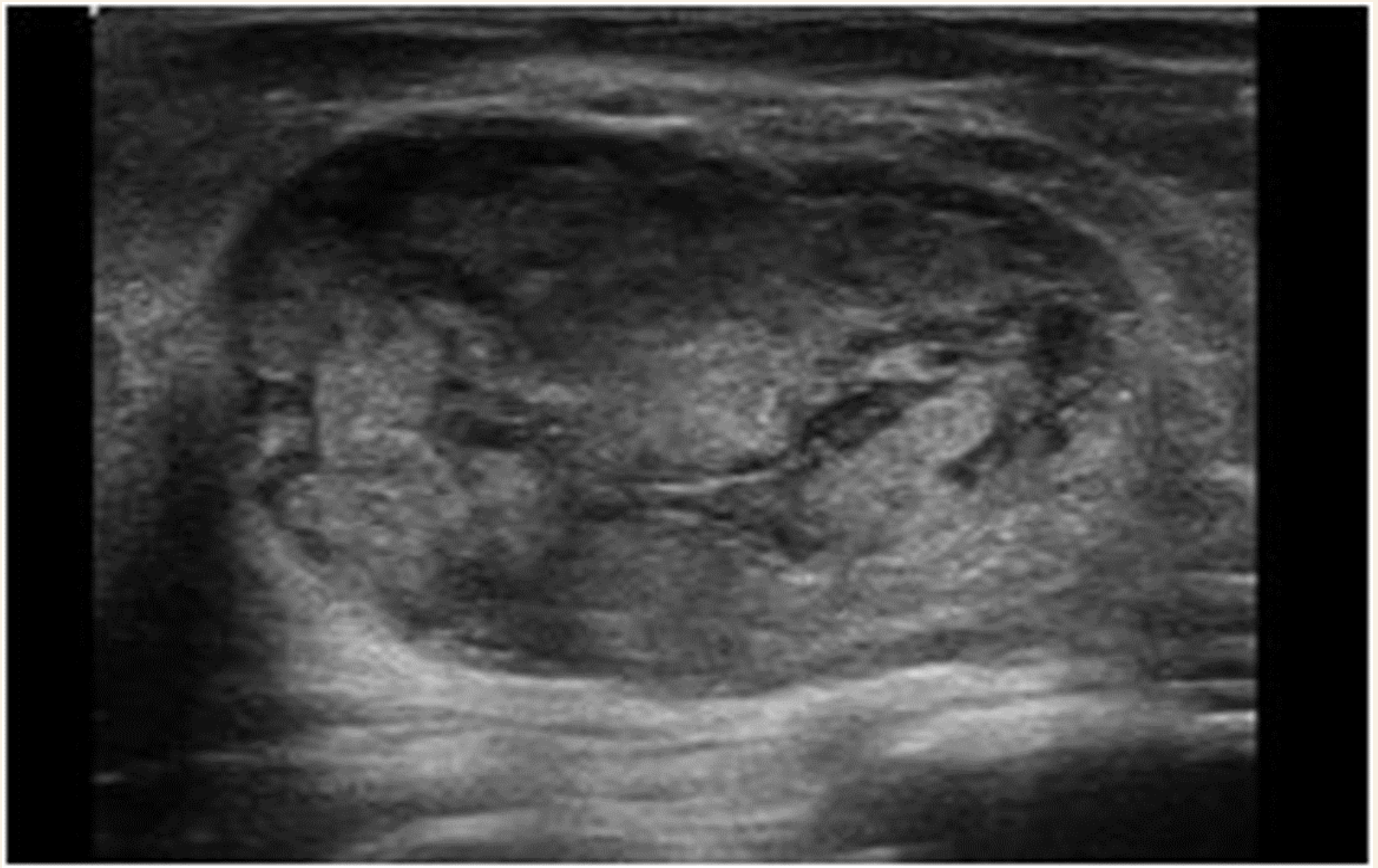

B



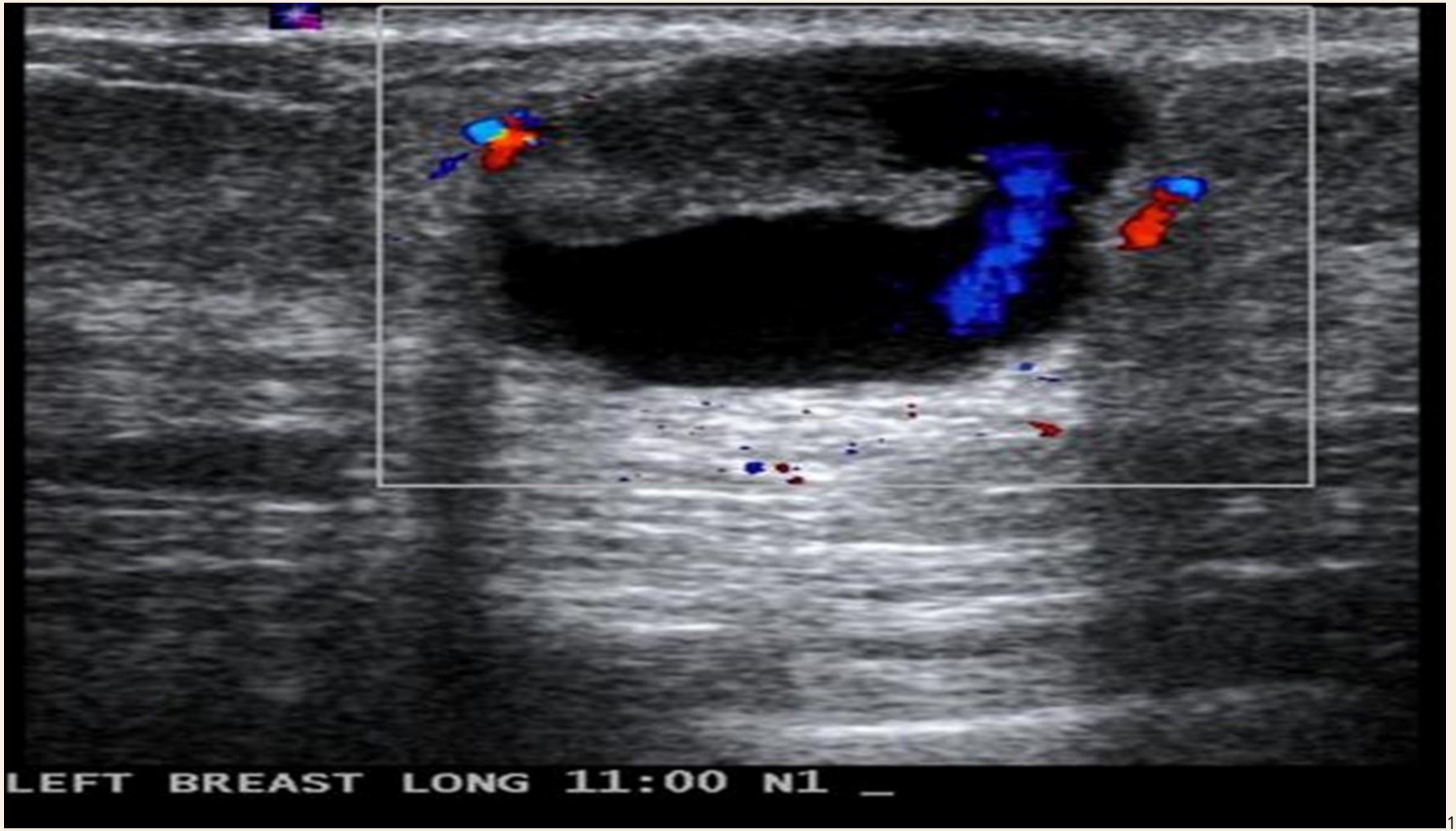
COLLOID CARCINOMA

- **Also known as Mucinous Carcinoma**
- **<u>Clinically</u>:**
  - **When palpable, it is soft and feels like "thickening" of the tissue**
- **<u>Sonographically</u>:**
  - **Hypoechoic with possible posterior enhancement**
  - **Microlobulations may be present**
  - **Well defined margins**



PAPILLARY CARCINOMA

- Slow growing tumor
- Occurs mostly in postmenopausal women
- Clinically:
  - Bloody nipple discharge
  - Can cause retraction and skin dimpling
  - Palpable mass in subareolar region
- Sonographically:
  - Solid mass associated with dilated duct
  - May mimic papilloma


LEFT BREAST LONG 11:00 N1 _

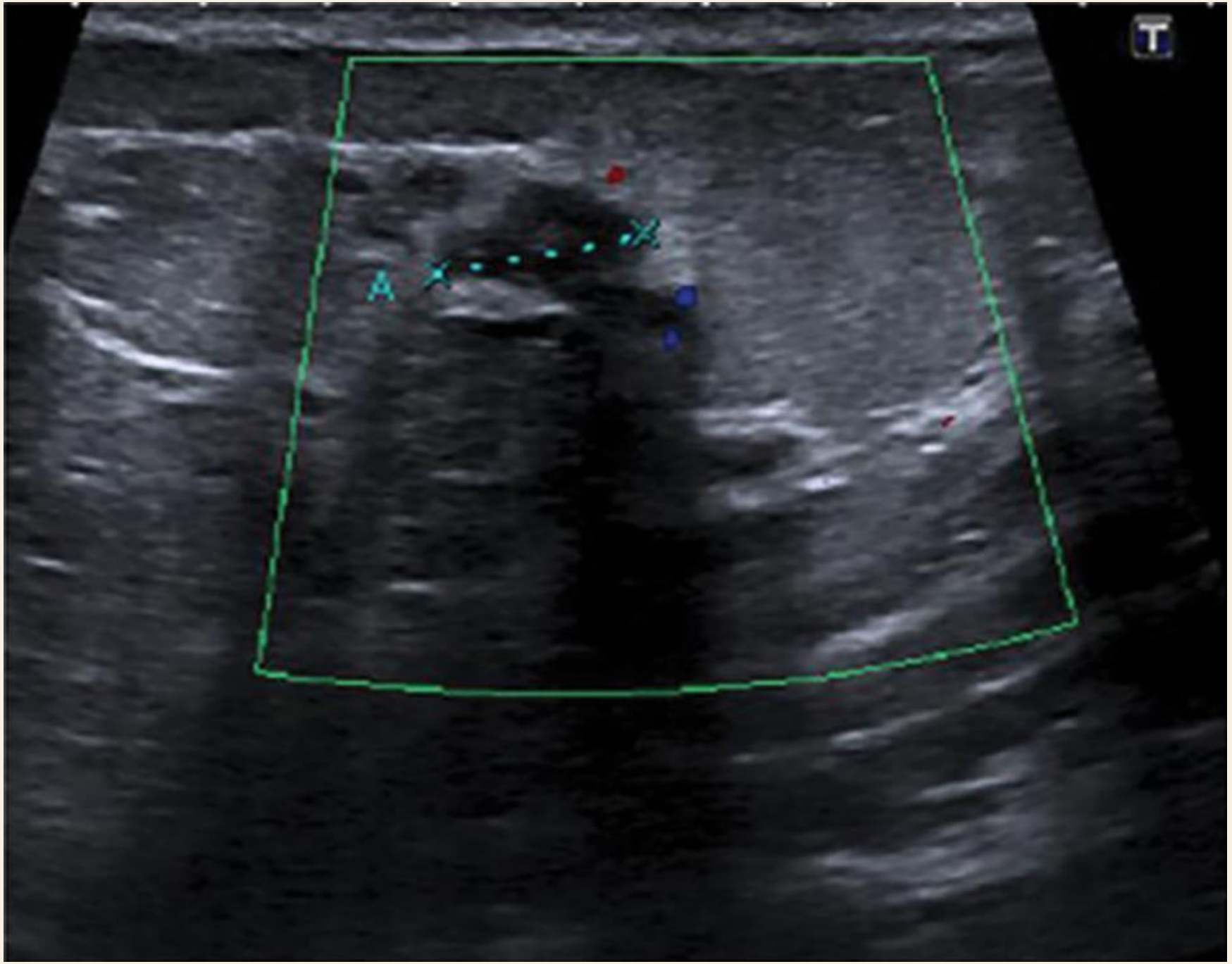
INFLAMMATORY CARCINOMA

- Occurs when highly invasive carcinoma invades the lymphatics of the skin
- Clinically:
  - Red, hot edematous skin
  - Painful and hard breast
  - Peau d'orange appearance
- Sonographically:
  - Breast texture is extremely disrupted
  - Skin thickening with dilated lymph vessels


14LX7
diffT14.0
14LX7
diffT14.0

PAGET DISEASE

- Rare tumor that arises in the retroareolar ducts and spreads into the nipple and areola
- Creates a rash like appearance that is often confused with melanoma
- Any ulceration, enlargement, or deformity of the nipple or areola should suggest Paget disease
- Sonographically:
  - Retroareolar mass with irregular margins
  - Heterogeneous internal echoes
  - Attenuation with posterior shadowing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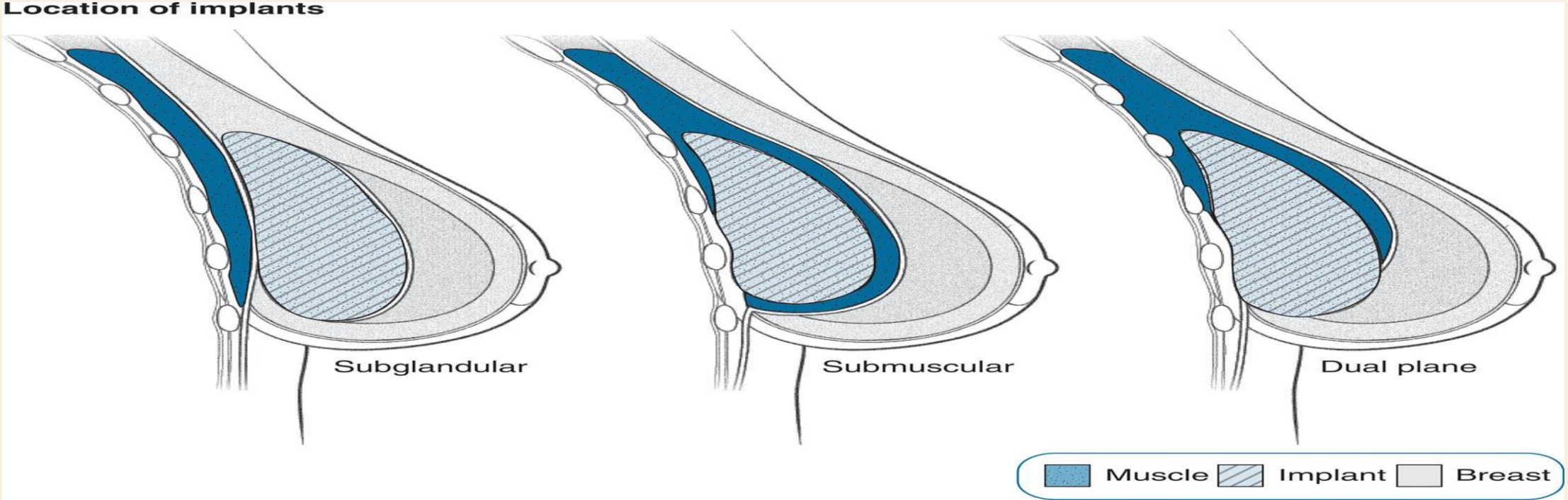
BREAST AUGMENTATION

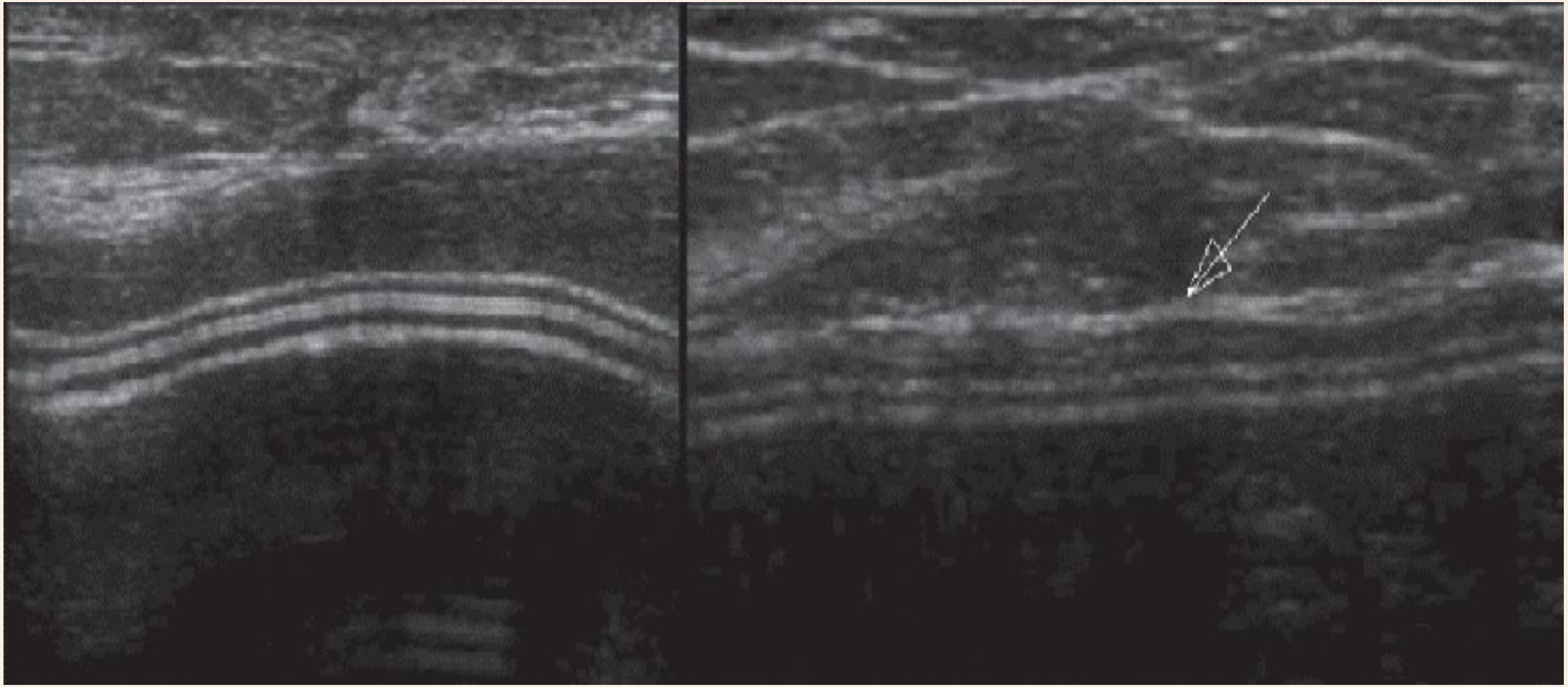
BREAST AUGMENTATION

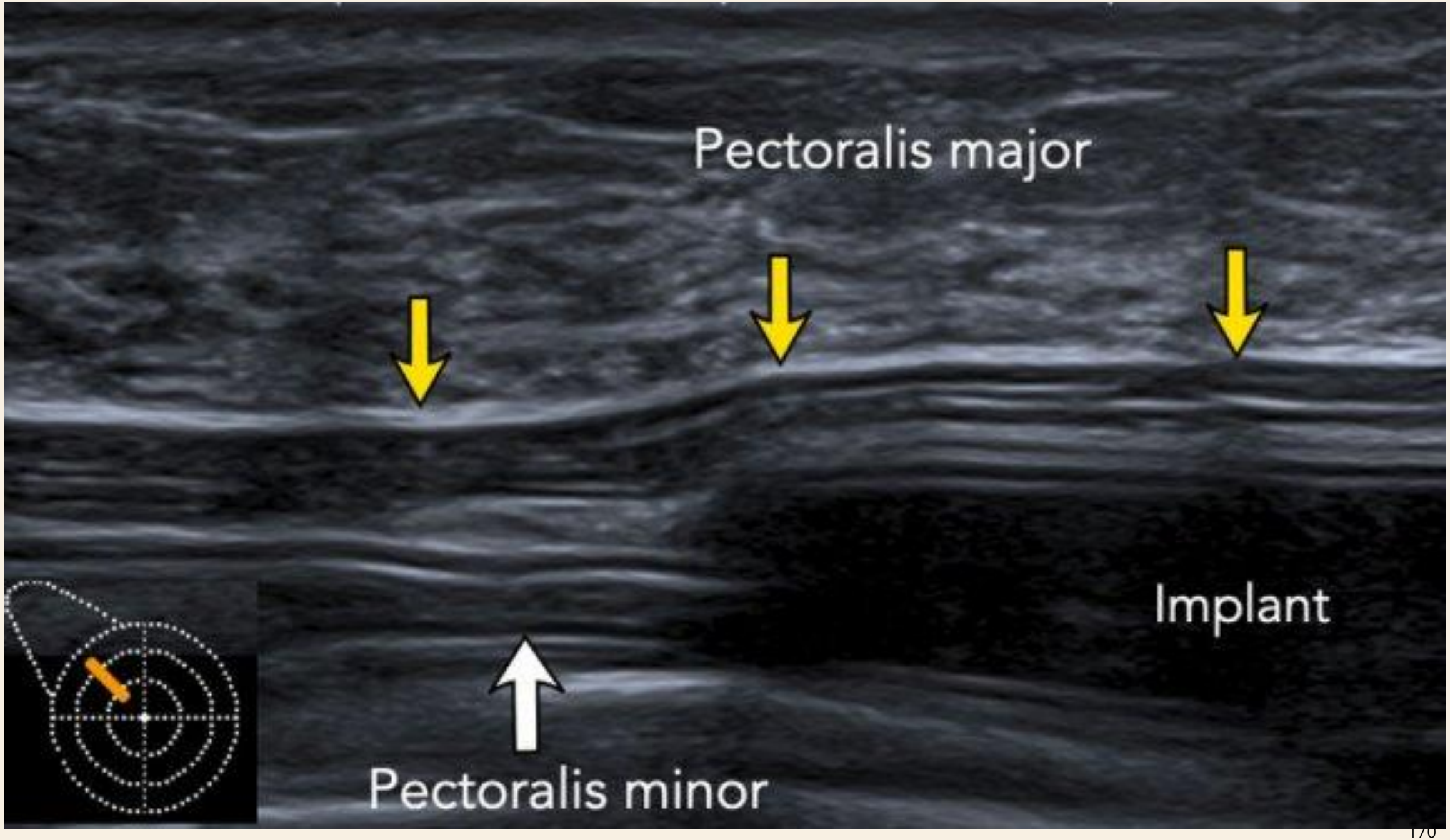
- **Mammography is often limited in its ability to image beyond the implant**
- **Ultrasound can image tissue surrounding the implant, look for defects in the membrane and identify leakage**



BREAST AUGMENTATION

- **Most common implants are saline and/or silicone gel-filled**
- **<u>Sonographically</u>:**
  - **Normal implant should have well-defined outline between the implant and the patient's tissue**
    - **Should identify several closely spaced linear echoes corresponding to the surface of the shell and fibrous capsule**



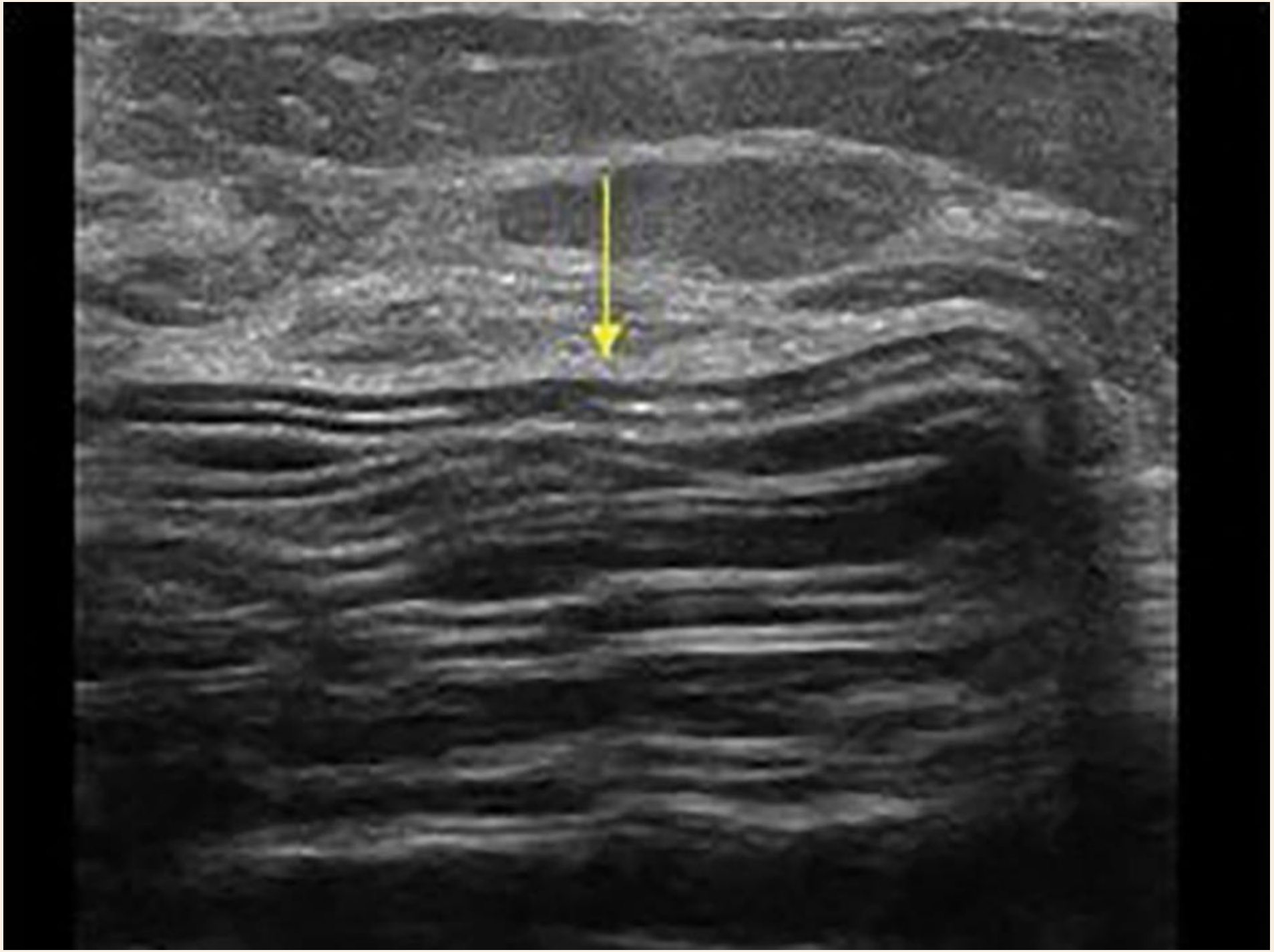

Pectoralis major
Implant
Pectoralis minor

IMPLANT RUPTURE

- Rupture can be intracapsular or extracapsular
- Trauma and implant age are common risk factors
- Silicone implants have a lifespan 11-15 years
  - Can result in granuloma formation and inflammatory reactions due to leaking silicone
- Saline implant rupture simply causes deflation if the implant
  - Fluid is absorbed by the body without consequence

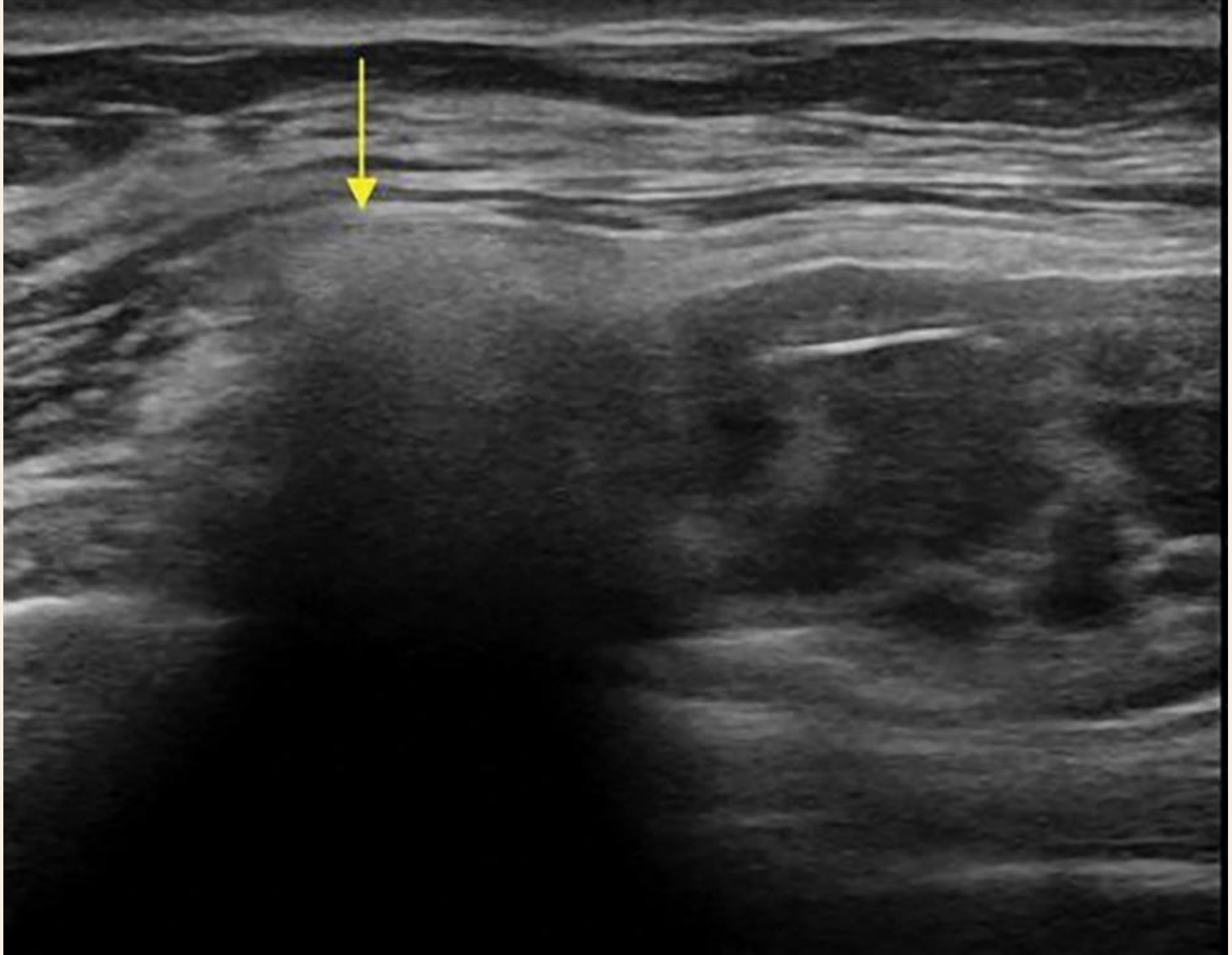
IMPLANT RUPTURE

- **Intracapsular rupture:**
  - **Most silicone implant ruptures are contained by the fibrous outer capsule**
  - **Identified sonographically by collapse of the implant**
    - **Produces a *"stepladder"* or *"parallel line sign"***



IMPLANT RUPTURE

- **Extracapsular rupture:**
  - **Break in the implant shell and fibrous capsule allowing silicone to seep into surrounding tissues**
  - **Identified sonographically as a *"snowstorm"* sign or echogenic noise**
    - **Affected tissues will be hyperechoic with dirty shadowing**
    - **Lymph nodes also impacted as silicone is absorbed**



US-GUIDED PROCEDURES

PROCEDURES

- **Cyst aspirations – using either a syringe/needle, or with a vacutainer**
- **Aspiration biopsy – fine needle aspiration of a solid mass (small sample)**
- **Large core biopsy – large samples are taken from solid masses**
- **Pre-op localization (Needle Loc) – wire needle is inserted into lesion prior to surgery**

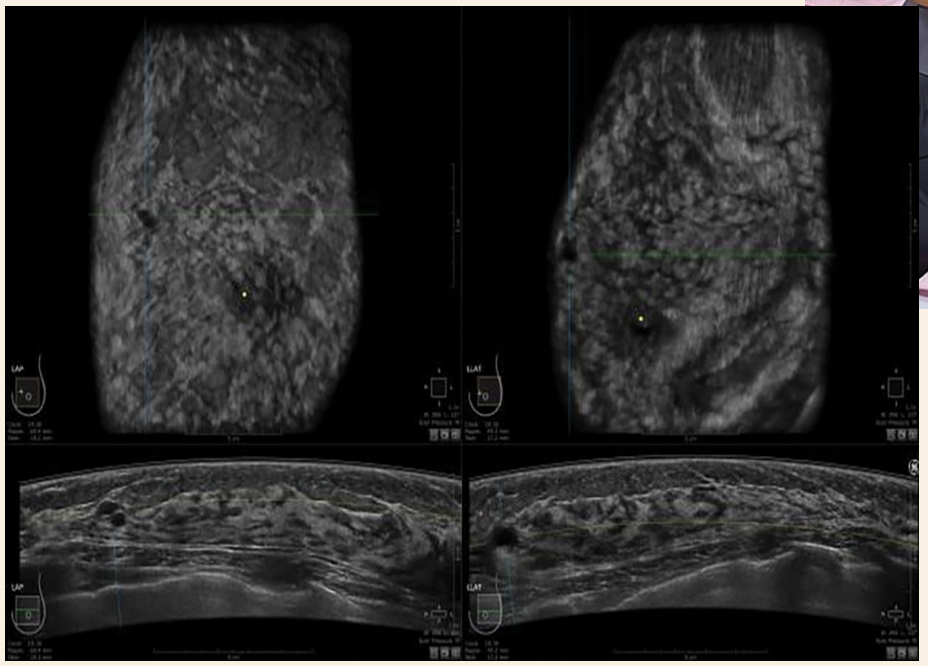
PROCEDURES

- **<u>Sentinel Node Procedure</u> – also called *Lymphoscintigraphy***
  - **First node to receive drainage from the breast is considered the sentinel node**
    - **Most at risk for metastasis**
  - **Injects blue dye into the area of the breast tumor and it is traced via nuclear medicine to the "hot spot" or sentinel node**
  - **Aides the surgeon in removal or biopsy**

OTHER IMAGING MODALITIES

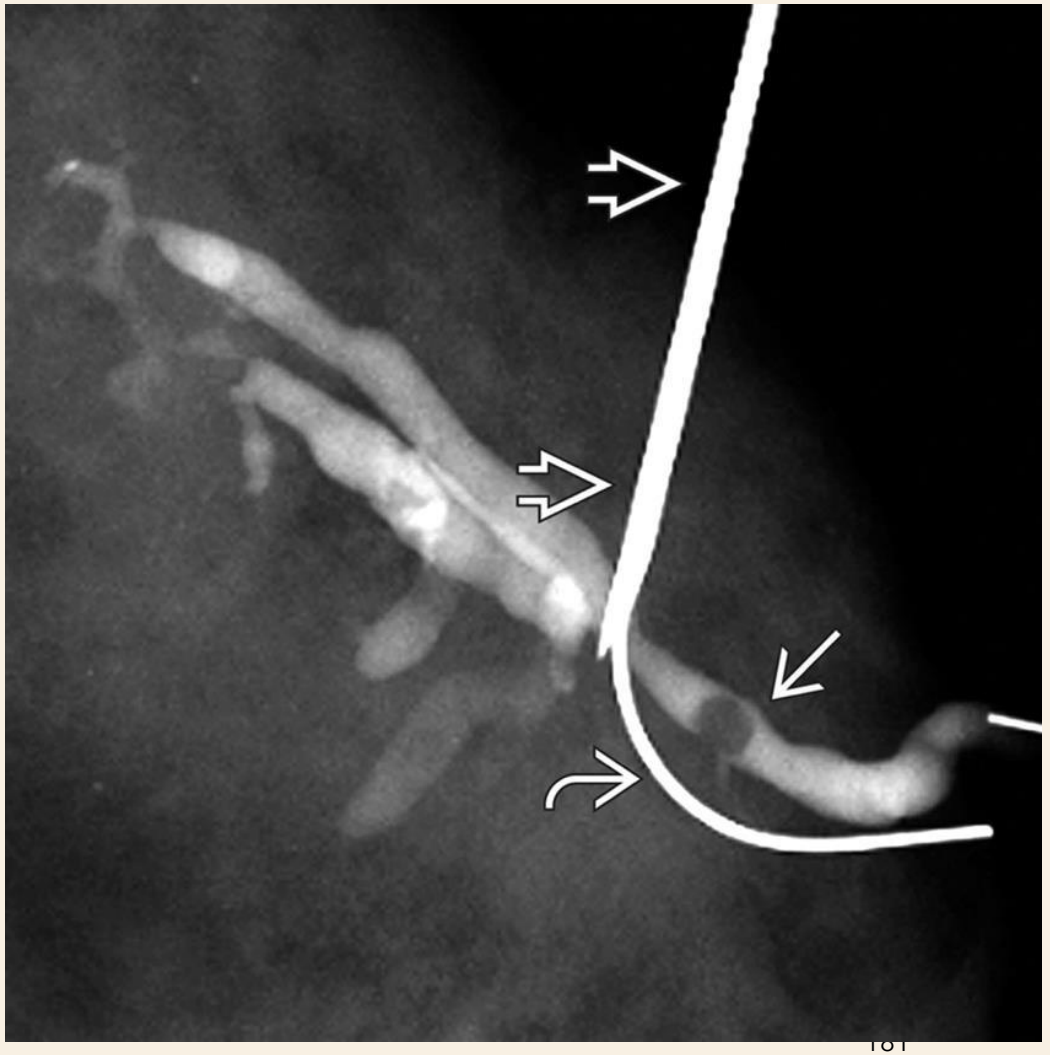
OTHER IMAGING MODALITIES

- **<u>Automated Breast Ultrasound (ABUS)</u> – sonography based imaging that involves a water path system to compress and image the entire breast**
  - **Allows for 3D view of the anatomy**

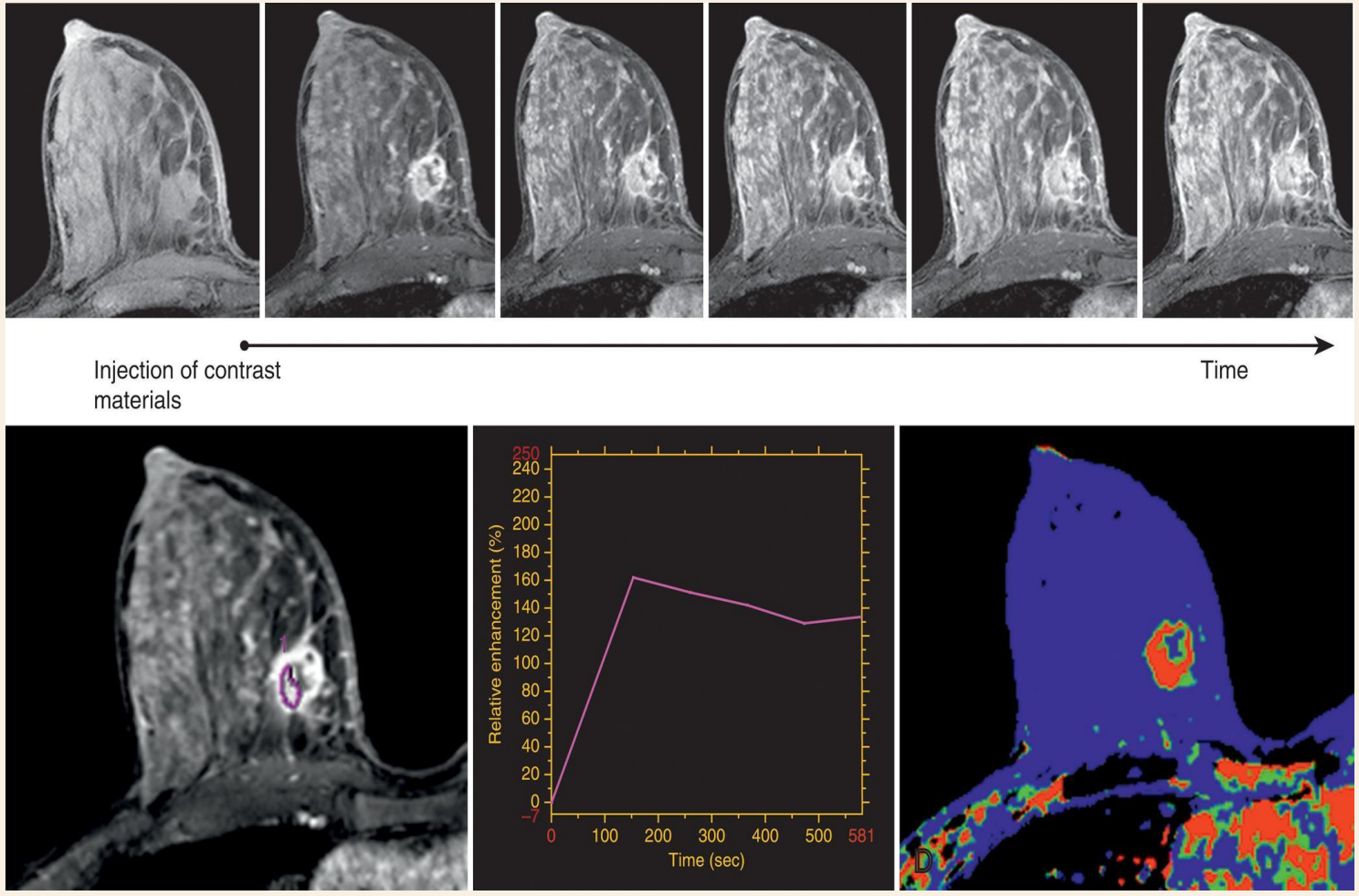


OTHER IMAGING MODALITIES

- **<u>Ductography/Galactography</u> – a ductogram can be performed to evaluate patients with worrisome nipple discharge**
  - **Retrograde injection of contrast agent into the lactiferous duct**



OTHER IMAGING MODALITIES



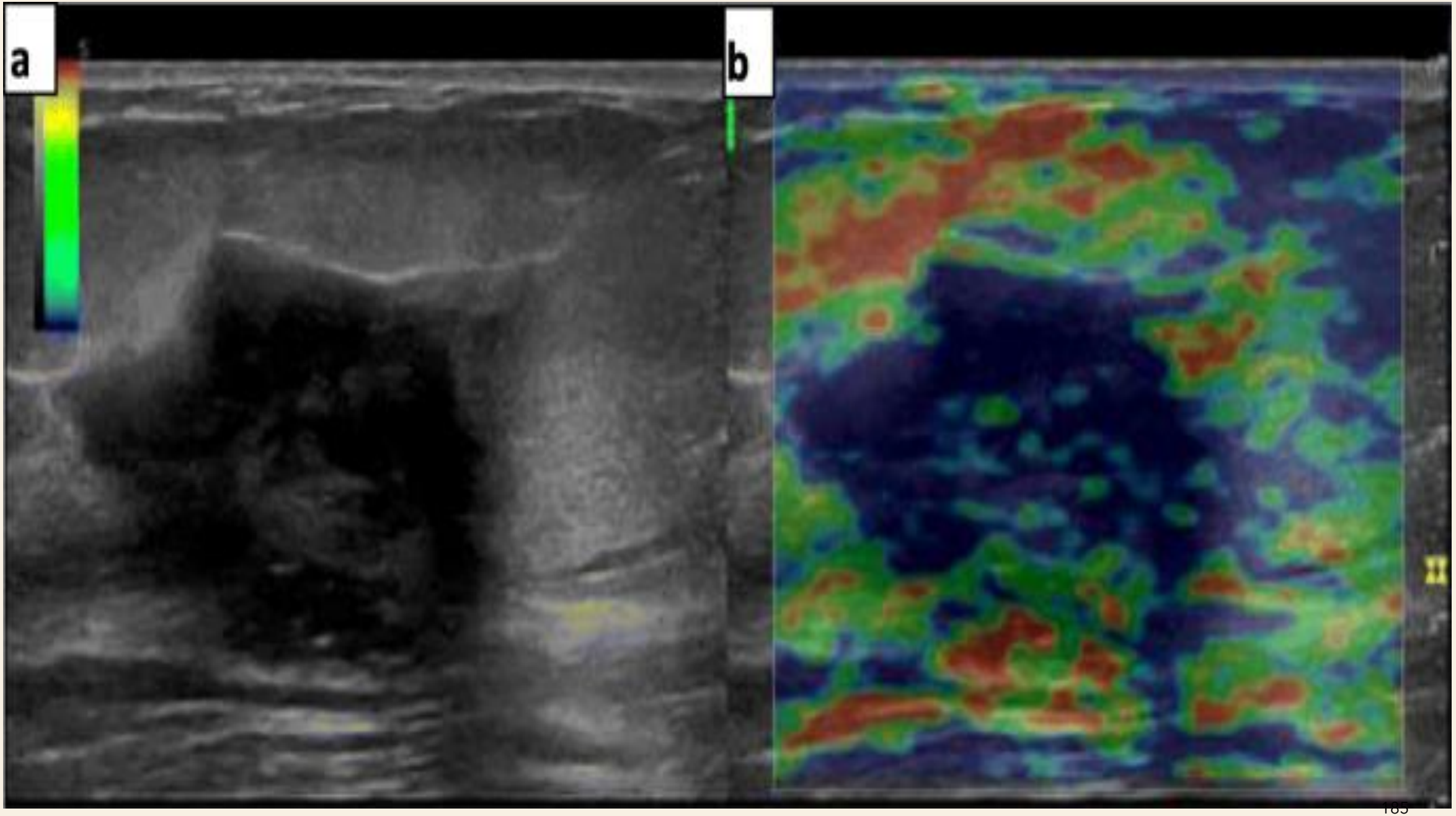
- **<u>Magnetic Resonance Imaging (MRI)</u> – allows for improved visualization of breast lesions that are questionable for malignancy**
  - **Utilizes Gadolinium to enhance malignant tumors**

OTHER IMAGING MODALITIES

- **Single Photon Emission Computed Tomography (SPECT) – injection of radioactive material will locate cancer cells using CT**
- **Positron Emission Mammography (PEM) – newer imaging test that combines a PET scan with a Mammogram**
  - **Utilizes radioactive tracer to detect cancer cells**
- **Molecular Breast Imaging (MBI) – uses radioactive tracers and a gamma camera to detect cancer cells**
- **Computer Aided Detection (CAD) – designed to detect abnormal breast tissue**
  - **Allows for earlier detection of breast cancer**

OTHER IMAGING MODALITIES

- **Elastography – noninvasive technique that details the stiffness of a lesion**
  - **Increases specificity of ultrasound to diagnose malignant lesions using color coding of hard vs. soft lesions**
    - **Cancers are more stiff than normal tissue**
    - **Cancers are also identified as larger with elastography compared to conventional ultrasound**
      - **Desmoplastic response**


a
b