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# Breast Overview

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## TERMINOLOGY

### Abbreviations

- Terminal duct lobular unit (TDLU)
- Anterior mammary fascia (AMF)
- Posterior mammary fascia (PMF)
- Anterior suspensory ligaments (ASL) of Cooper
- Posterior suspensory ligaments (PSL)

## IMAGING ANATOMY

### Overview

- Breast
  - Conical, round, or hemispherical shape
  - Composed of 15-20 lobes, each encased in fascial sheath defined by AMF and PMF
  - Extends from 2nd or 3rd intercostal space to 6th or 7th intercostal space
  - Extends laterally to anterior axillary fold and medially to lateral sternum
  - Relationship to chest wall
    - Superior 2/3 overlies pectoralis major muscle
    - Lateral portion overlies serratus anterior muscle
    - Inferior-most margin overlies upper abdominal oblique muscles
  - Axillary tail of Spence
    - Extension of normal breast tissue toward axilla
  - Average breast size
    - Diameter: 10-12 cm
    - Thickness: 5-7 cm
    - Median: 5 cm thick with mammographic compression
  - Support and mobility relate to fascial attachments to skin and chest wall

## Internal Contents

- Glandular elements
  - Extralobular ducts
  - TDLUs
  - Extralobular ducts and TDLUs contain 2 cell layers
    - Outer myoepithelial cell layer
    - Inner epithelial cell layer
- Stroma/connective tissue
  - Fat, connective tissue
  - ASL (Cooper ligaments) and PSL
  - Nerves, blood vessels, and lymphatics
- Interlobular tissue
  - Higher in collagen content
  - Relatively lower in cellular elements and hyaluronic acid
- Intralobular tissue
  - Higher in cellular elements and hyaluronic acid
  - Relatively lower collagen content

## Zonal Anatomy

- Premammary (subcutaneous) zone
  - Most superficial zone
  - Anterior margin defined by skin, posterior margin defined by AMF
  - Contains subcutaneous fat, blood vessels, ASL
  - May contain ectopic ducts and TDLU
  - ASL
    - Formed from 2 leaflets of AMF inserting into dermis
    - Provide support for breast
    - Usually visible on mammograms and sonograms
- Mammary zone
  - Defined anteriorly by AMF and posteriorly by PMF
  - Contains fibroglandular tissue: Majority of ducts/TDLU, stromal fat, and stromal connective tissue
  - Subdivided haphazardly by interspersed ASL
- Retromammary zone
  - Most posterior of 3 zones
  - Defined anteriorly by PMF and posteriorly by chest wall
  - Contains fat and PSL, which attach PMF to chest wall

# ANATOMY IMAGING ISSUES

## Mammography

- Overall breast density reflects ratio between glandular elements (higher density) and fat (lower density)
  - Usually symmetric between breasts but wide range of normal
- Fatty involution typically begins in lower outer quadrant
  - Progresses with age to upper outer quadrant
- American College of Radiology Breast Imaging and Reporting and Database System (BI-RADS)
  - Density categories
    - A: Almost entirely fat
    - B: Scattered fibroglandular densities
    - C: Heterogeneously dense, which could obscure detection of small masses
    - D: Extremely dense, which lowers sensitivity of mammography
- ↑ fibroglandular density ↓ sensitivity of mammography and ↑ risk of developing breast cancer

## US

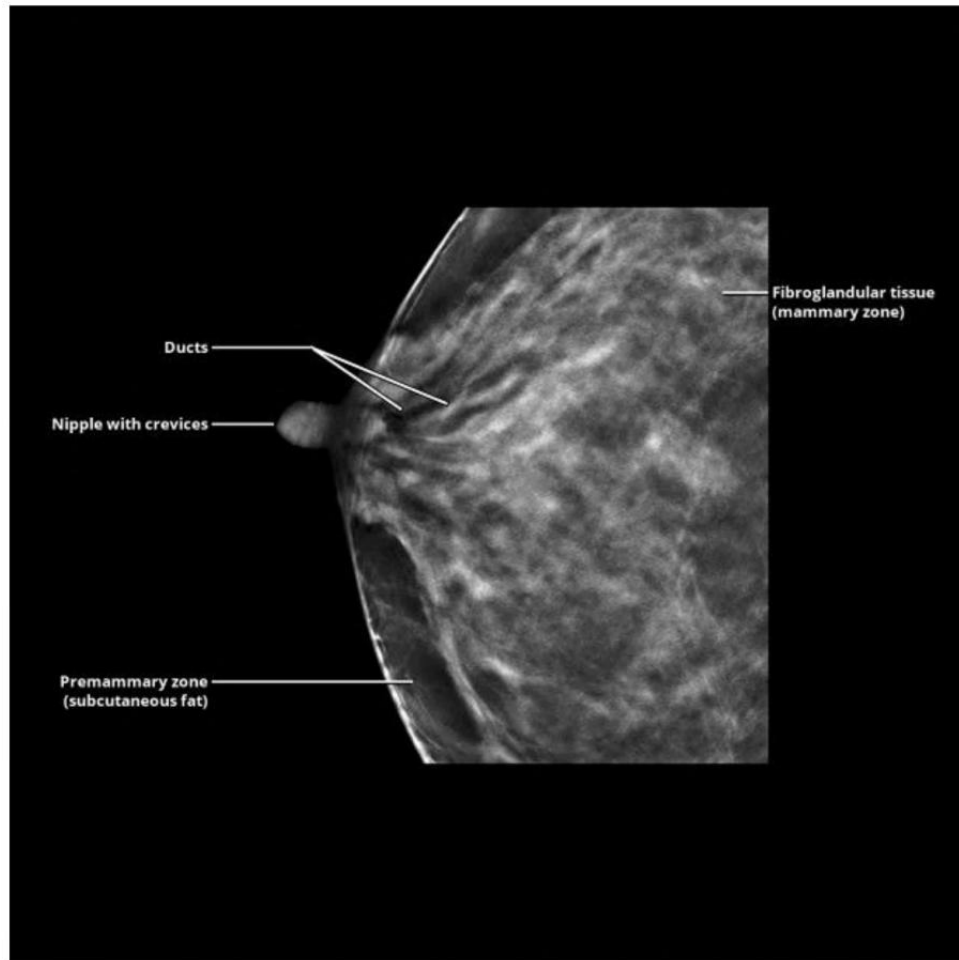
- Thin, echogenic skin line:  $\leq 2$  mm
- ASL usually visible in subcutaneous zone
  - Subcutaneous fat lobule(s) surrounded by ligaments can present as palpable mass(es)
- Echogenicity defined relative to subcutaneous fat
- Interlobular stroma and glandular elements usually hyperechoic
  - Fibrotic tissue can be hyperechoic or hypoechoic
- Pectoral muscles and ribs visible as hypoechoic posterior structures

## MR

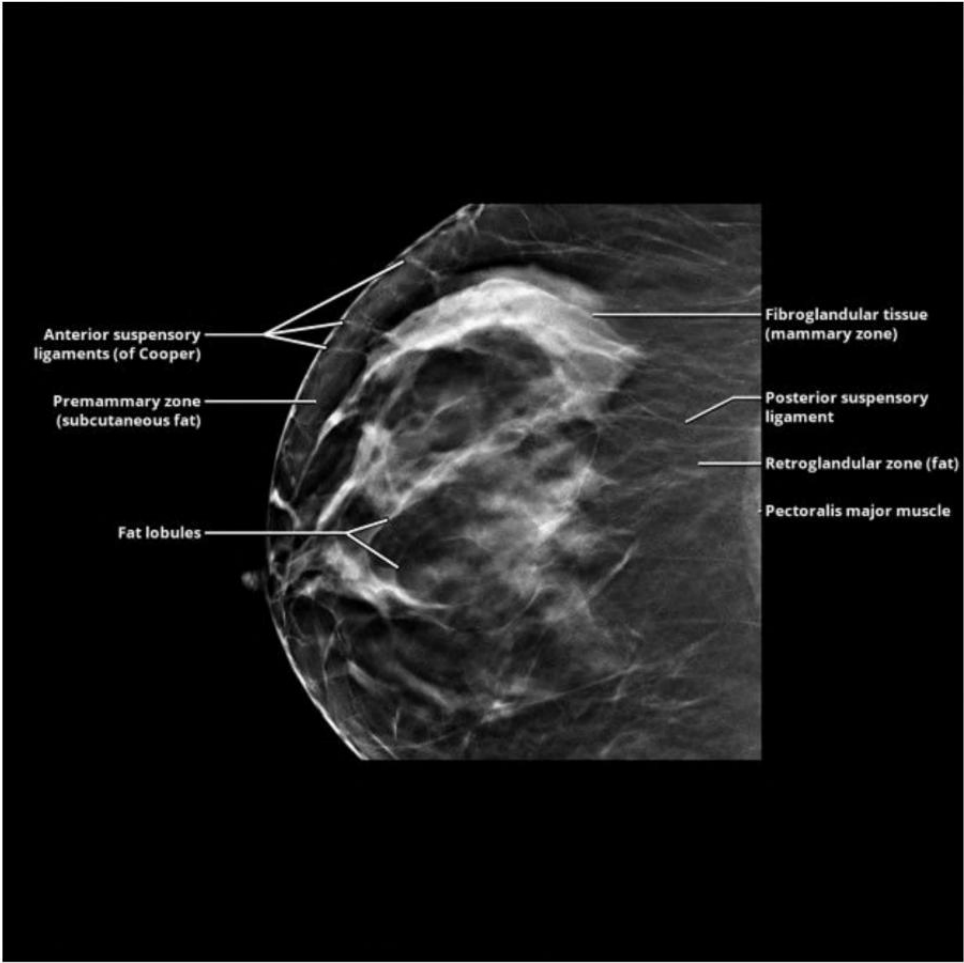
- Fibroglandular tissue/muscle often shows physiologic enhancement
- Density and enhancement features of parenchyma vary with patient age and phase of menstrual cycle
- Ideally performed during follicular phase menstrual cycle
  - Less dense stroma and lower breast water content
- Describe fibroglandular tissue: Fatty, scattered, heterogeneous, extreme
- Describe background parenchymal enhancement (BPE)

- Minimal, mild, moderate, marked
- ↑ BPE predicts ↑ risk of developing breast cancer
- ↑ false-positives, but sensitivity retained when BPE moderate or marked

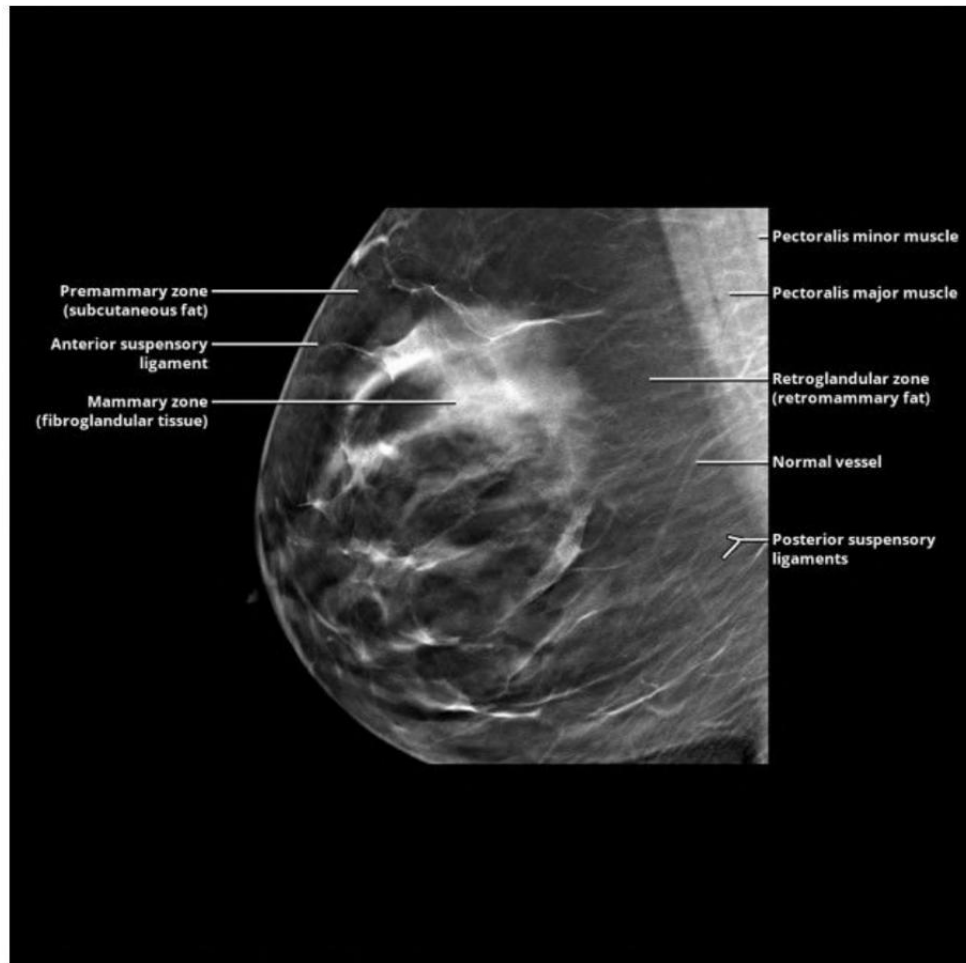
#### TOMOSYNTHESIS OF NORMAL ZONAL ANATOMY



CC tomosynthesis of normal breast with scattered fibroglandular density shows radially arrayed ducts leading to the nipple. Approximately 15-20 lobes comprise the glandular portion of the breast, each leading to a duct. Some ducts may fuse before leading to an orifice in the nipple.

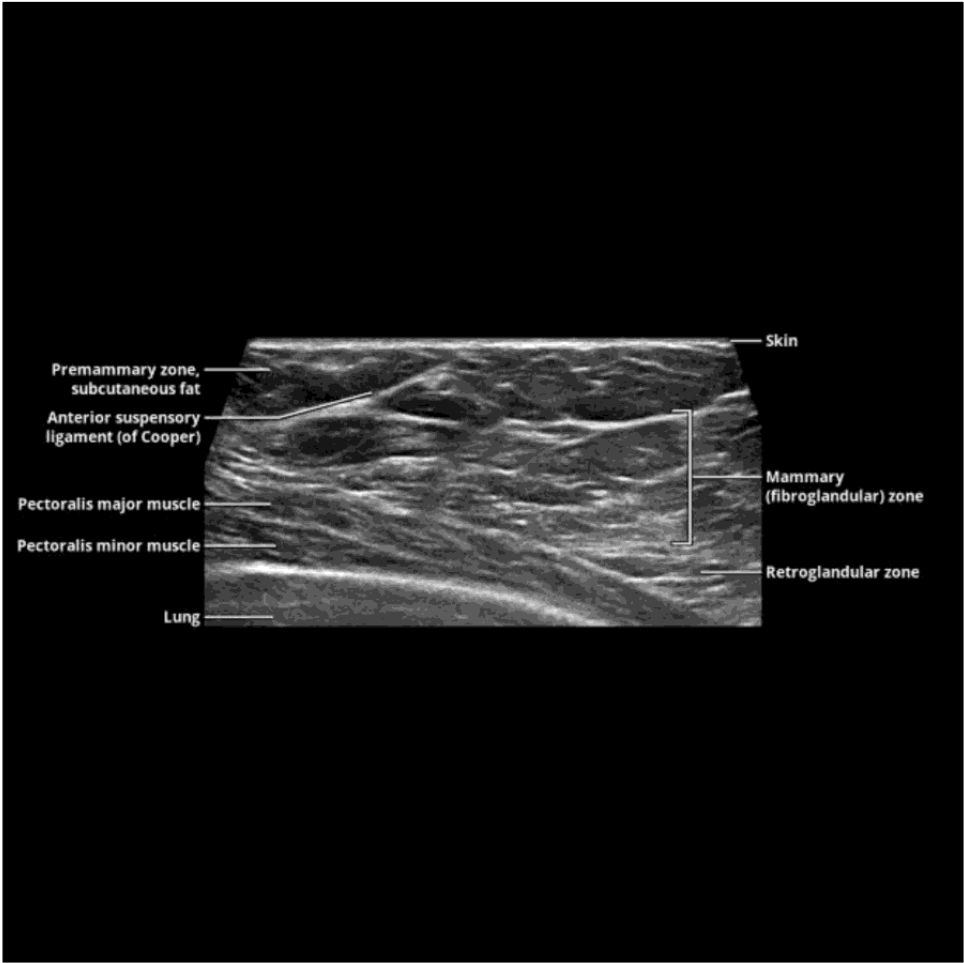


CC tomosynthesis shows scattered fibroglandular density and nicely depicts normal zonal anatomy.

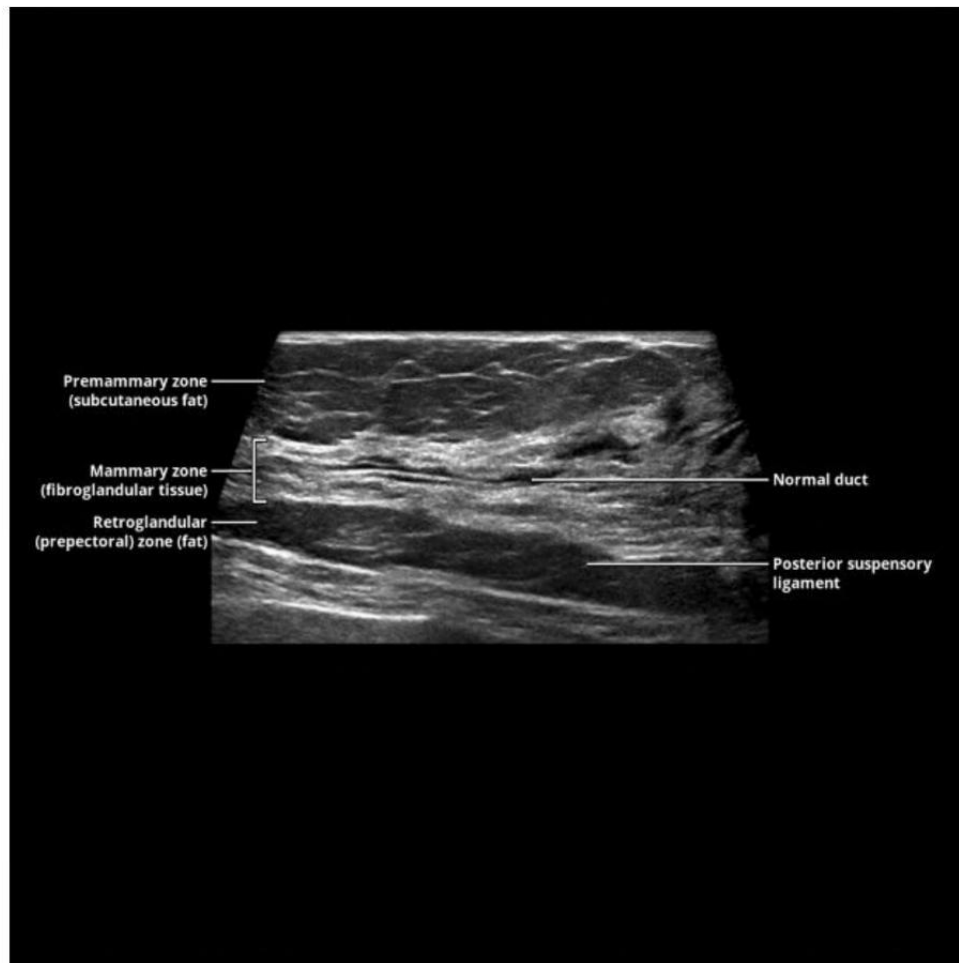


MLO tomosynthesis shows normal zonal anatomy of the breast.

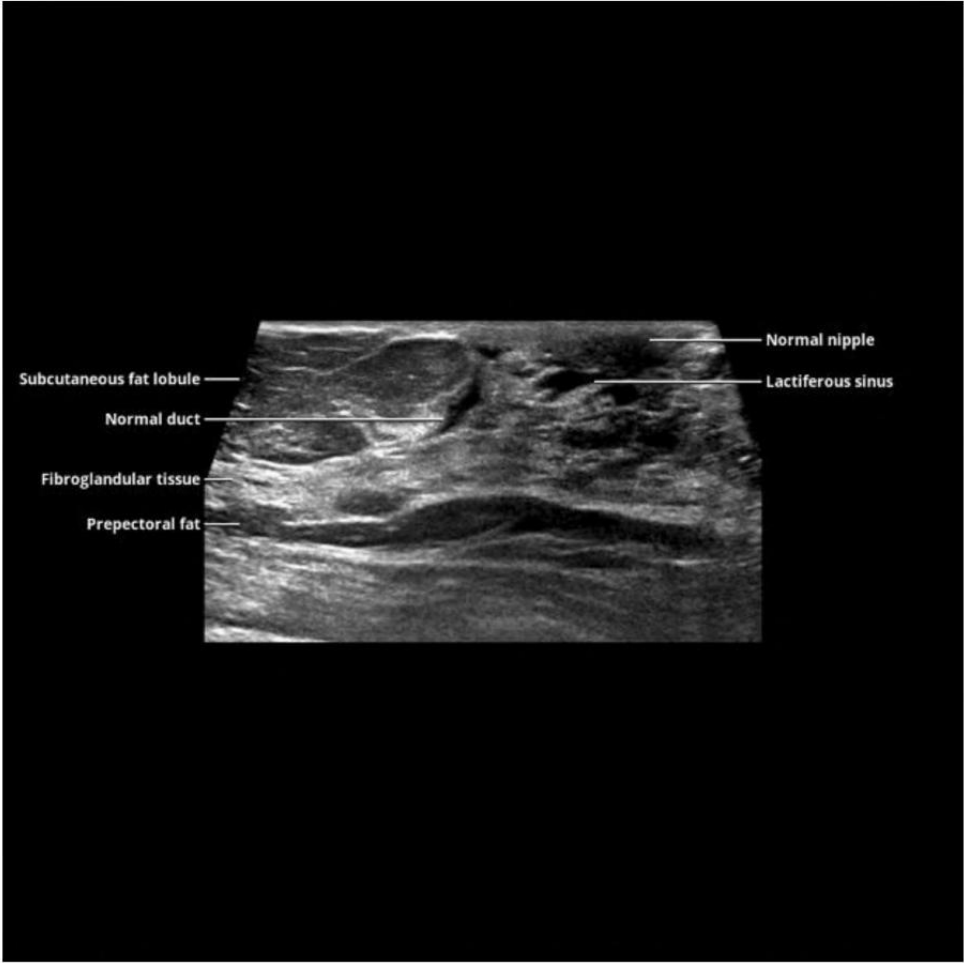
#### US OF ZONAL ANATOMY



Radial US in the axillary tail (fatty portion) of the breast shows position of breast anterior to pectoralis muscles.

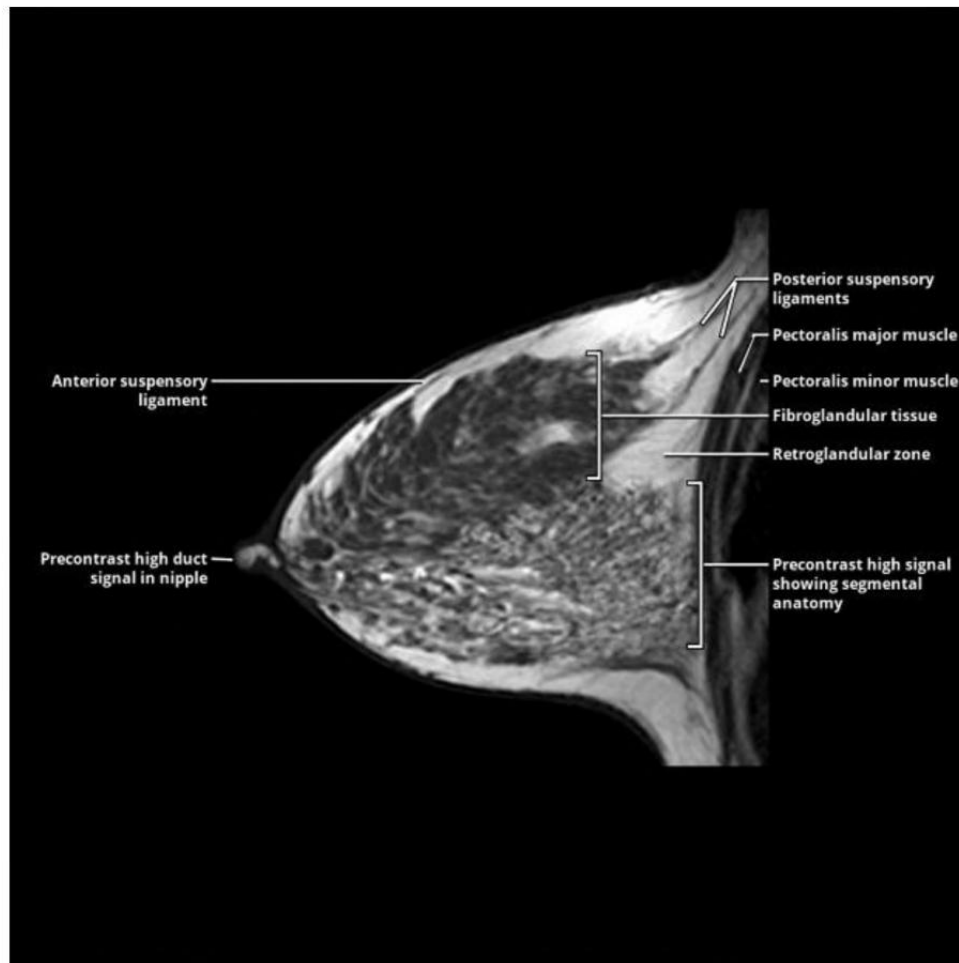


Radial US of the right breast (same patient) along the orientation of the ducts at the 9:00 position near the nipple demonstrates the 3 zones of the breast: Premammary, mammary, and retromammary.

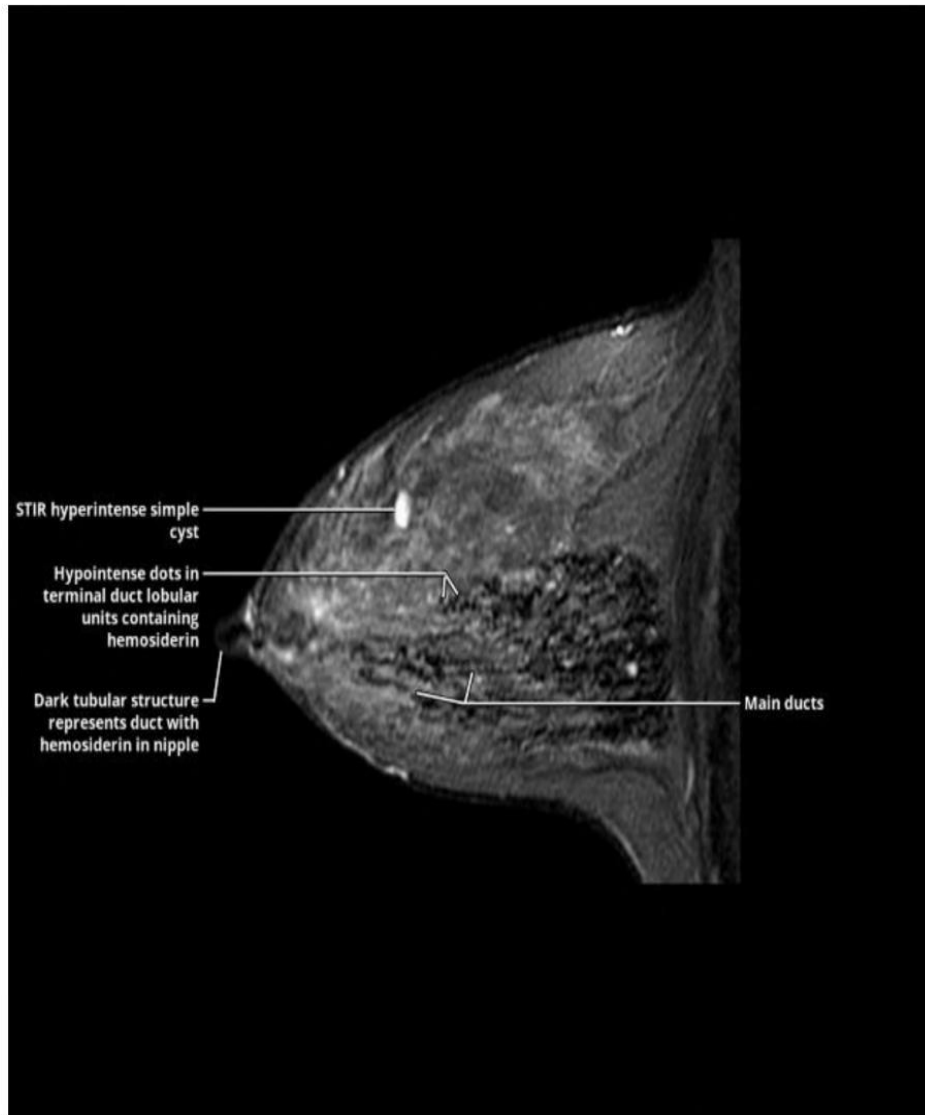


Normal transverse US at the level of the nipple shows subareolar ducts.

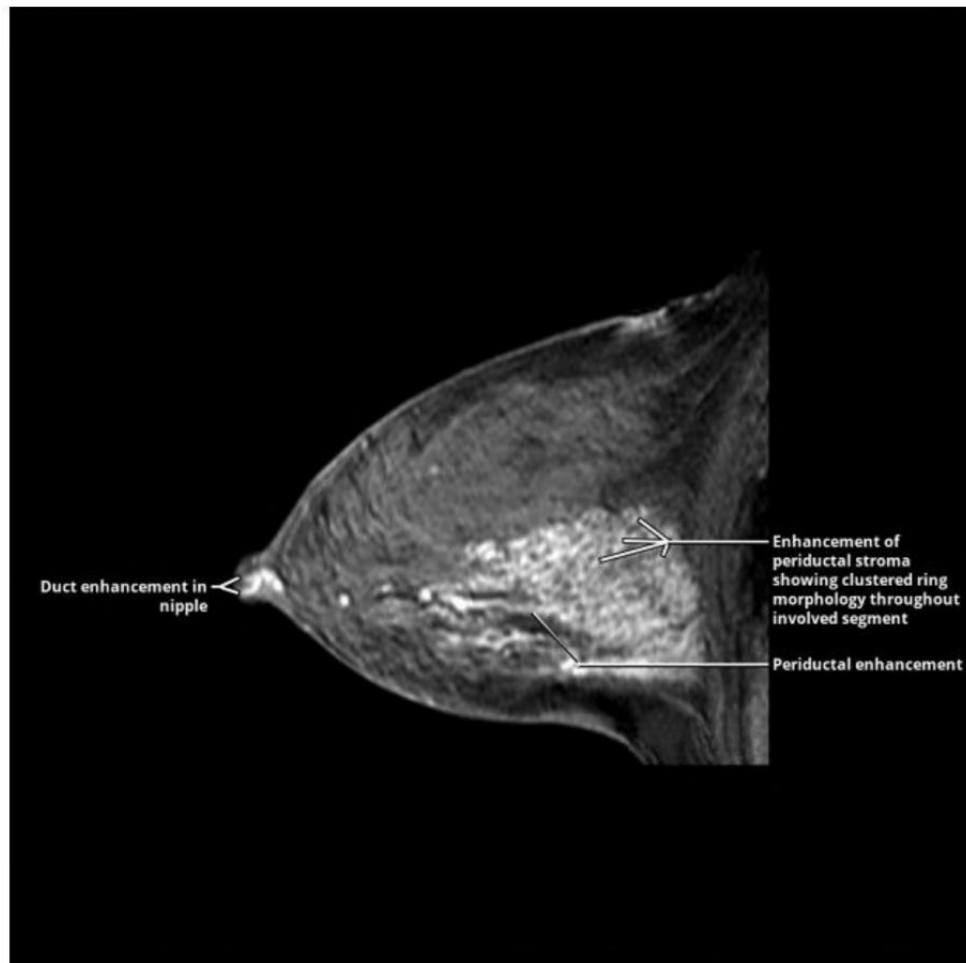
**MR OVERVIEW OF BREAST ANATOMY**



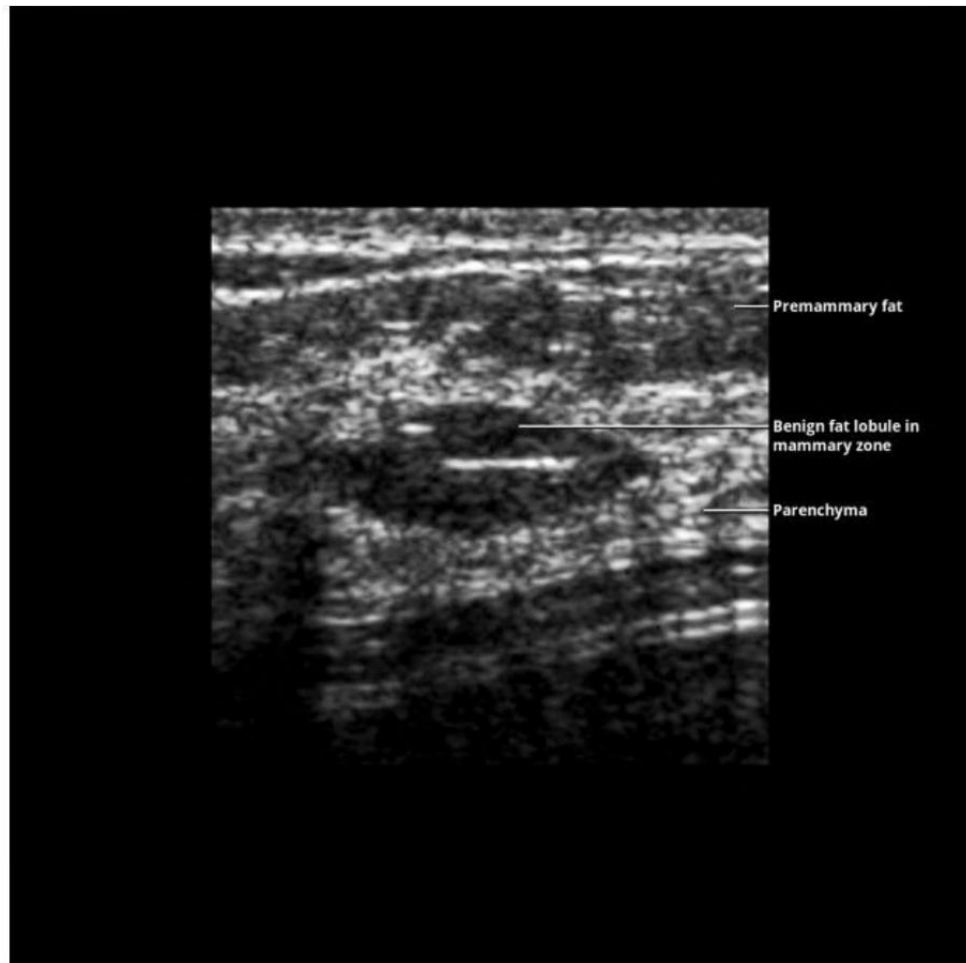
Sagittal T1 MR prior to contrast injection shows extensive high duct signal due to blood in a woman with bloody nipple discharge.



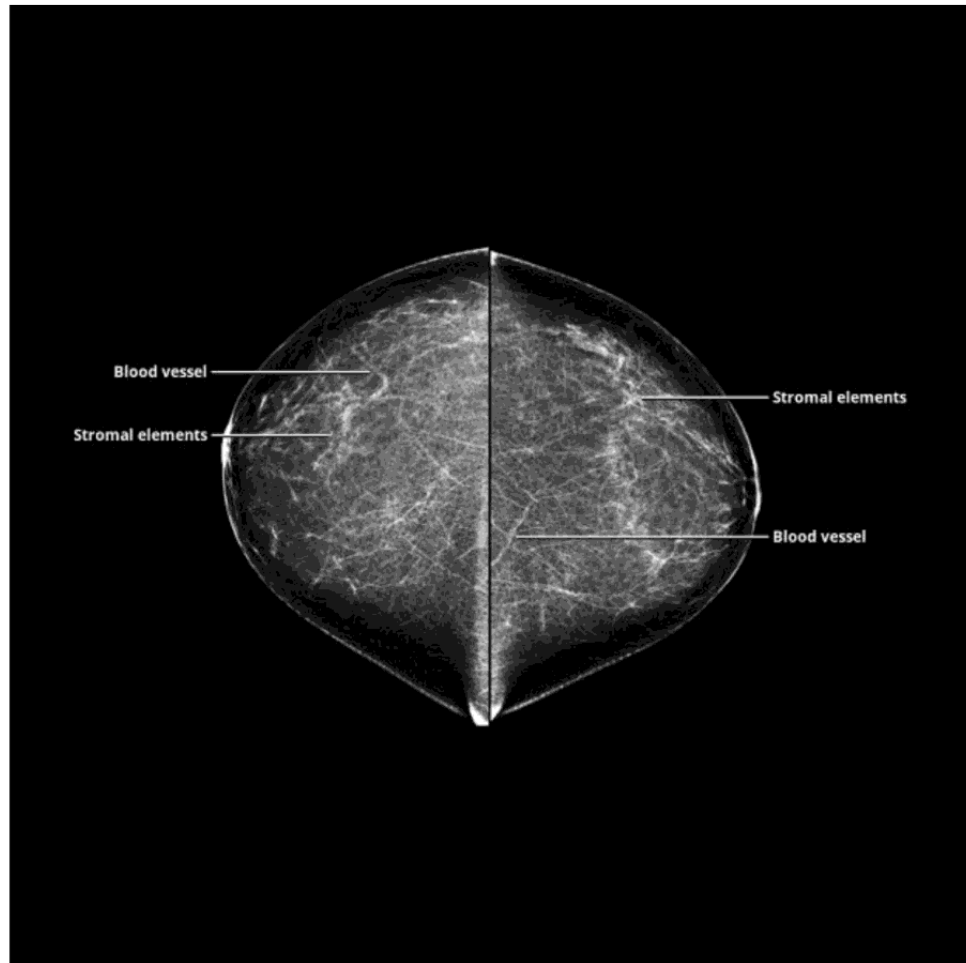
Sagittal STIR MR (same patient) shows magnetic susceptibility artifacts due to hemosiderin in the blood in ducts throughout several segments involved by DCIS. An incidental cyst is seen.



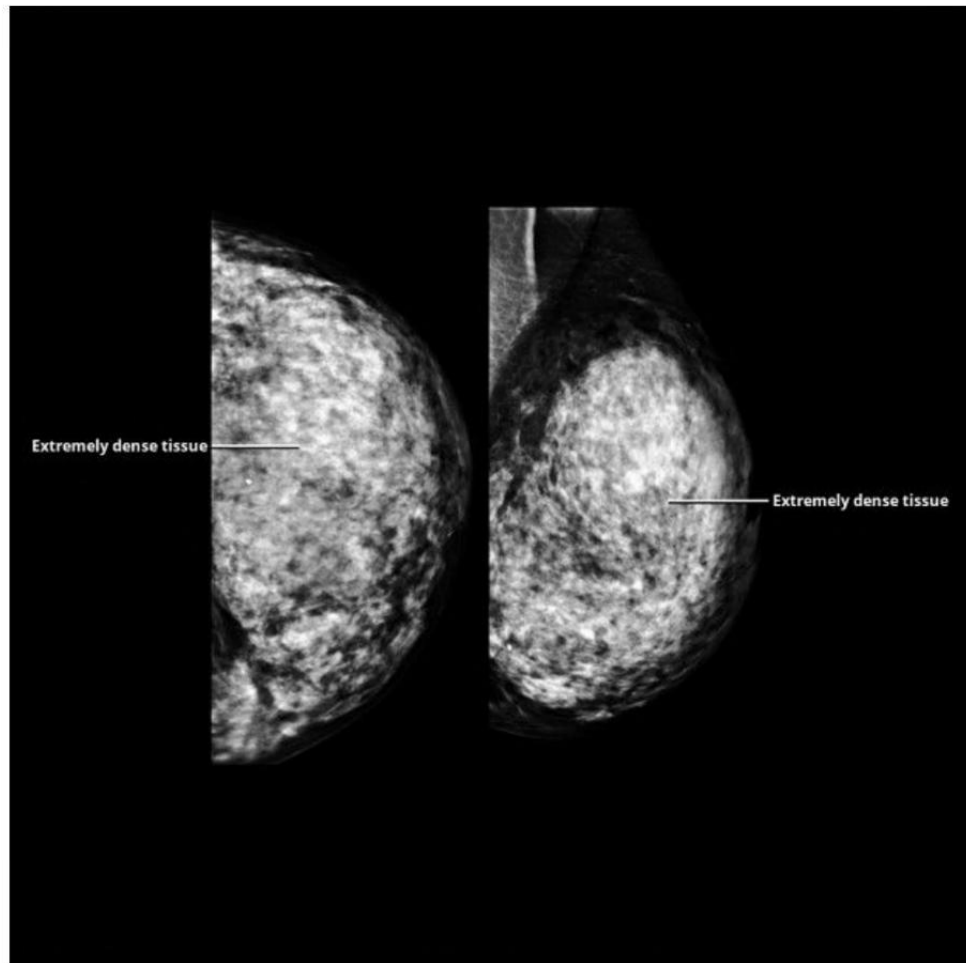
Sagittal T1 C+ FS MR (same patient) shows extensive segmental nonmass enhancement in a clustered ring/periductal pattern. Findings were due to extensive low nuclear grade DCIS.



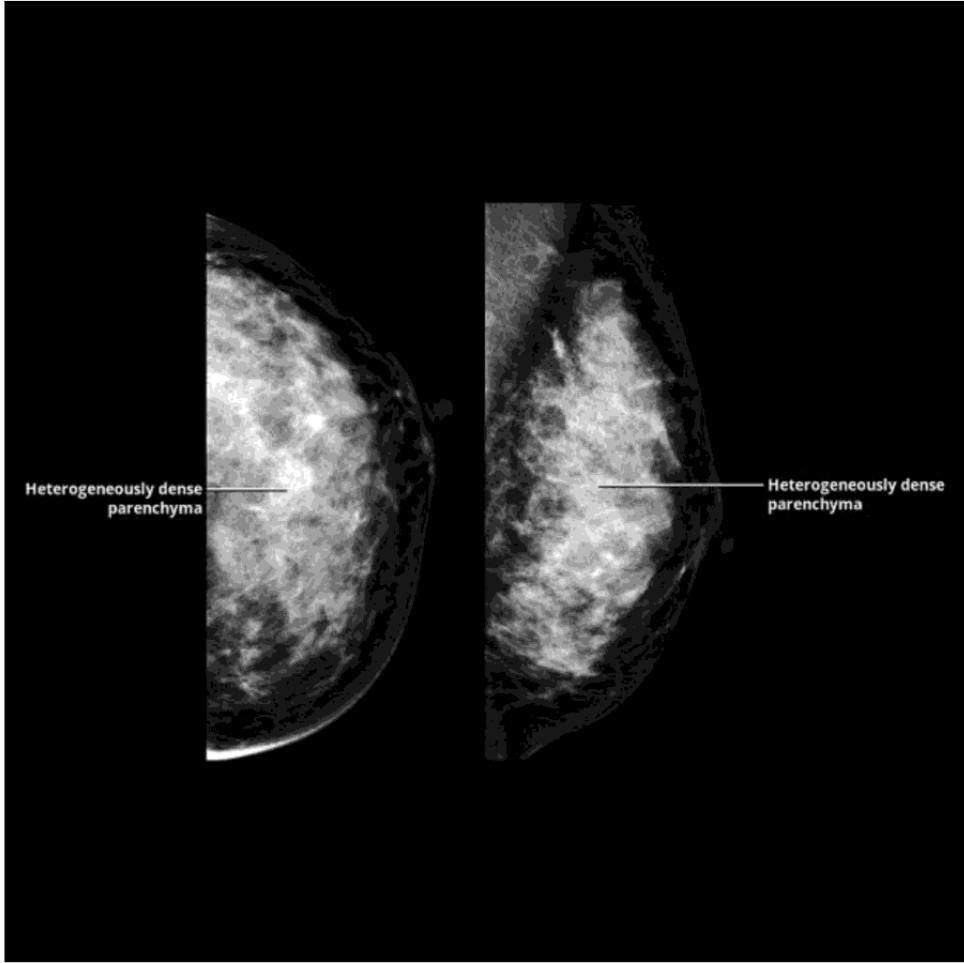
Breast US shows fat in the premammary zone and a classic benign fat lobule in the mammary zone. Fat lobules are circumscribed, isoechoic to subcutaneous fat, usually compressible, and often demonstrate linear echo(es) parallel to their long axis, as seen in this example. This is a benign finding and does not require tissue sampling or excision. Surrounding parenchyma is hyperechoic to fat.



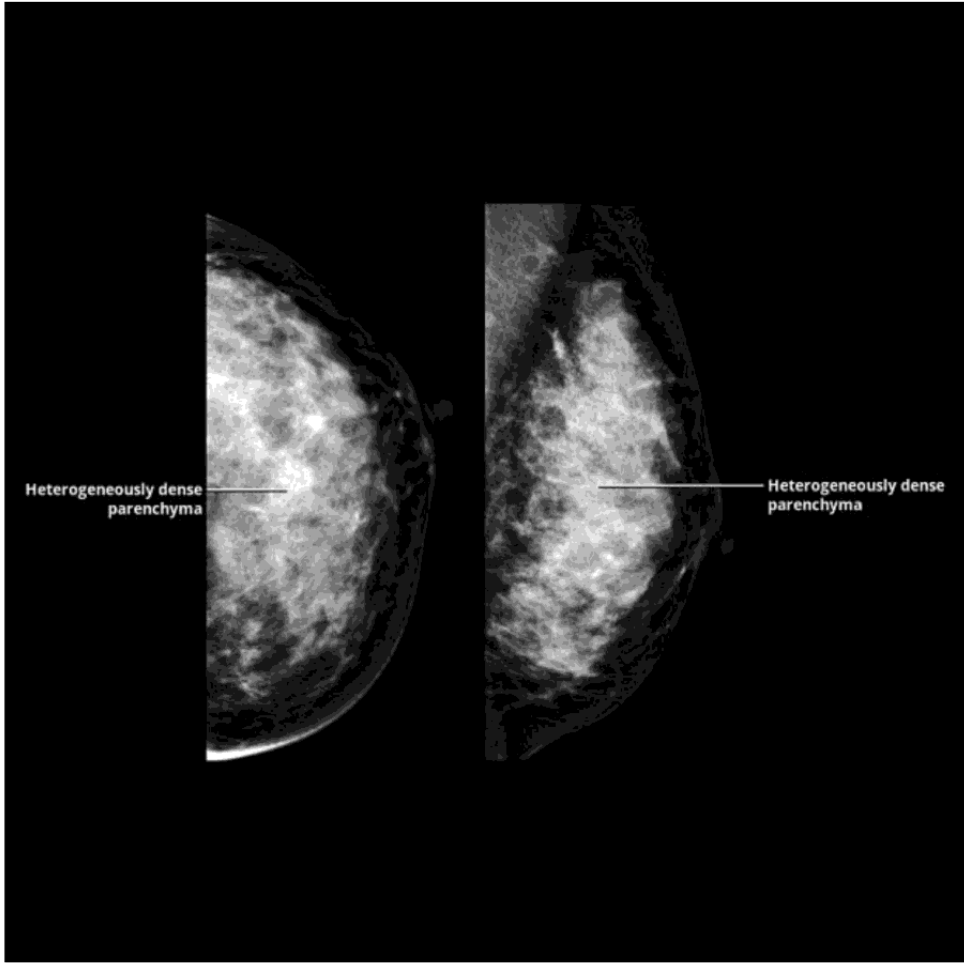
Bilateral CC mammograms demonstrate fatty involution in a postmenopausal woman. The overall breast density is low, reflecting fatty replacement of most glandular elements. Residual scattered linear densities are stromal elements including connective tissue, blood vessels, and lymphatics.



CC/MLO digital mammograms show an extremely dense breast tissue composition, which lowers the sensitivity of mammography.



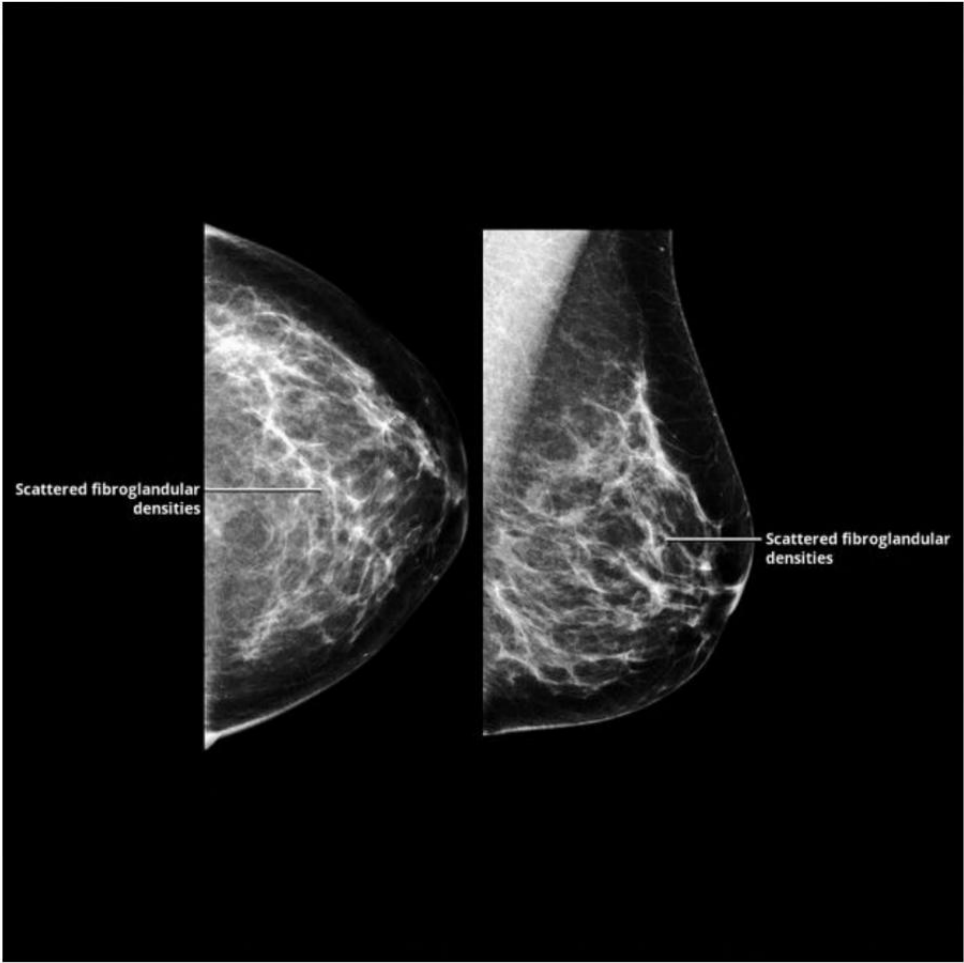
CC/MLO digital mammograms show heterogeneously dense parenchyma, which could obscure detection of small masses.



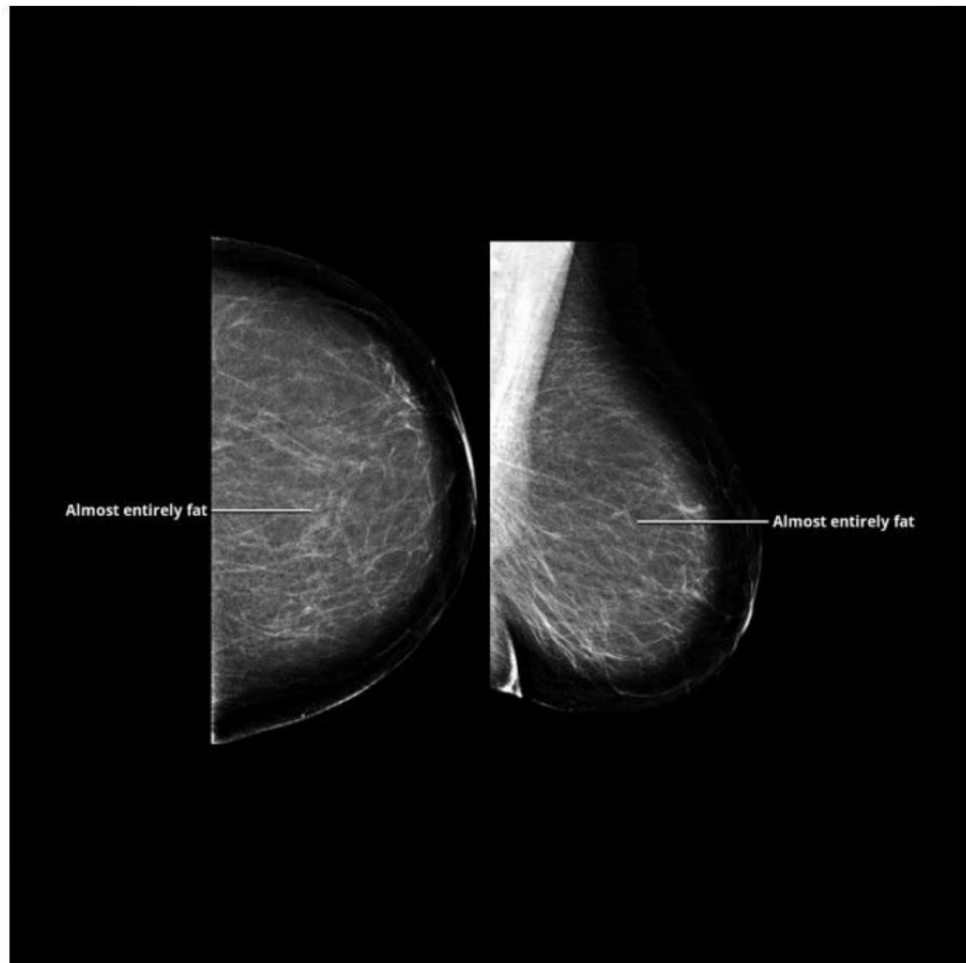
Heterogeneously dense  
parenchyma

Heterogeneously dense  
parenchyma

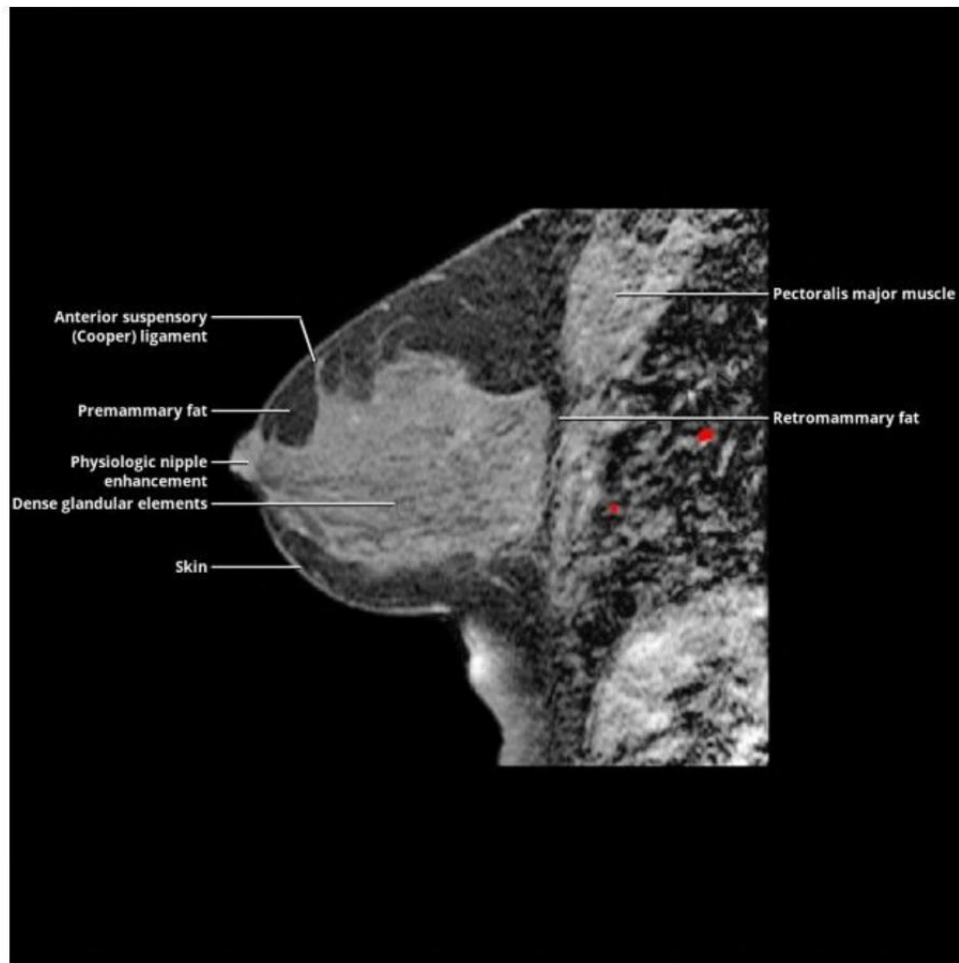
CC/MLO digital mammograms show heterogeneously dense parenchyma, which could obscure detection of small masses.



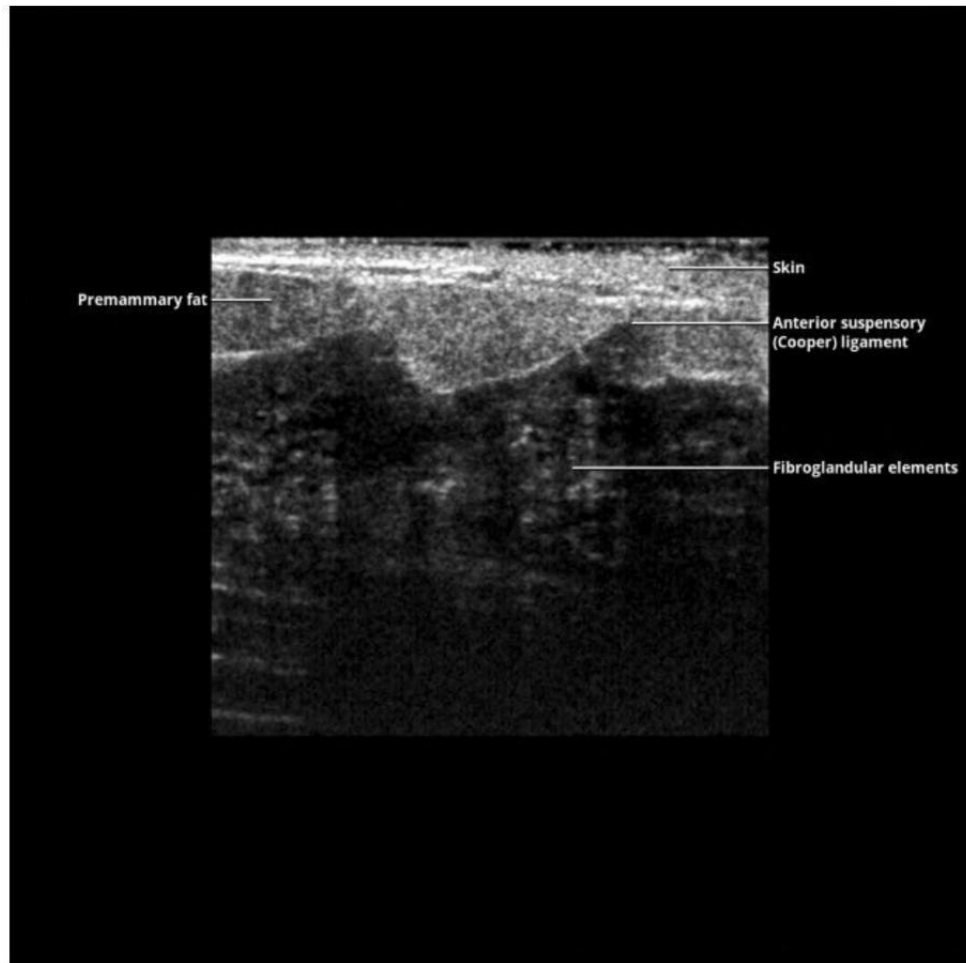
CC/MLO digital mammograms show a pattern of scattered fibroglandular density.



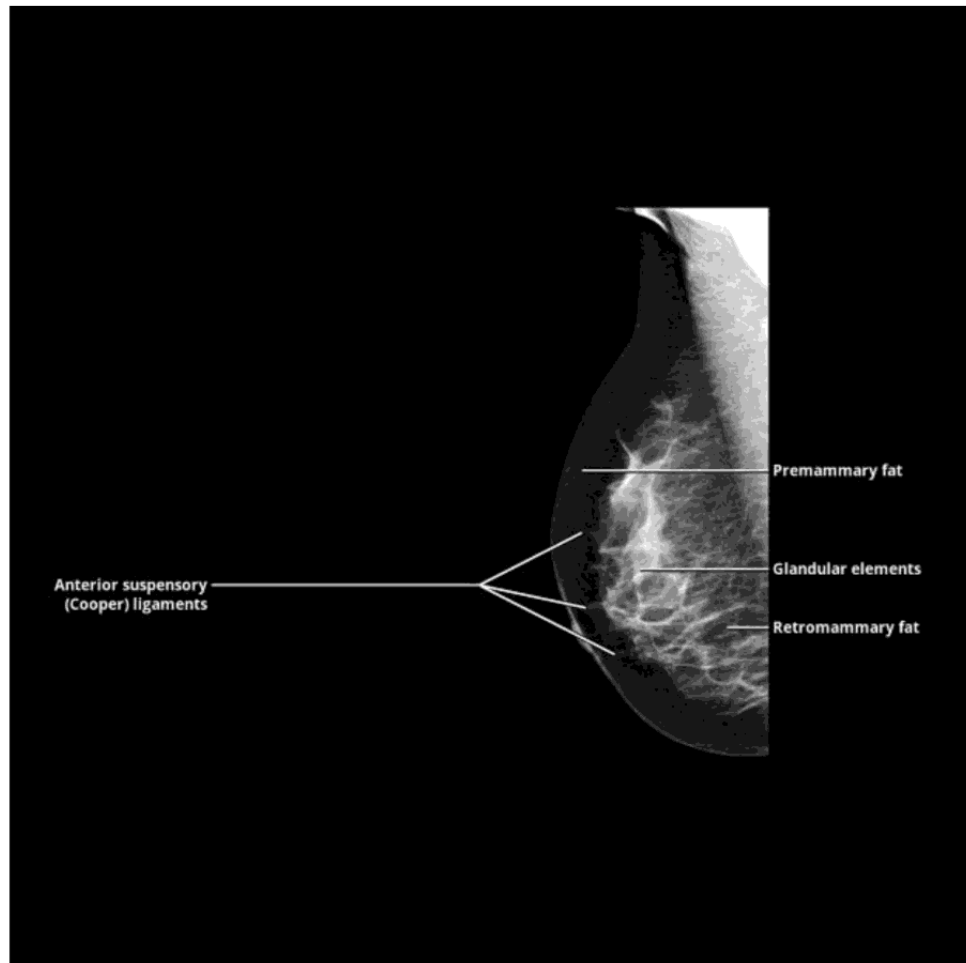
The American College of Radiology Breast Imaging and Reporting Database System (BI-RADS) divides breast composition into 4 categories: 1) almost entirely fat, 2) scattered fibroglandular densities, 3) heterogeneously dense, and 4) extremely dense. CC/MLO digital mammograms show almost entirely fat composition.



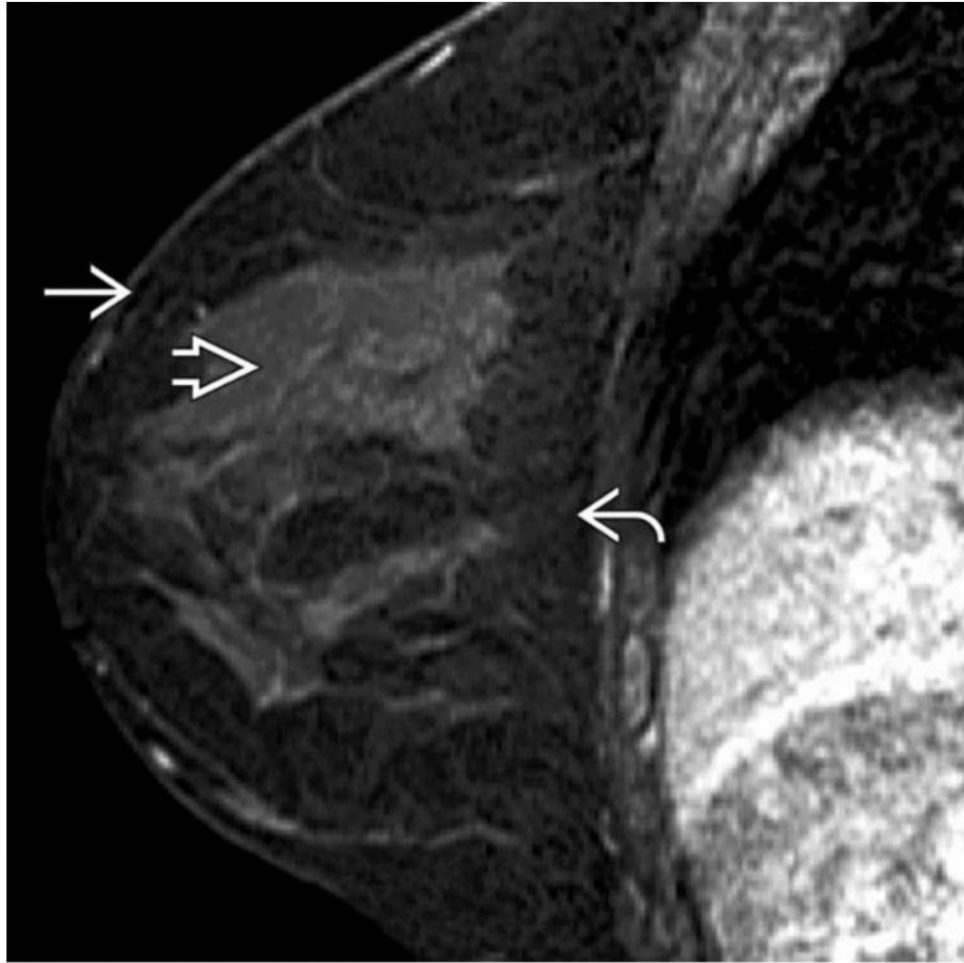
Sagittal T1 C+ FS MR in a premenopausal woman shows a few anterior suspensory (Cooper) ligaments with mild physiologic enhancement of normal glandular elements and nipple.



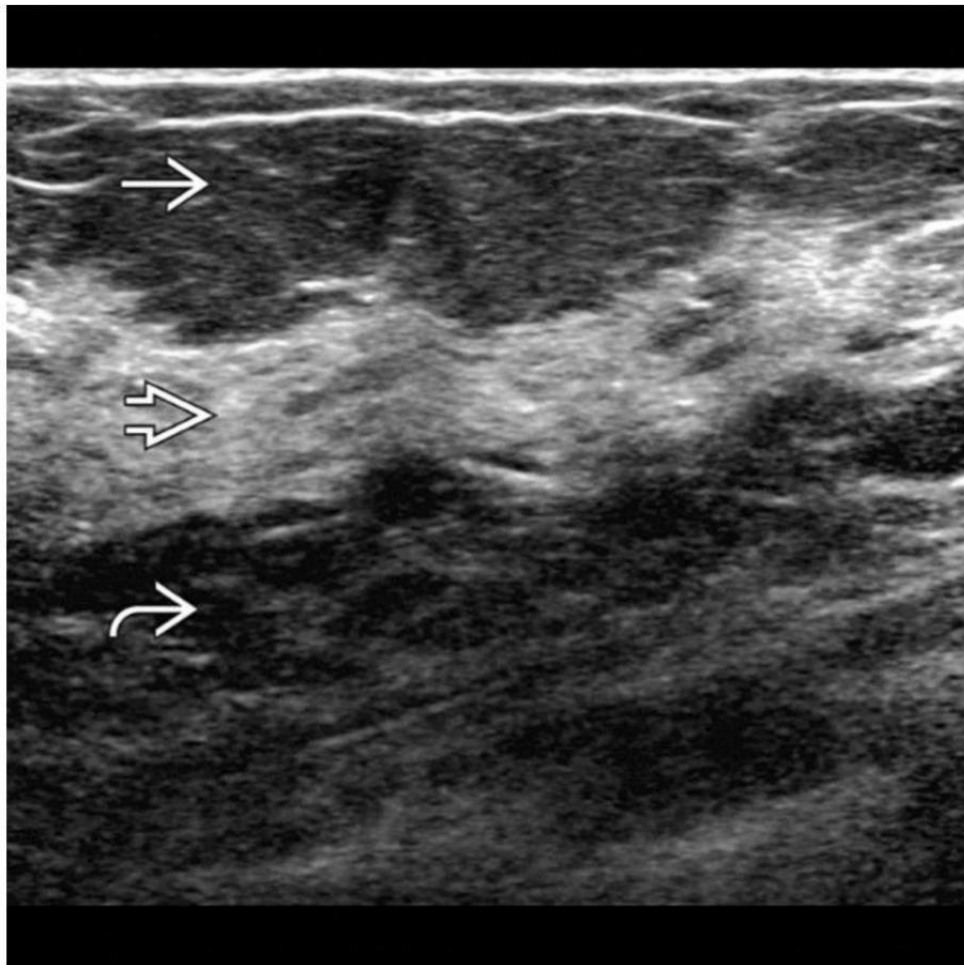
Breast US nicely demonstrates leaflets of anterior mammary fascia converging to form anterior suspensory (Cooper) ligaments.



Right MLO digital mammogram shows abundant fat in the subcutaneous (premammary) and retromammary zones and glandular elements and stroma in the mammary zone. Anterior suspensory (Cooper) ligaments are formed from leaflets of the anterior mammary fascia and insert into the dermis to stabilize the breast.



Sagittal T1 C+ SPGR breast MR demonstrates zonal anatomy: Subcutaneous fat/premammary zone →, fibroglandular zone ⇨, and retroglandular fat ↩.



Breast US demonstrates zonal anatomy: Subcutaneous fat →, fibroglandular zone ⇨, and retroglandular fat ⇨.

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# Embryology and Normal Development

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## EMBRYOLOGY

### Embryologic Events

- Weeks 4-6
  - Ectodermal streaks develop from fetal axilla to groin
  - Mammary ridges develop in thoracic region
- Weeks 6-8
  - Mammary ridges involute
  - Invagination of chest wall mesenchyme
- Weeks 12-16
  - Differentiation of smooth muscle of nipple and areola
  - Development of epithelial buds and bud branching
- Weeks 16-20
  - Development of hair follicles, apocrine glands, and glands of Montgomery
  - Appearance of primitive elements of breast parenchyma
- 3rd trimester
  - Epidermis depresses into shallow mammary pit
  - Nipple-areolar complex enlarges and develops pigmentation
  - Main ducts canalize, lobules begin differentiation

## BREAST DEVELOPMENT

### Neonatal

- Connective tissue proliferates causing nipple to become erect
- Hormonally stimulated lobular tissue may secrete colostrum

### Childhood and Puberty

- Main ducts branch and give rise to terminal buds, precursors of terminal duct lobular units (TDLUs)
- Adipose cells proliferate, enlarge, and extend into subcutaneous tissue
- Periductal tissues (stroma) ↑; blood vessels proliferate
- Tanner phases of pubertal breast development
  - I: Nipple elevation but no palpable glandular elements
  - II: Nipple and breast project as mound from chest wall with palpable tissue in subareolar region
  - III: ↑ glandular tissue/↑ areolar size and pigmentation
  - IV: Development of separate nipple-areolar complex as secondary mound anterior to breast
  - V: Final adolescent development with smooth breast contour

## Menarche

- Proliferative phase (follicular phase of ovary)
  - Days 3-14 of menstrual cycle
  - Overall regression of breast epithelium
  - ↑ ovarian estrogen production under pituitary control
  - Stroma becomes less dense
  - Duct lumens expand with ↑ epithelial cell activity
  - Lowest breast volume and water content
- Secretory phase (luteal phase of ovary)
  - Days 15-28 of menstrual cycle
  - Ductal epithelium proliferates
  - Stromal density ↑ with ↑ water content
  - Symptoms relate to ↑ interlobular fluid
    - Generalized lobular proliferation

## Pregnancy

- Marked ductal and lobular proliferation in early weeks of pregnancy
- Weeks 5-9
  - Generalized breast enlargement
  - Progressive ↑ nipple-areolar complex pigmentation
- 2nd half of pregnancy
  - Progressive lobular proliferation
  - Stromal and fat elements increase
  - Colostrum accumulates in alveoli

## Lactation

- Immediate postpartum enlargement due to colostrum accumulation
- Milk secreted into alveoli 3-7 days post partum
- Postlactational changes
  - ↑ periductal and perivascular stromal connective tissue
  - Alveolar cells and ductal branches regress

## Menopause

- Generalized fatty replacement/atrophy of epithelium and stroma
- Hormone replacement therapy (HRT) stimulates residual elements; may ↑ mammographic breast density

## DEVELOPMENTAL ANOMALIES

### Congenital

- Polymastia
  - Accessory tissue, incomplete involution of mammary ridge (usually ↑ during pregnancy/lactation)
- Polythelia
  - Accessory nipples
  - Most common congenital anomaly
- Amastia
  - Absence of breast development
- Amazia
  - Nipple present but no breast development
- Hyperplasia: Unilateral or bilateral
- Hypoplasia: Unilateral or bilateral
- Congenital inversion of nipple
  - Incidence: 3% of live births
  - Association: Duct ectasia, periductal mastitis
- Poland syndrome: Unilateral hypoplasia of breast, hemithorax, and pectoral muscle

### Acquired Hypoplasia or Amastia

- Inadvertent biopsy of breast bud during childhood
- Trauma; chest wall burn or radiation during childhood

# **ANATOMY IMAGING ISSUES**

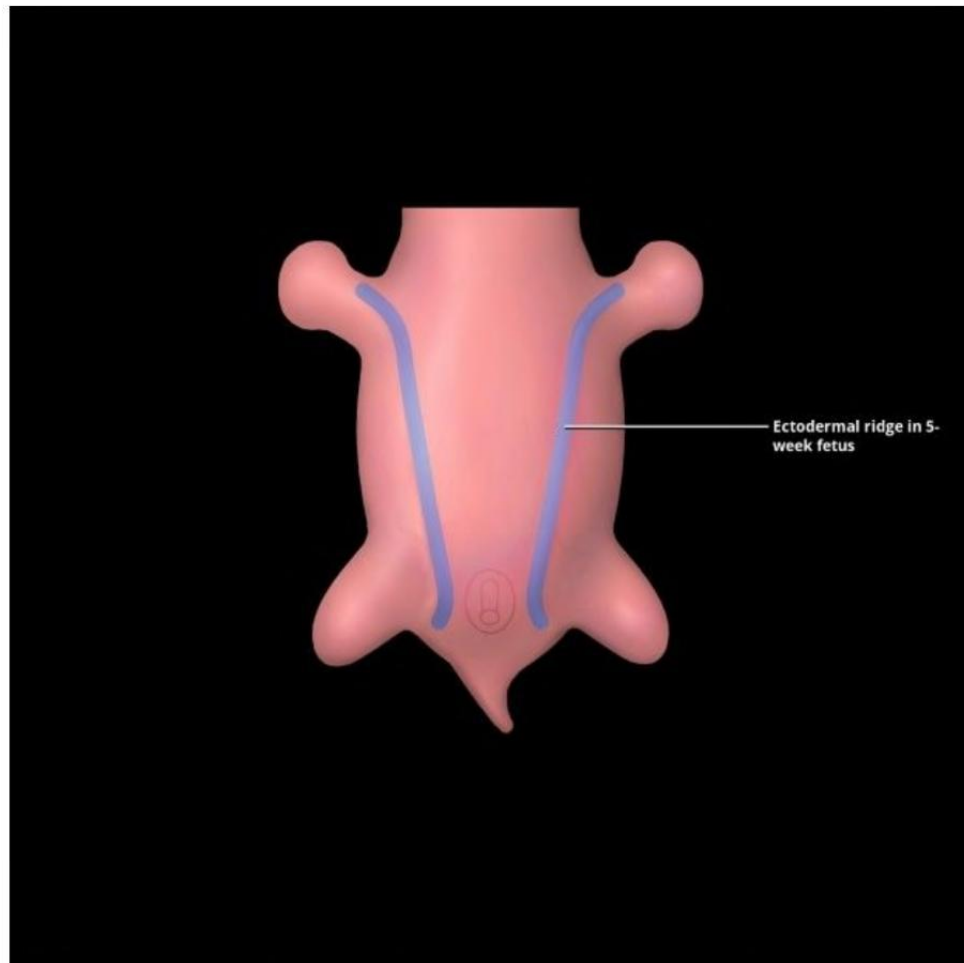
## **Mammography**

- Anomalies of pectoralis muscles (MLO views)
- Masses and fibroglandular tissue (axillary breasts)

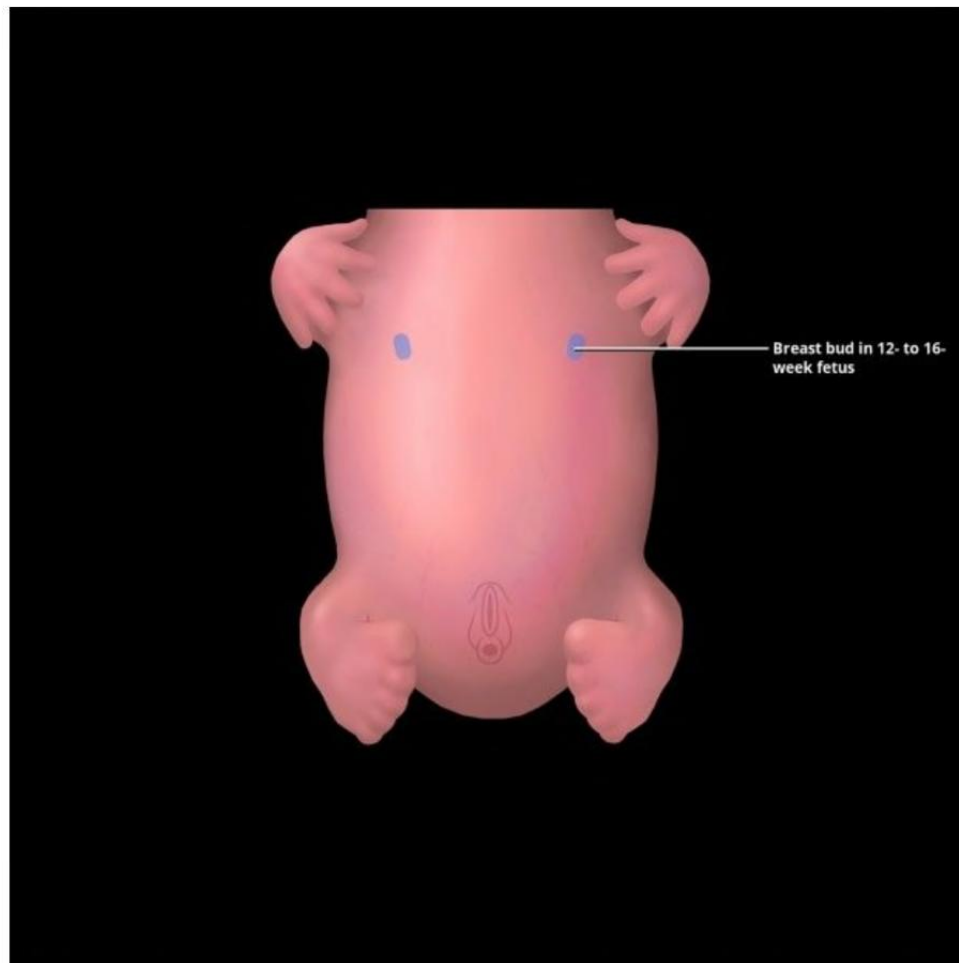
## **Ultrasound**

- Normal fibroglandular tissue, benign and malignant masses in axillary breasts; guide biopsy
- Pregnancy and lactation: Ductal, lobular proliferation (hypoechoic); stromal proliferation (hyperechoic)
- Differentiate physiologic pubertal changes from neoplasm

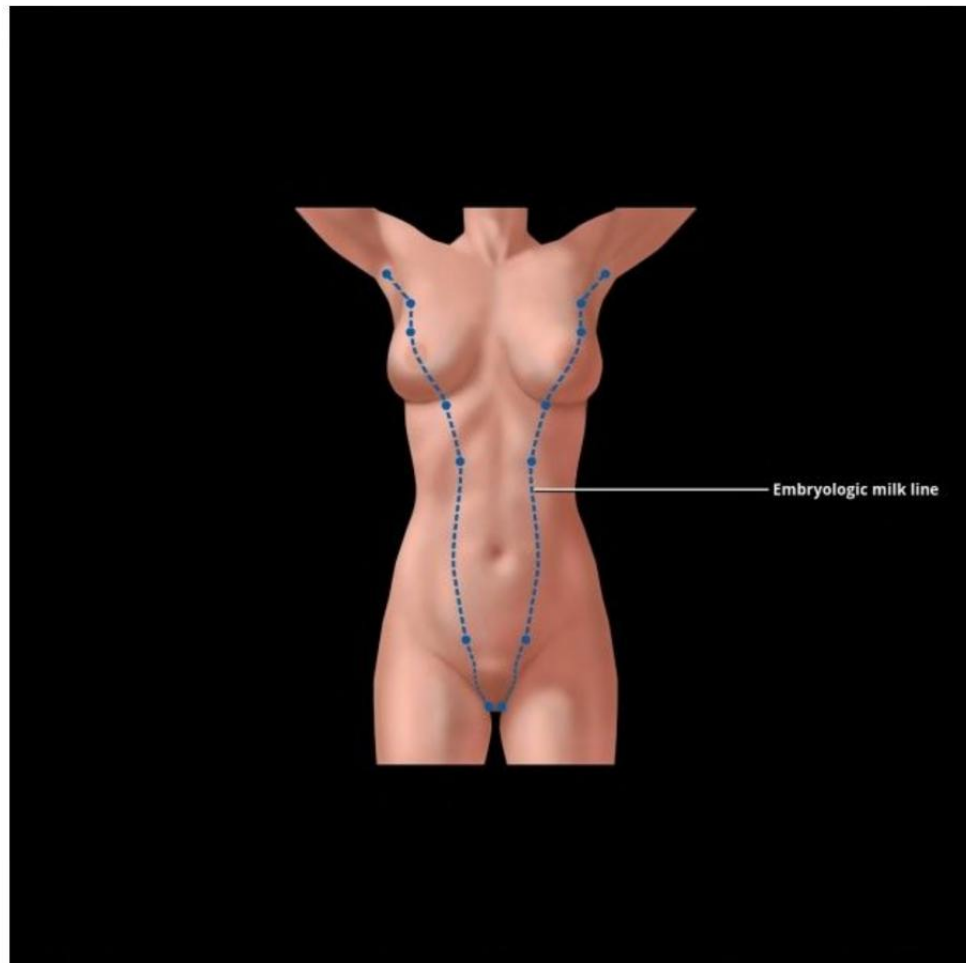
## **EMBRYOLOGY**



The ectodermal milk streaks develop between the axillae and the inguinal regions during the 5th week of fetal growth and evolve into the mammary ridges in the thoracic region, the progenitor tissue of normal breasts. Incomplete involution of the ectodermal streaks produces accessory breast, nipple, and areolar tissue, which can present anywhere between the axillae and groin.

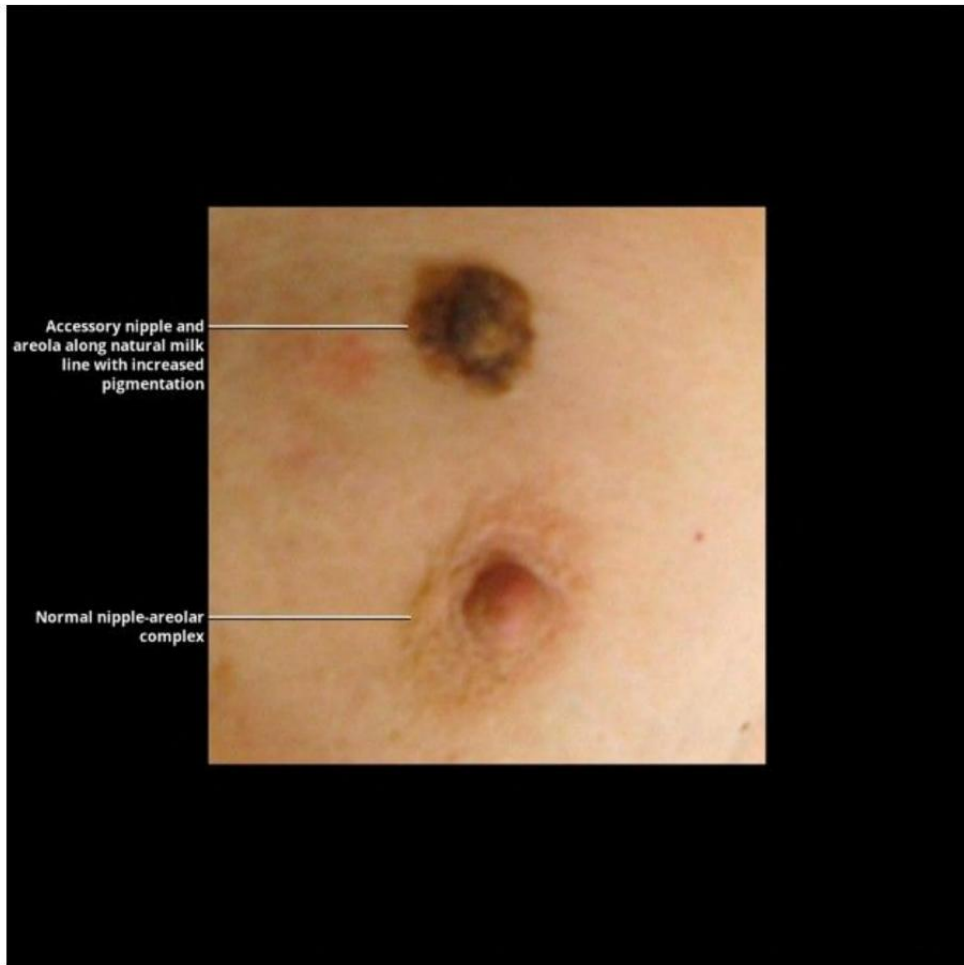


The epithelial breast buds develop between weeks 12 and 16 of fetal growth. Breast buds may simulate cutaneous masses in infancy and childhood. Inadvertent biopsy of breast buds can cause acquired breast hypoplasia/amastia.

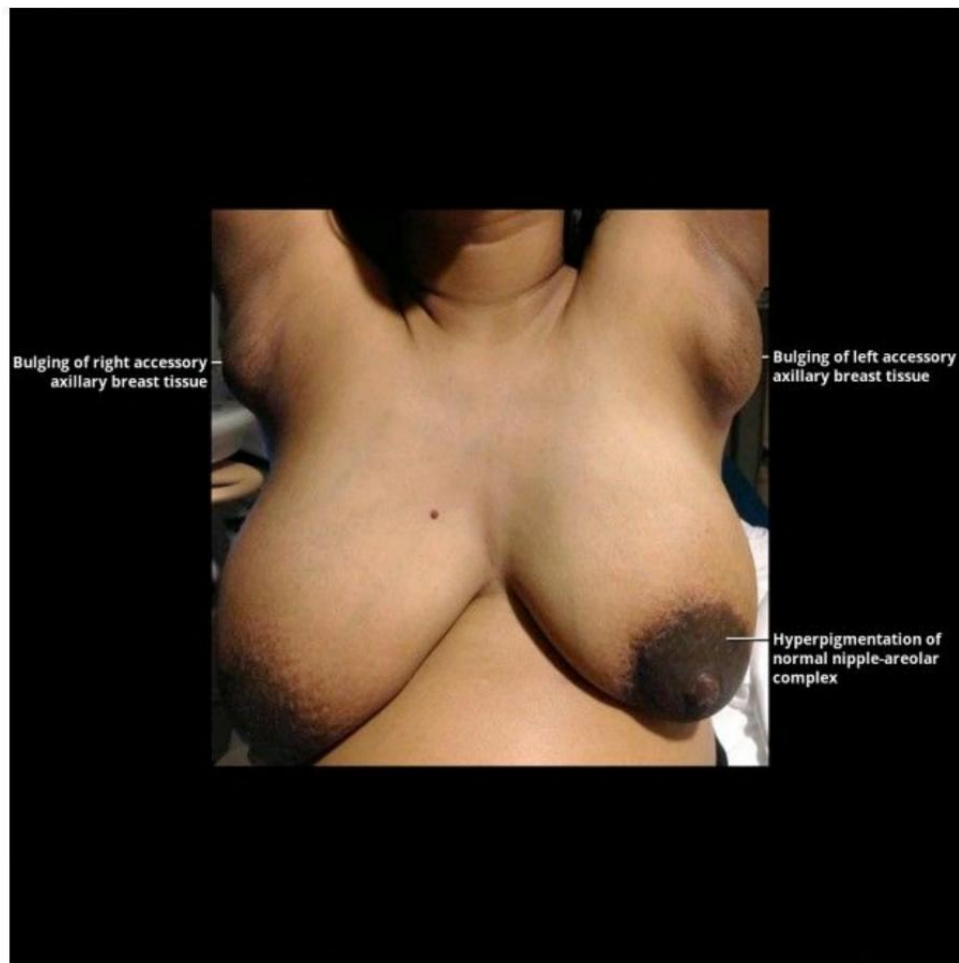


Schematic diagram demonstrates potential foci for accessory breast tissue in the adult woman. Accessory tissue may become clinically evident during pregnancy, lactation, or hormone replacement therapy.

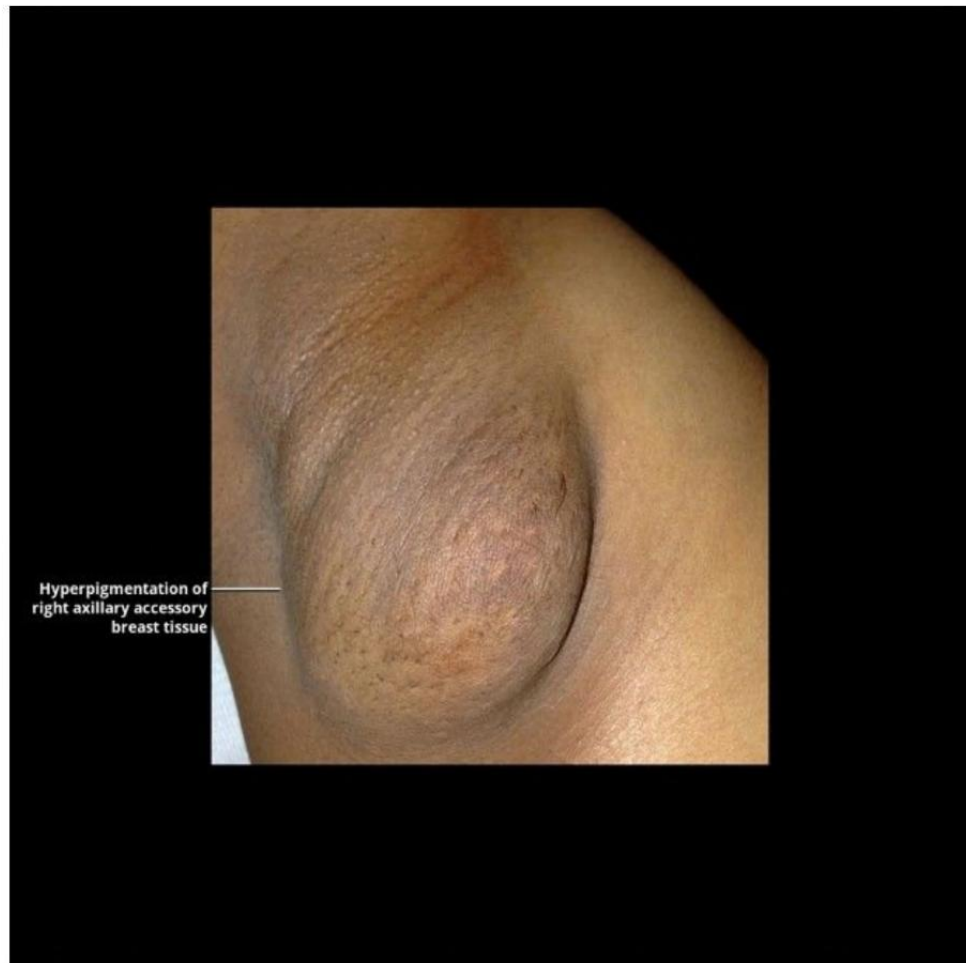
#### **ACCESSORY NIPPLE AND ACCESSORY BREAST**



Clinical photo demonstrates an accessory nipple and areola located superior to the normal nipple-areolar complex, along the natural milk line. Accessory nipples are the most common congenital anomaly.

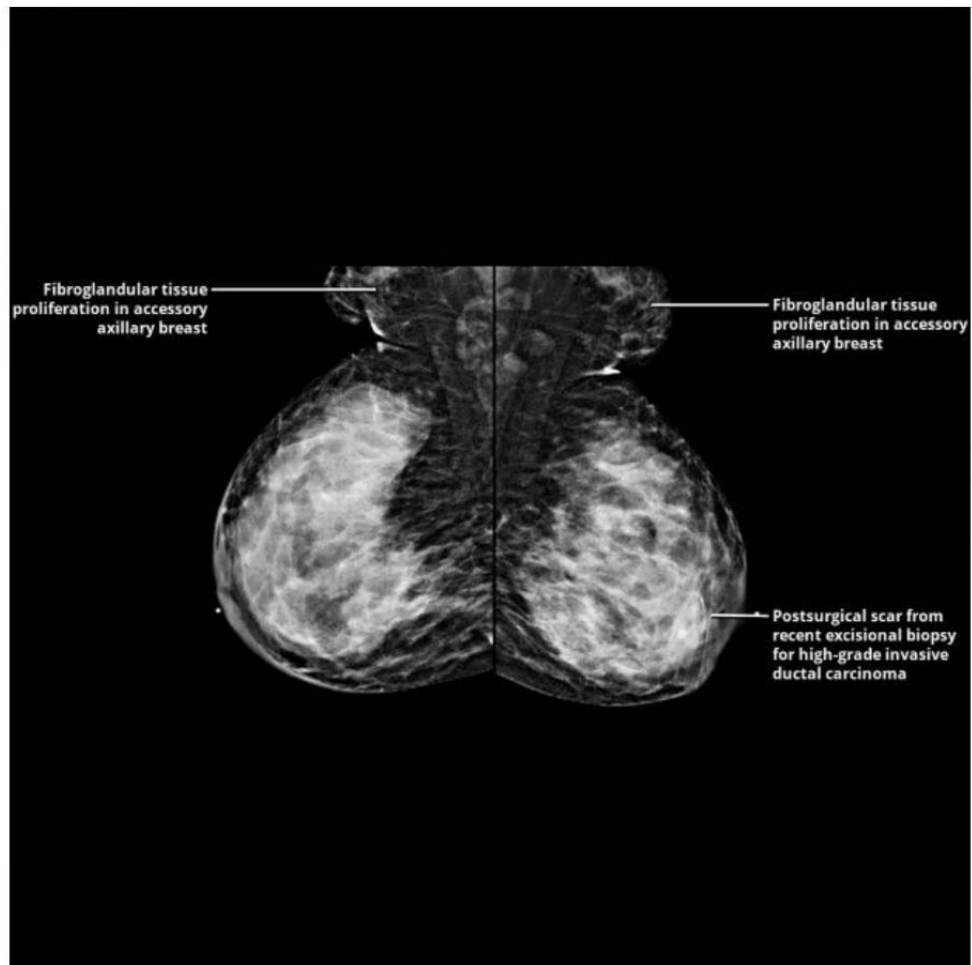


Clinical photo of a 36-year-old woman at 33-weeks gestation shows enlarged breasts with increased size and pigmentation of the normal nipple-areolar complex, associated with bilateral axillary masses. Fluctuation in size of accessory breasts is common with hormonal stimulation during pregnancy.

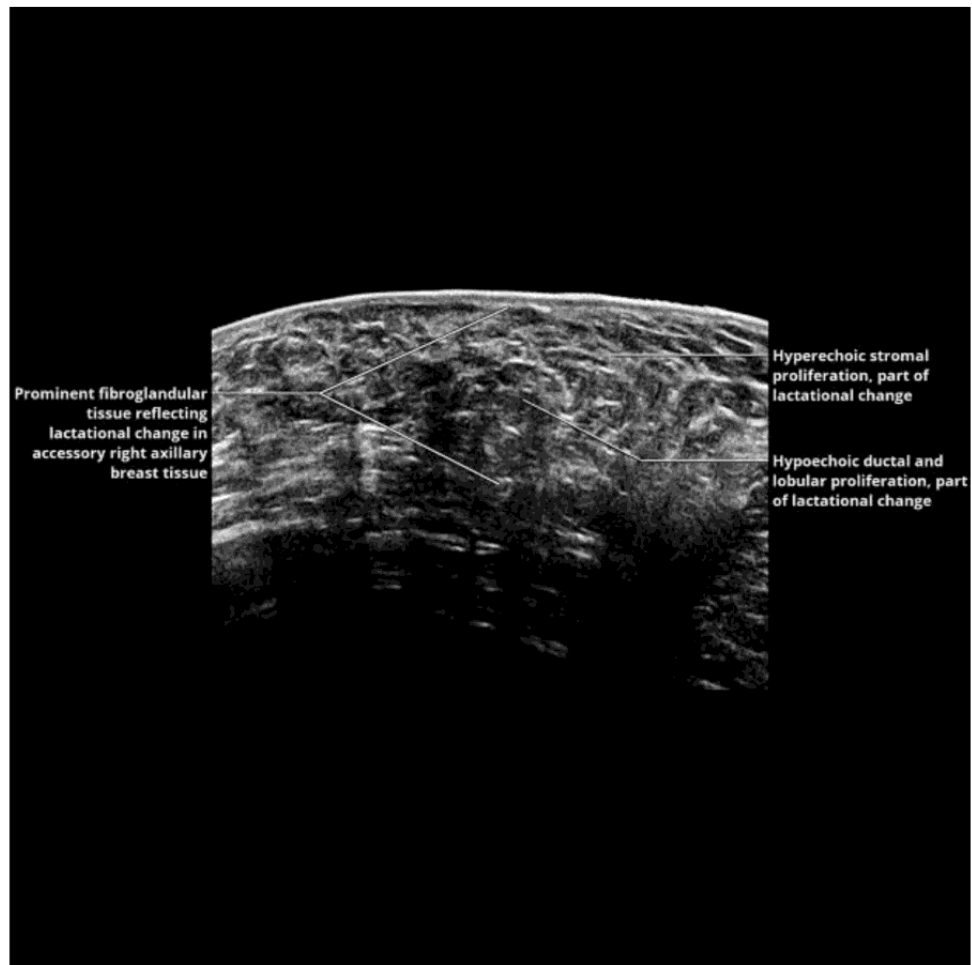


Close-up clinical photo (same patient) shows bulging right axillary breast tissue with associated dermal hyperpigmentation. Accessory breasts are a result of incomplete involution of the mammary ridge, commonly enlarge during pregnancy and lactation, and are associated with increasing hyperpigmentation during pregnancy.

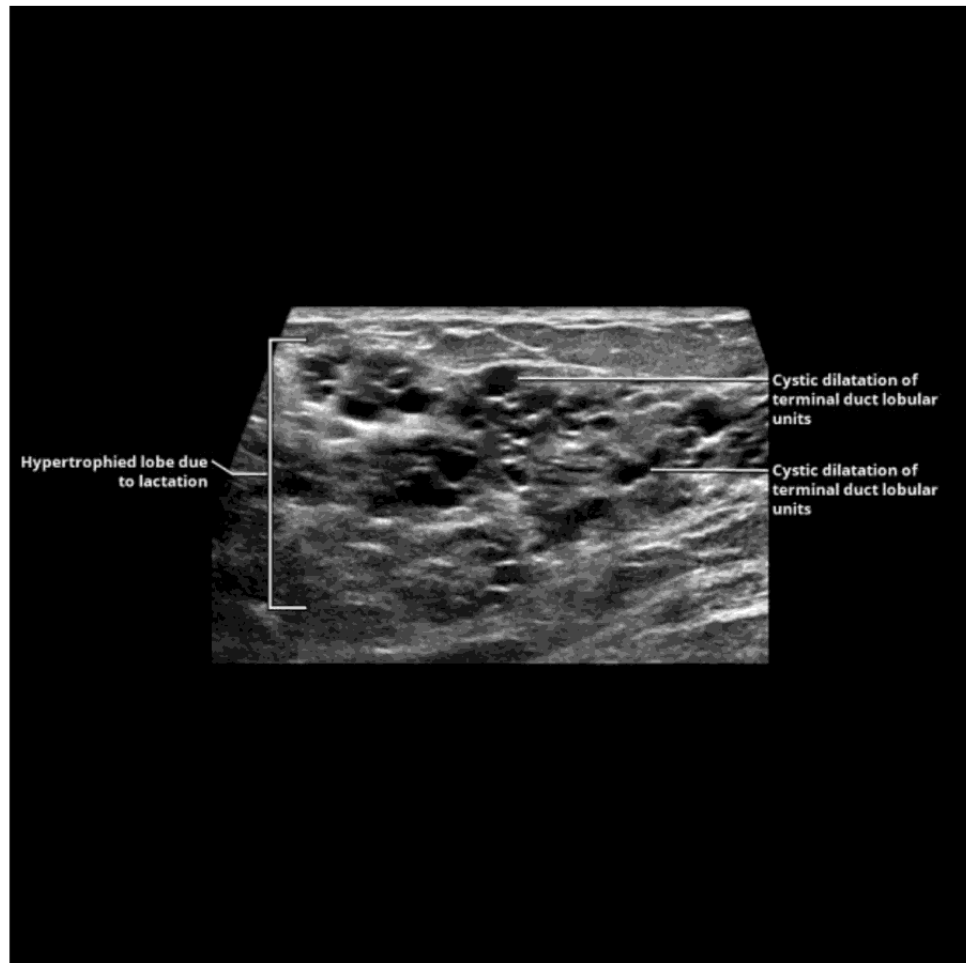
#### **MAMMOGRAPHY AND US OF ACCESSORY BREAST**



Bilateral MLO mammograms show exuberant, heterogeneously dense glandular tissue at 33-weeks gestation in a woman recently diagnosed with left breast cancer. Bilateral symmetric axillary breasts demonstrate prominent fibroglandular tissue.

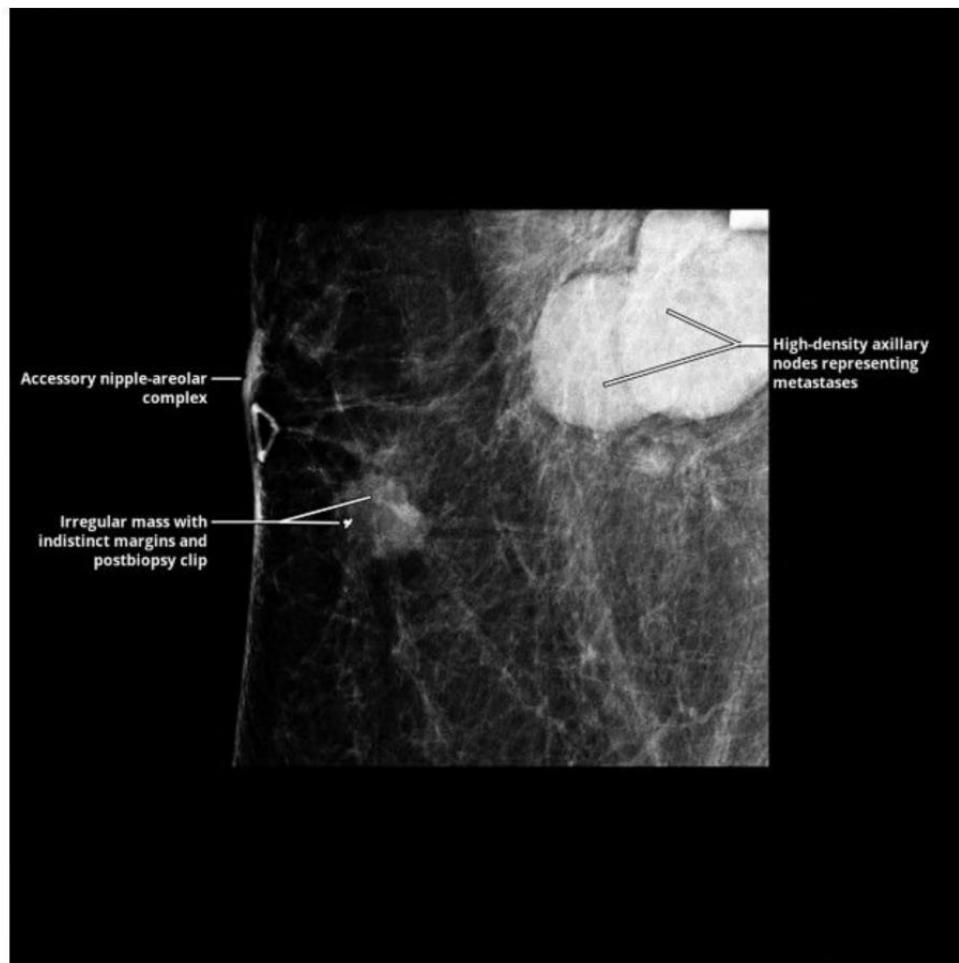


US of the right axilla demonstrates prominent fibroglandular tissue reflecting lactational change in axillary breast tissue. Similar findings were noted on the left.

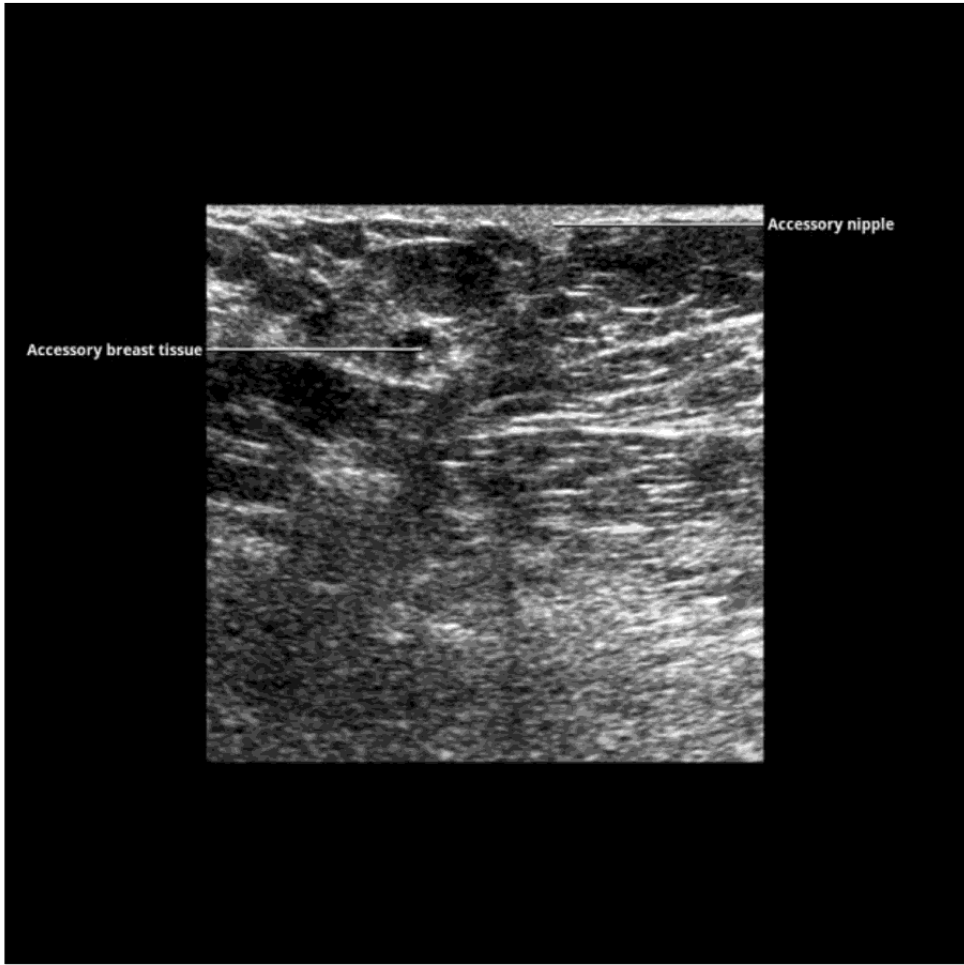


This 35-year-old lactating woman reported a "lump" on the outer left breast, which decreased after breastfeeding. Targeted US shows a prominent lobe with diffuse cystic change in the terminal duct lobular units (TDLUs), which presumably distend with milk then decreased with breastfeeding, benign findings.

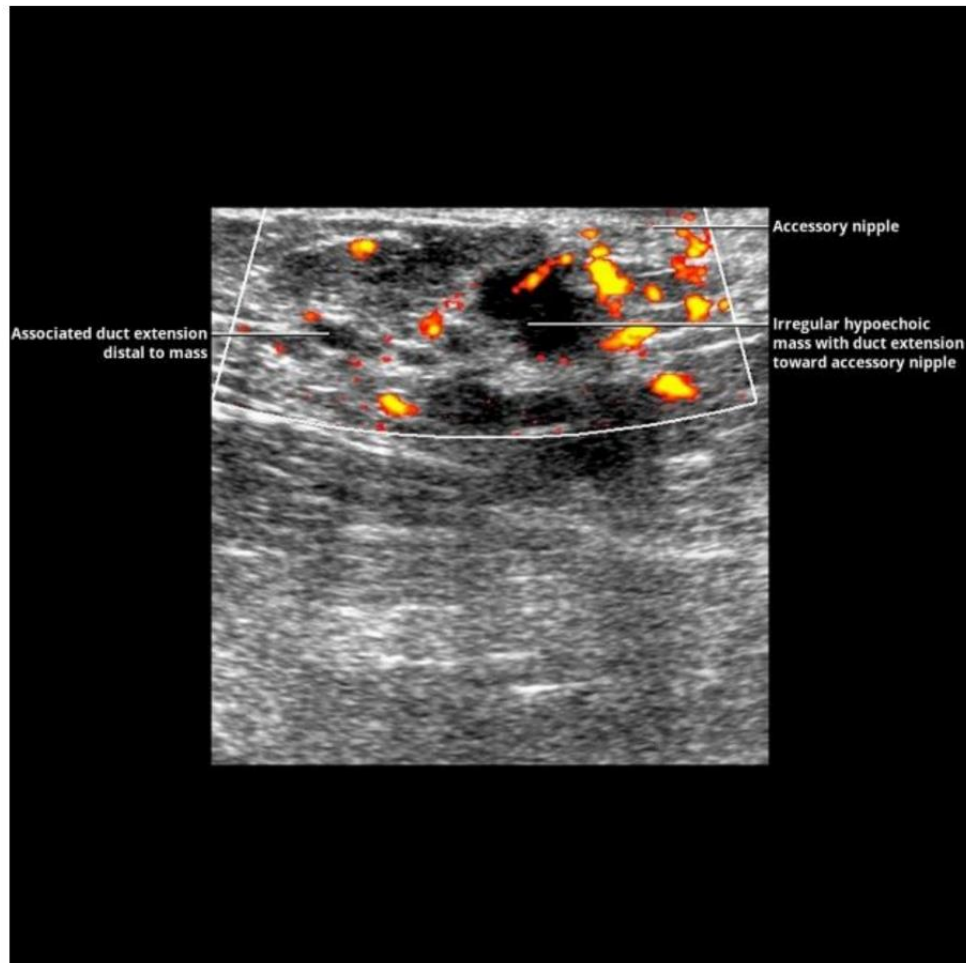
#### MAMMOGRAPHY AND ULTRASOUND OF ACCESSORY NIPPLE AND BREAST



Close-up right MLO mammogram demonstrates accessory nipple-areolar complex in the axilla. An underlying palpable mass with a clip in situ showed high-grade invasive ductal ER/PR(+), HER2(-) cancer at core biopsy. Associated enlarged dense axillary nodes represent known metastases. At final histopathology, Paget disease of the accessory nipple was associated with invasive ductal cancer.

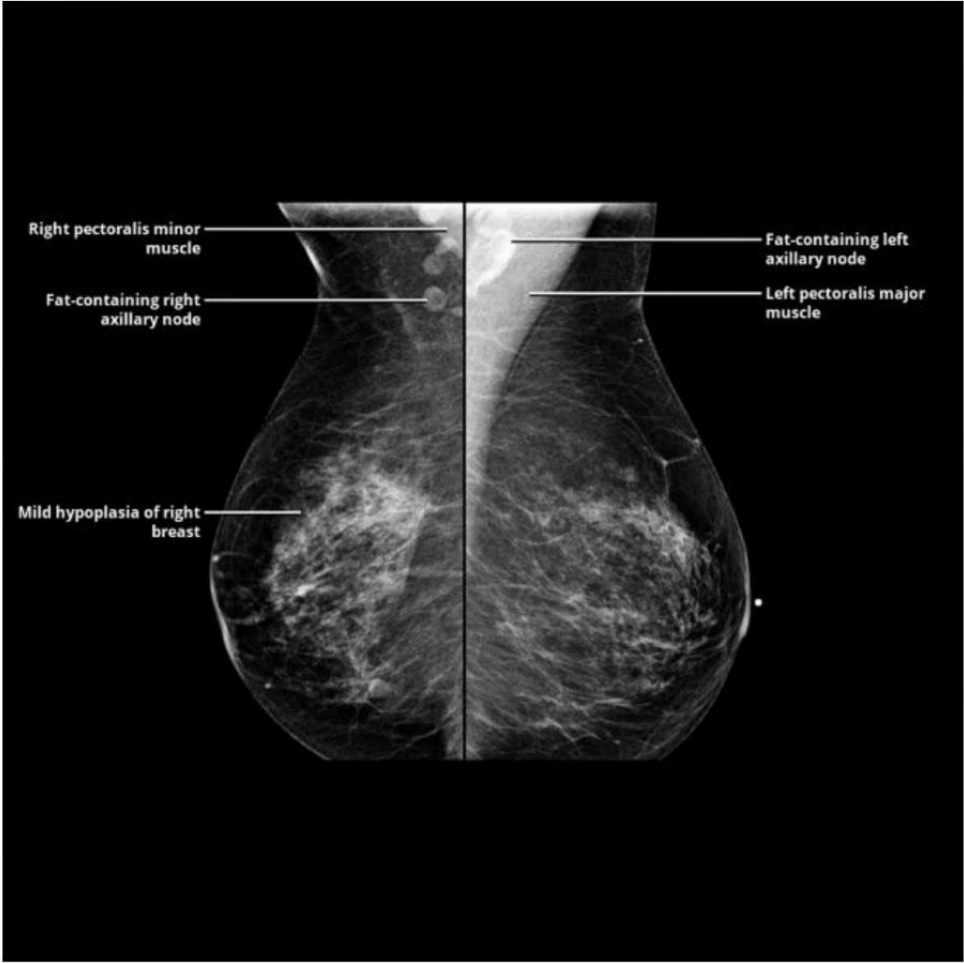


Longitudinal US (same patient) shows an accessory nipple in the axilla and associated axillary breast tissue.



Power Doppler US (same patient) shows an irregular, hypoechoic mass with associated duct extension distal to the mass and directed toward the overlying accessory nipple.

#### **POLAND SYNDROME, ACQUIRED HYPOPLASIA**



Bilateral MLO mammograms demonstrate absence of the right pectoralis major muscle and relative hypoplasia of the right breast. Findings are consistent with Poland syndrome.