Evaluation of Calcifications

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Breast Calcifications

- Calcifications can be the first and only sign of breast cancer
- When calcifications are detected, their number, morphologic appearance, size, associated findings and distribution should be examined to help characterize them
- Biopsy can be avoided if they appear absolutely benign
  - Typically these are larger, coarser, round with smooth margins and more easily seen
- Biopsy is warranted for calcifications that are described as Amorphous, Coarse Heterogeneous, Fine Pleomorphic, or Fine-Linear/Fine-linear Branching

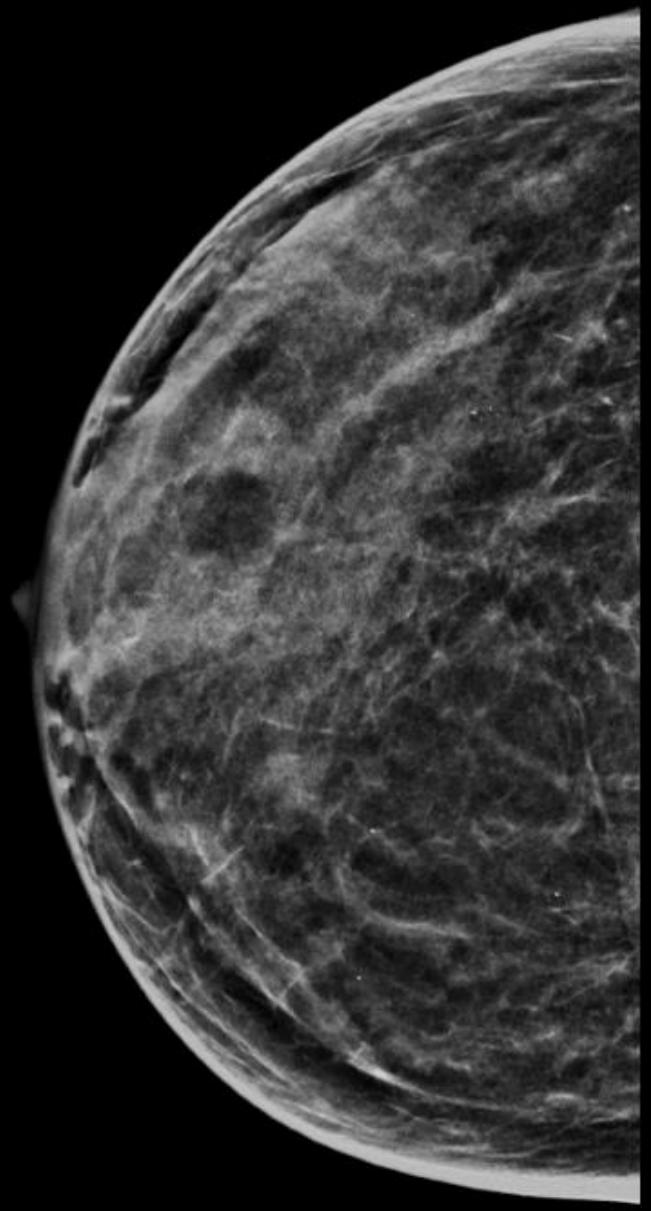
Calcifications Detection

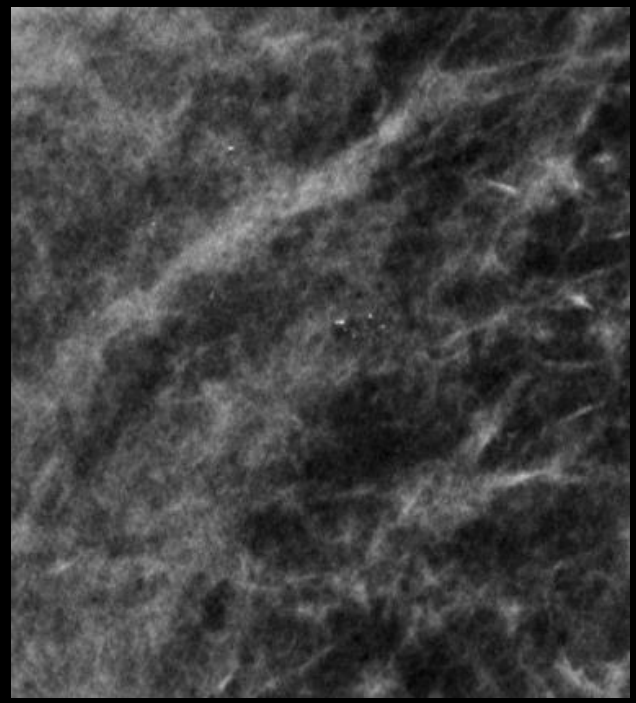
- Early DBT studies investigating the imaging of different lesion types found mixed results for quality of calcification imaging
- More recent studies have shown DBT has improved the imaging of calcifications with the addition of synthetic 2D view

- Wahab and colleagues showed FFDM and SM performed similarly in evaluation of microcalcifications
  - High sensitivity, modest specificity
  - Radiologists should be aware of possible image artifacts present on synthetic 2D images when evaluating potential microcalcifications – "pseudocalcifications"

Wahab RA, et al. A comparison of full-field digital mammograms versus 2D synthesized mammograms for detection of microcalcifications on screening. Eur J Radiol 2018; 107: 14-19.

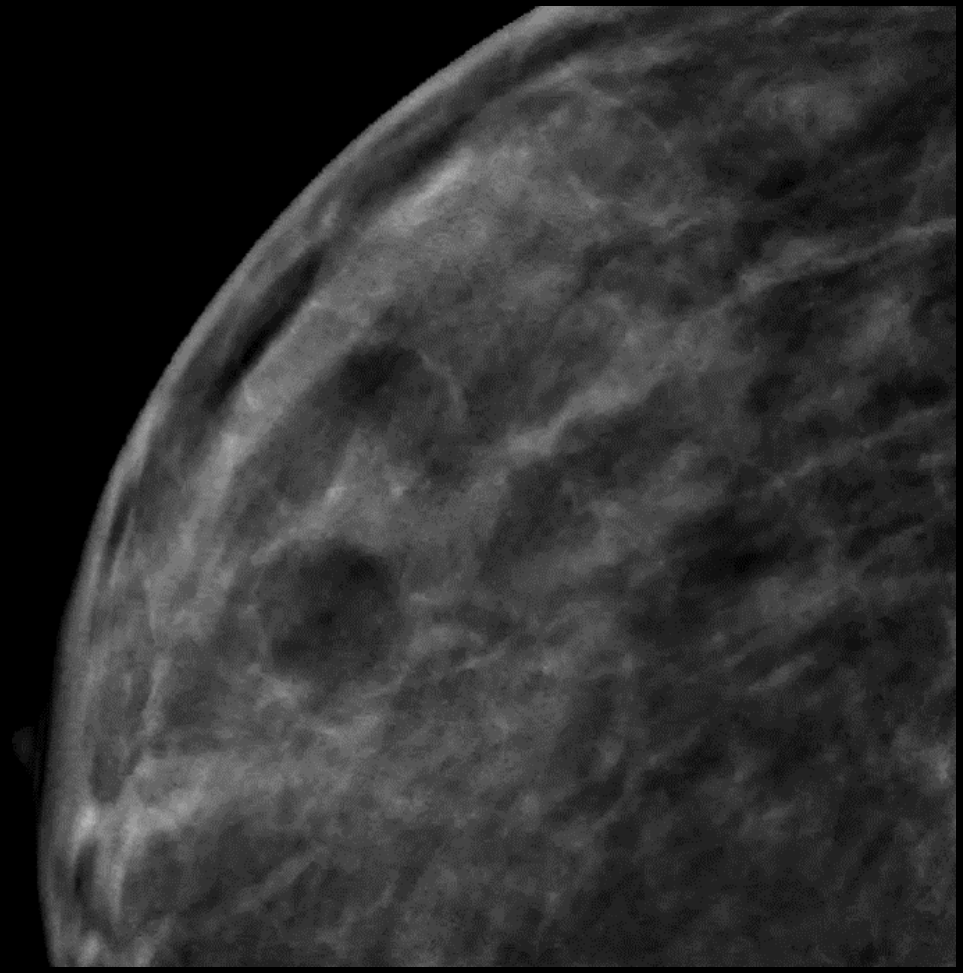
Patient presents for screening mammography – pleomorphic calcifications on synthetic view





Patient presents for screening mammography – pleomorphic calcifications on synthetic view

Not well visualized on DBT slices



Imaging of Calcifications

- Spatial resolution important in diagnosing calcifications
  - Spot compression and magnification views with higher spatial resolution are the imaging tools of choice for characterization and to confirm presence of calcifications if utilizing DBT

Zuckerman, S. P., Maidment, A. D., Weinstein, S. P., McDonald, E. S., & Conant, E. F. (2017). Imaging with synthesized 2D mammography: differences, advantages, and pitfalls compared with digital mammography. *American Journal of Roentgenology*, *209*(1), 222-229.

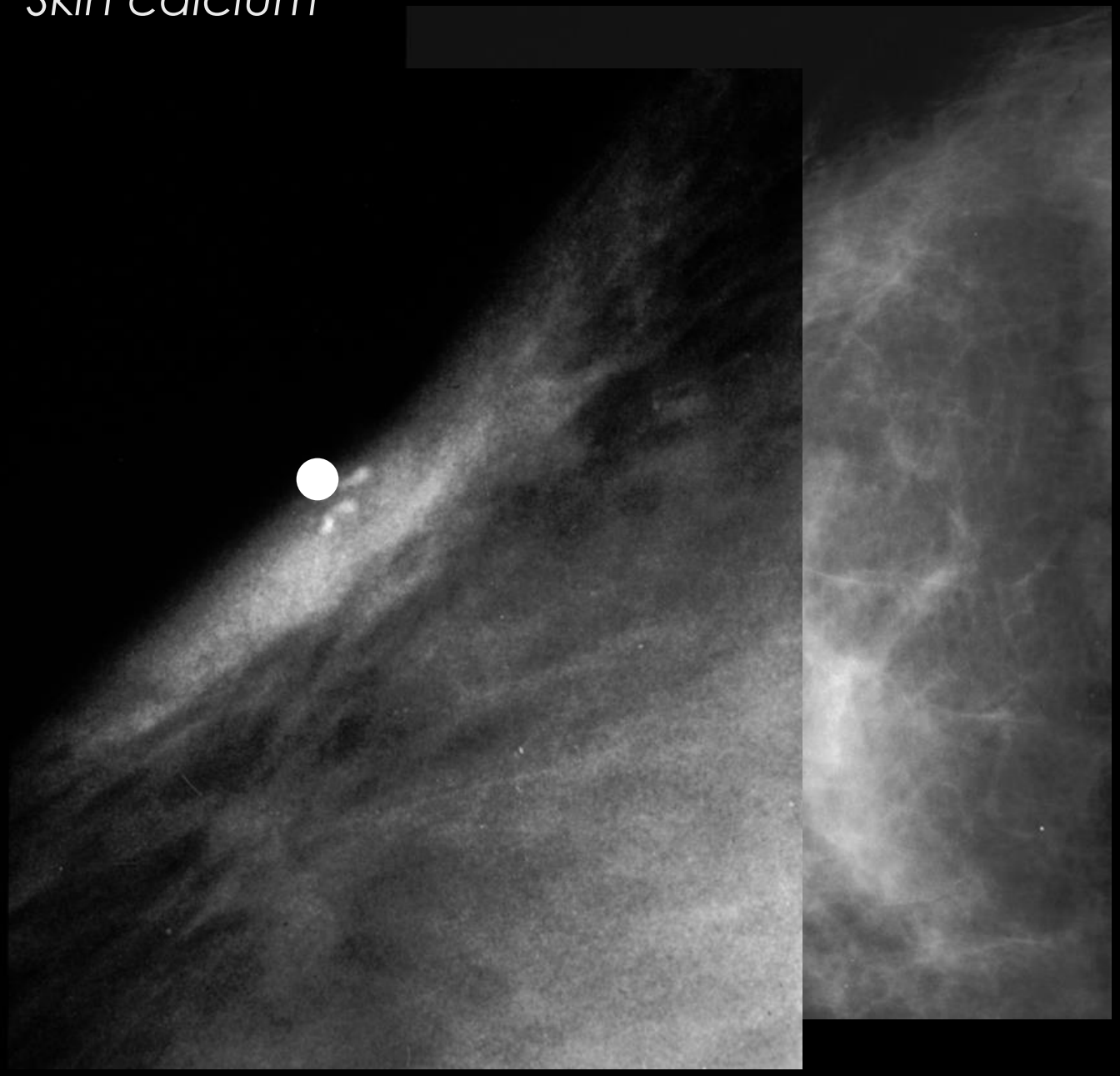
Typically Benign Calcifications

- Skin Calcifications
- Coarse or "Popcorn-Like" Calcifications
- Large Rod-like Calcifications
- Rim Calcifications
- Suture Calcifications
- Dystrophic Calcifications
- Round Calcifications
- Milk of Calcium Calcifications
- Vascular Calcifications

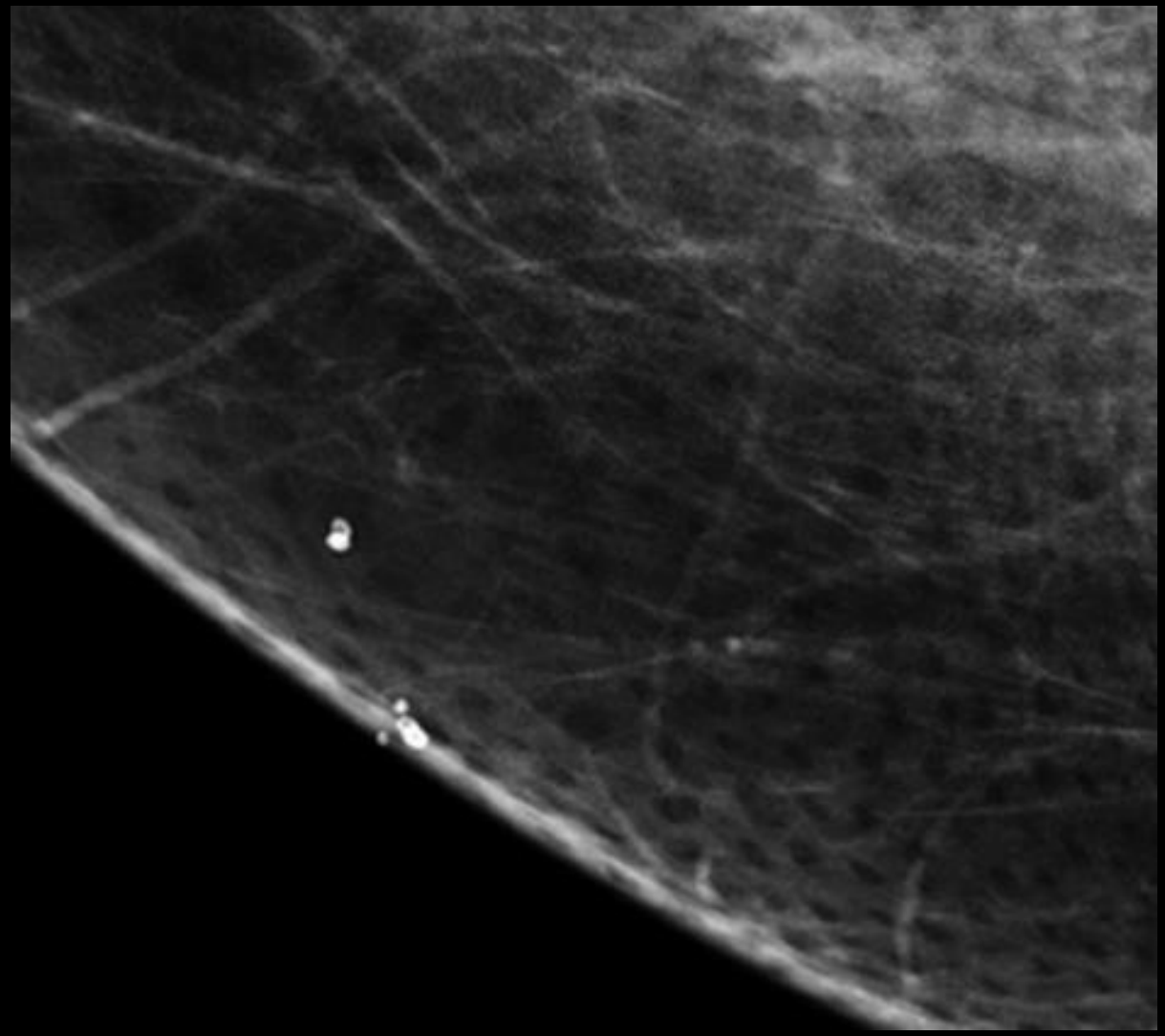
Skin Calcifications

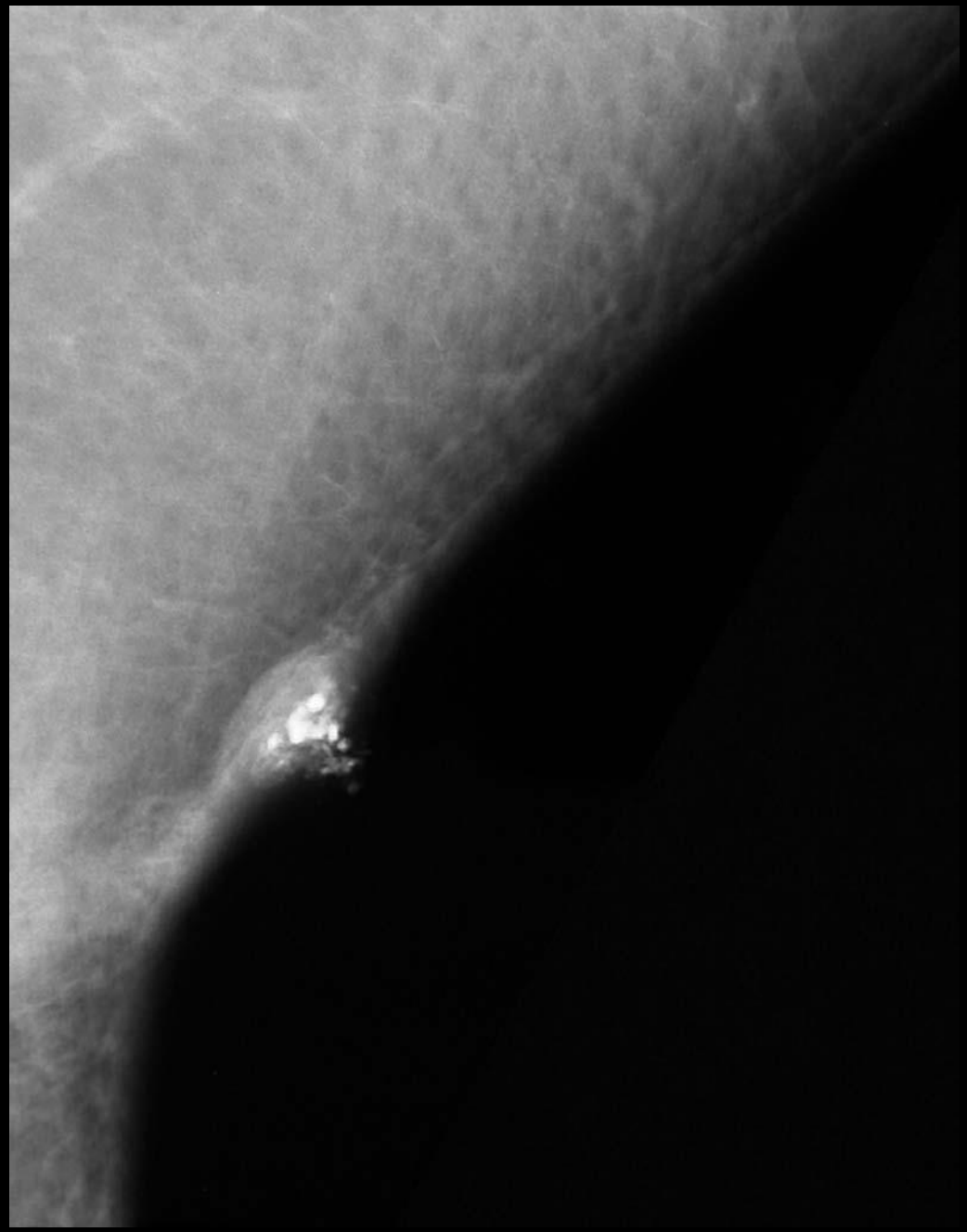
- Usually lucent-centered
- Most commonly seen along inframammary fold, in the parasternal region, the axilla and the areola
- Tangential views of the overlying skin can confirm
- Tightly grouped with individual calcs <5mm

Skin calcium



Skin calcium

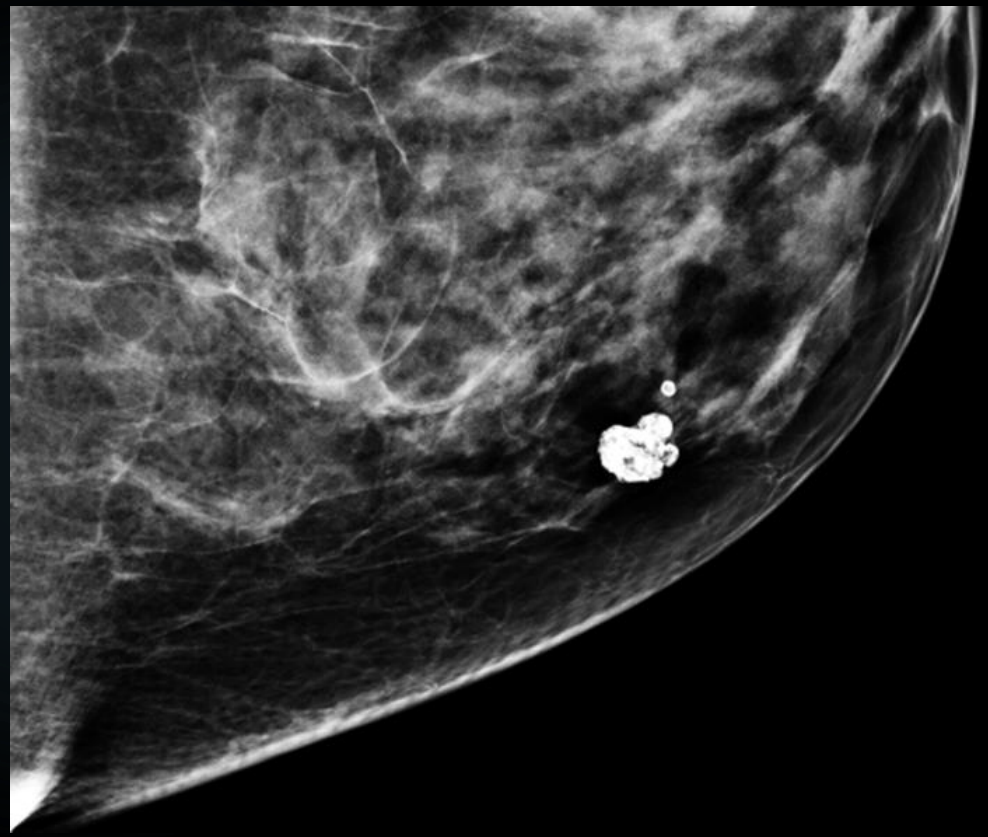


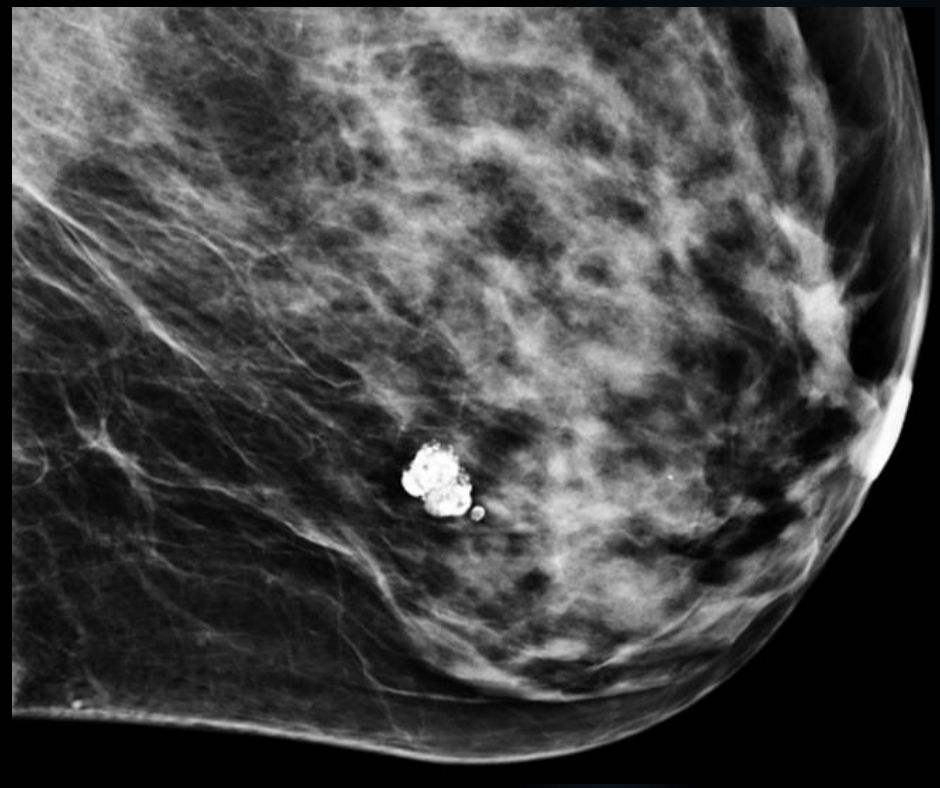


Sebaceous cyst

Coarse (Popcorn) Calcifications

- Large (>2-3mm in diameter), confluent, may start peripheral to a circumscribed mass
- Produced by an involuting fibroadenoma

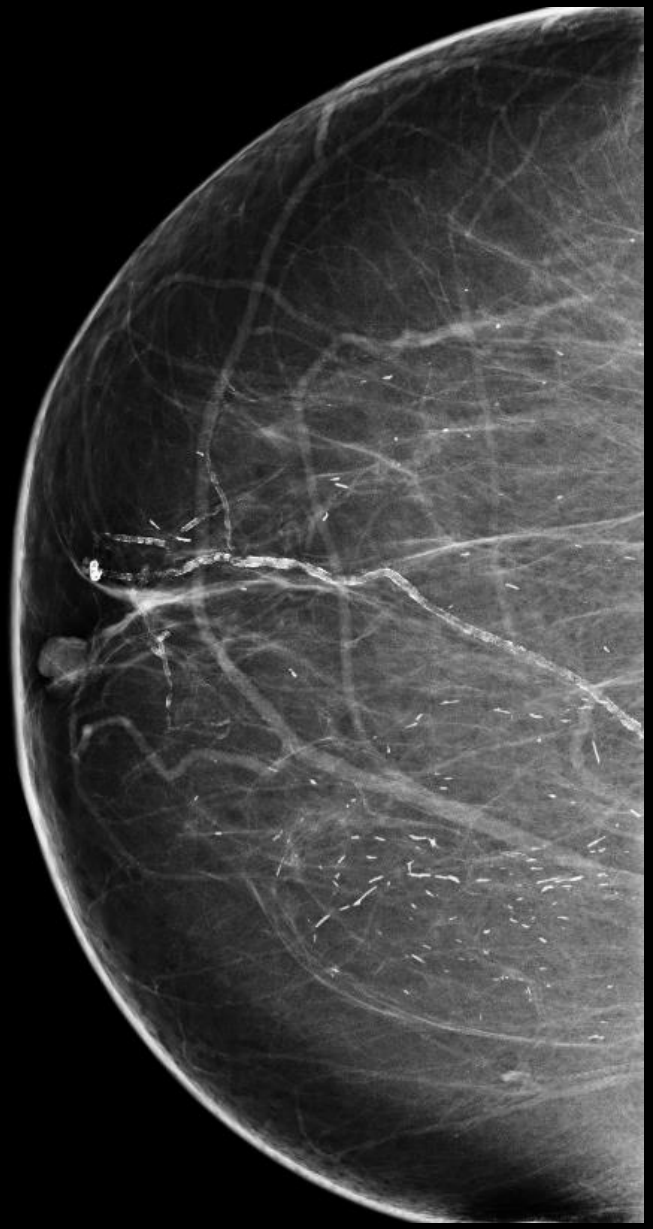




Large Rod-like Calcifications

- Benign calcifications associated with ductal ectasia
- Solid or discontinuous smooth linear rods
  - Usually ≥ 0.5 mm
- Some can have lucent centers if calcium is in the wall of the ducts, or be solid if secretions calcify in the lumen of the ectatic ducts
- Usually seen in women older than 60 years
- Follow a ductal distribution radiating toward the nipple

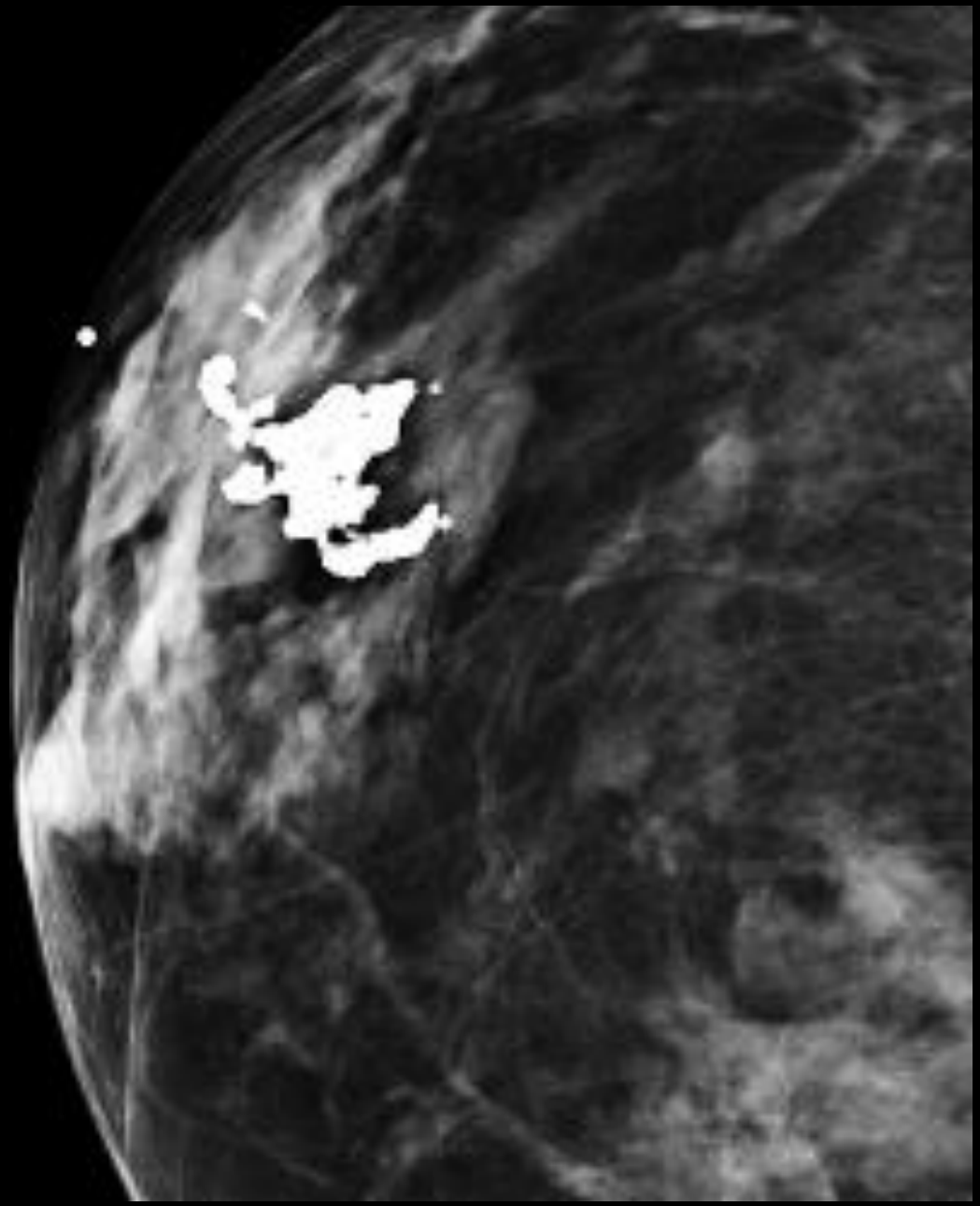
Large rod-like calcifications



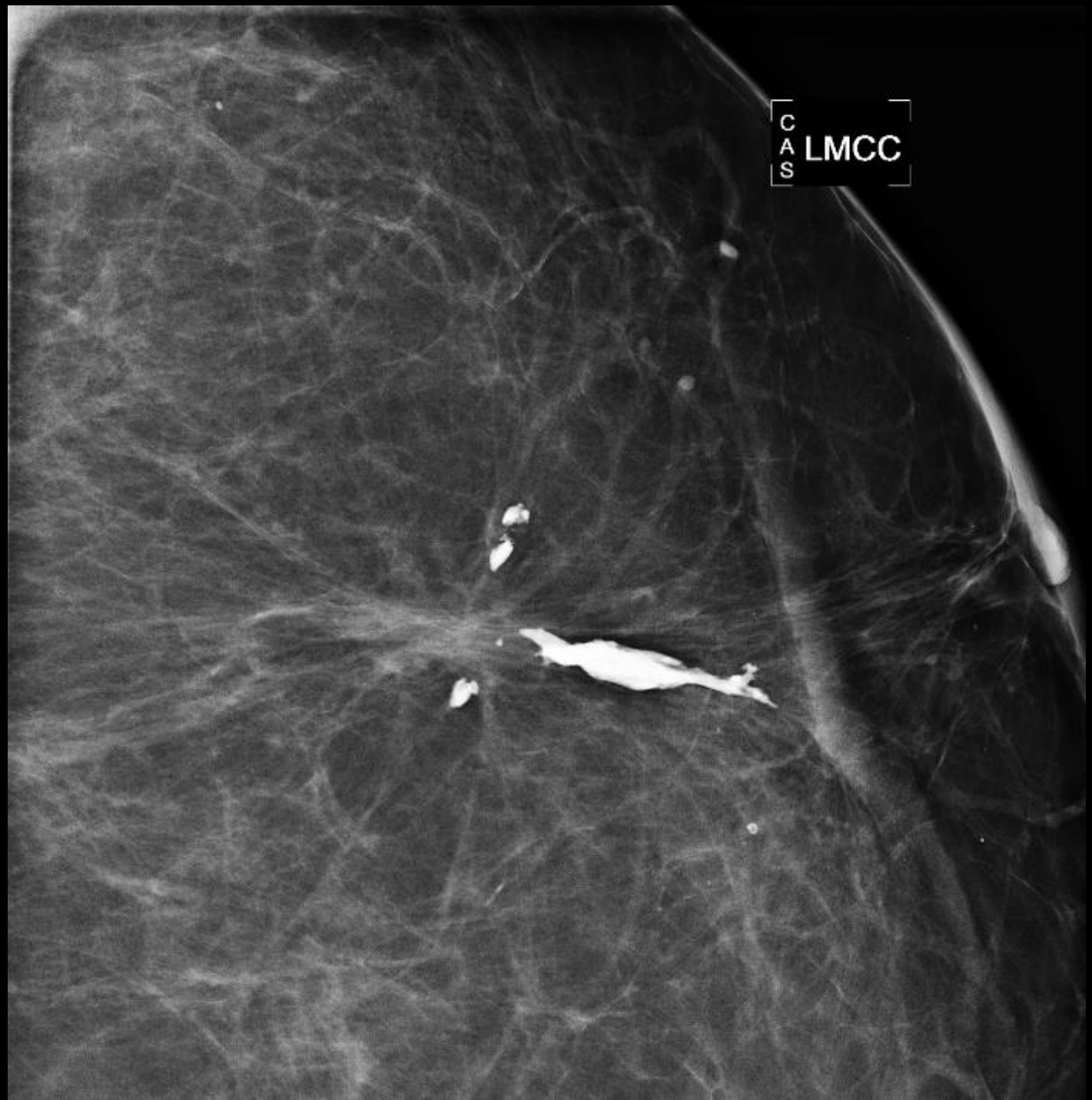
Dystrophic Calcifications

- Usually form in the breast post-surgically and post-radiation
- Irregular shape, coarse and usually have lucent centers
- Usually larger than >1mm
- Seen in fat necrosis arising from blunt trauma, ductal ectasia or breast infection
  - Arise from calcified cellular debris within breast parenchyma or ductal system
  - Typically appear as either round radiolucent oil cysts or irregular dystrophic calcifications along path of injury

Dystrophic calcs-related to prior surgery



Dystrophic calcs-fat necrosis

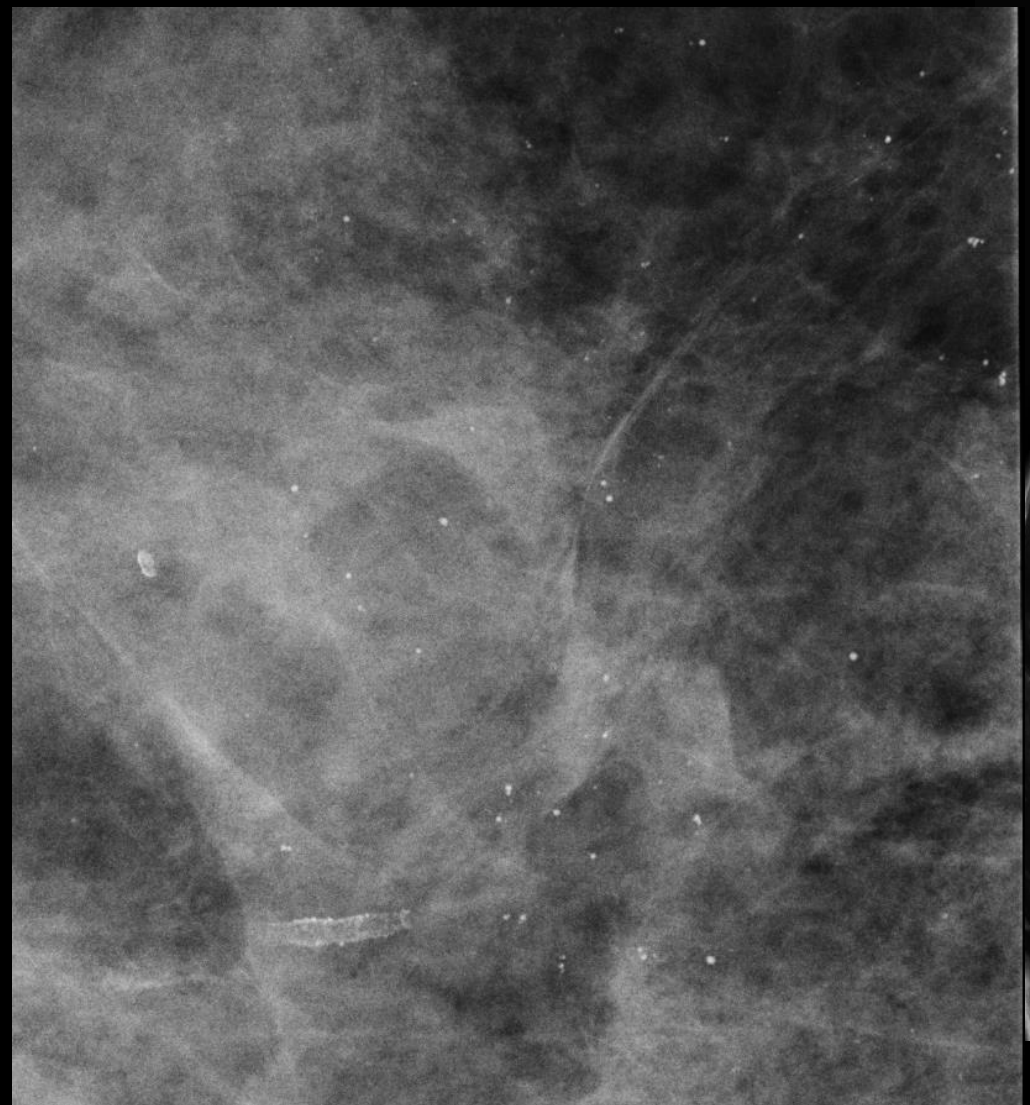


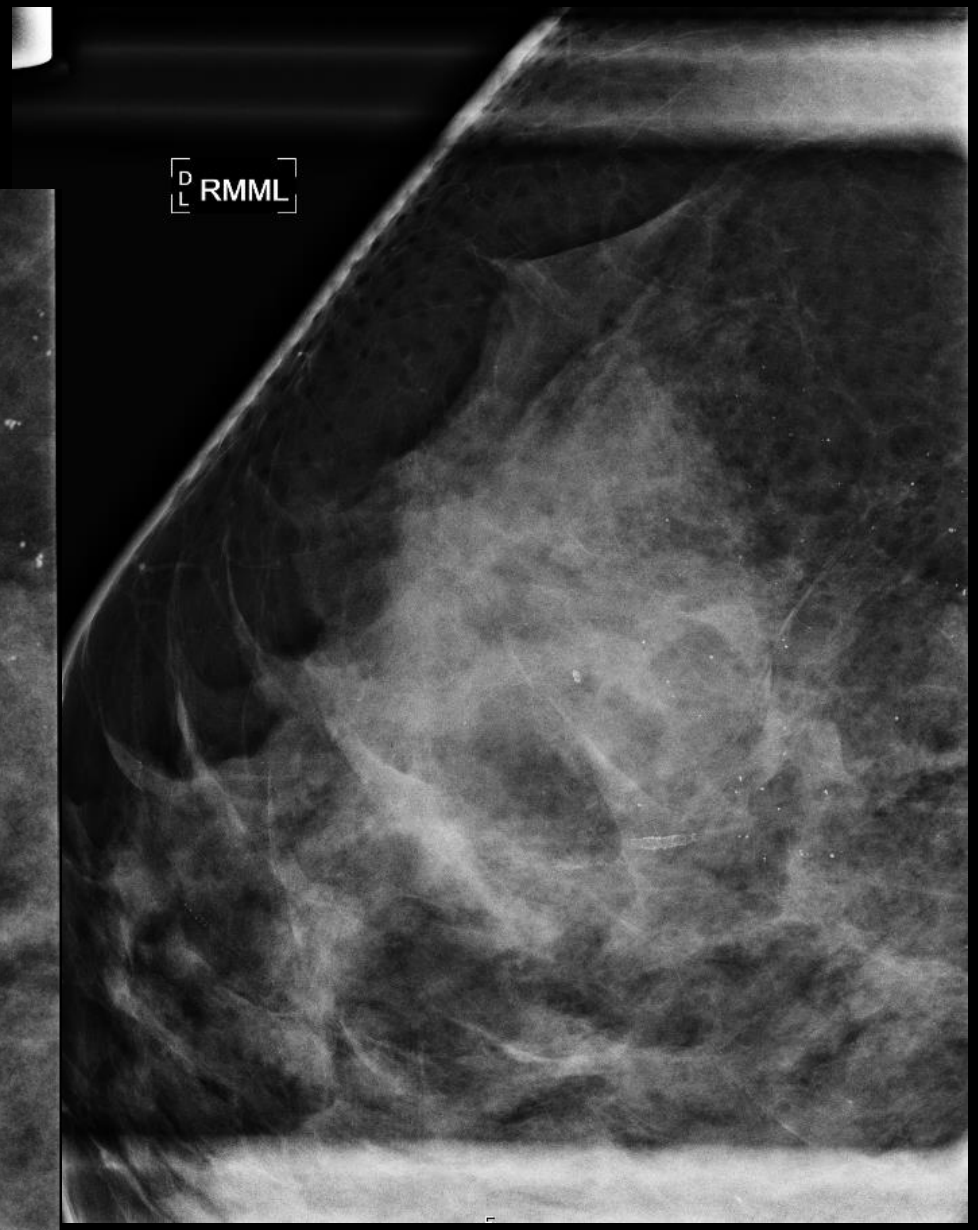
Dystrophic calcifications at lumpectomy site

Round Calcifications

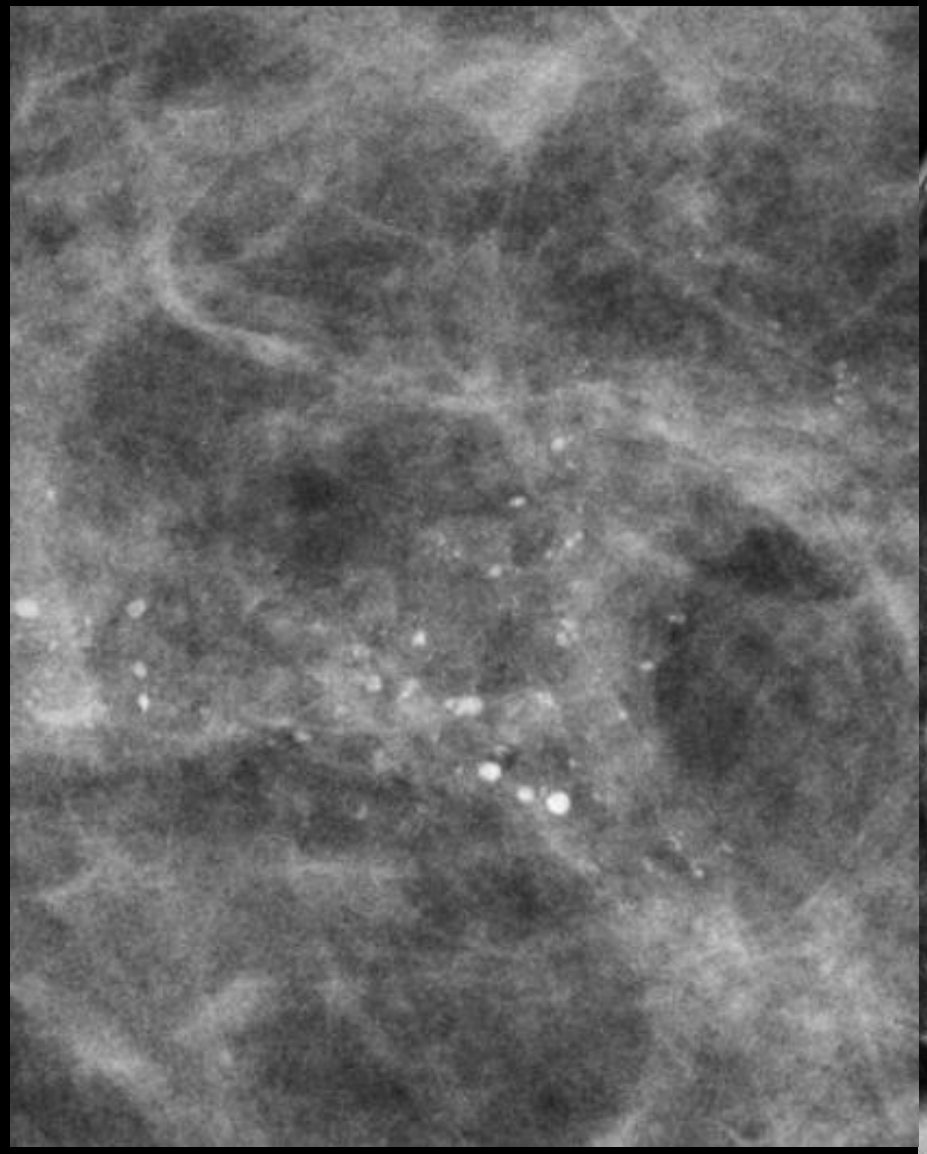
- May vary in size when multiple, considered benign when diffuse, when <1mm frequently formed in the acini of lobules
- When smaller than 0.5mm punctate is used to describe
- An isolated group of punctate calcifications may require closer surveillance
  - Probably benign assessment (BIRADS III) and mammo surveillance if no priors to compare
  - Image guided biopsy if new, increasing, linear, segmental

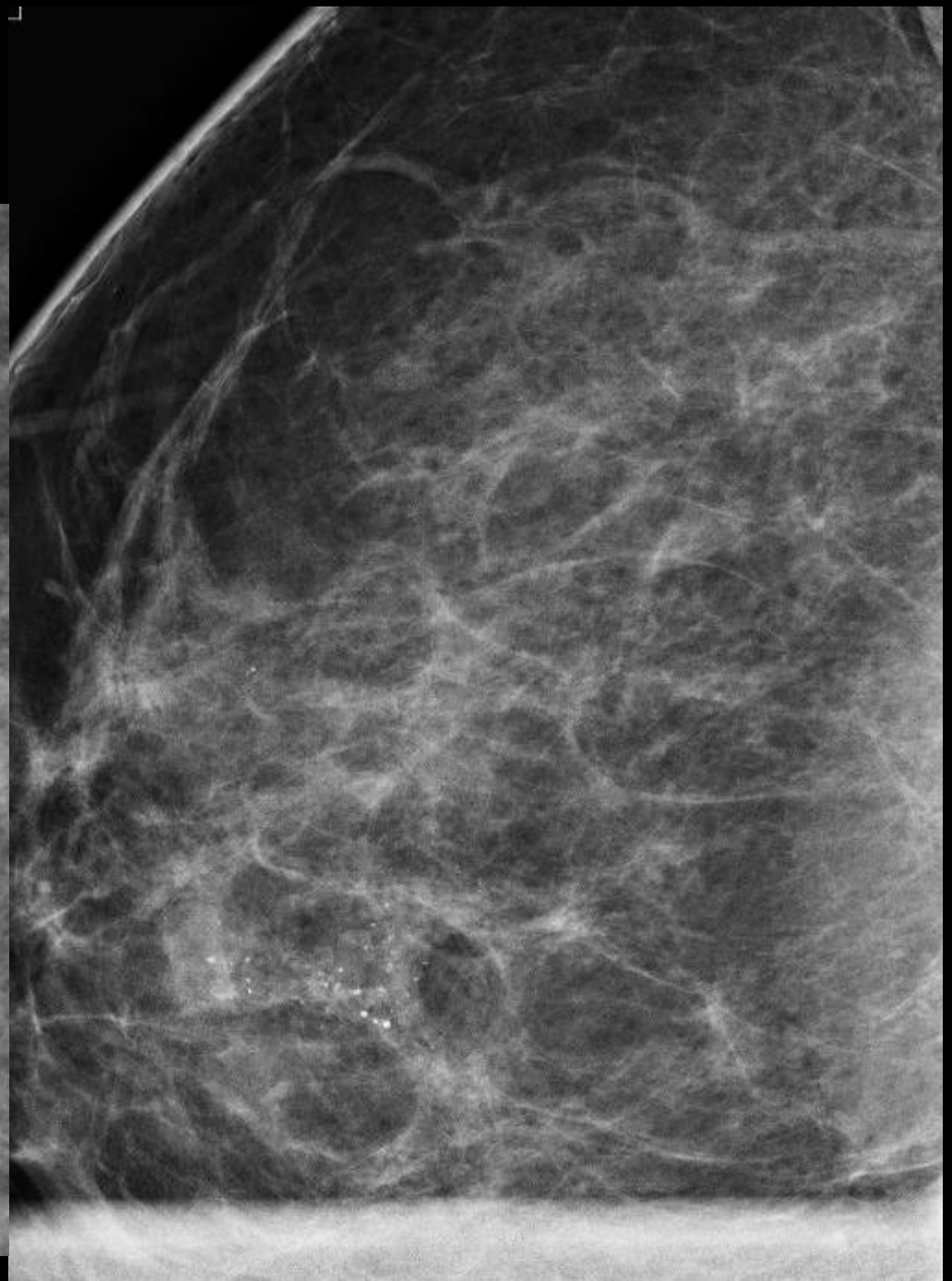
Round regional-benign





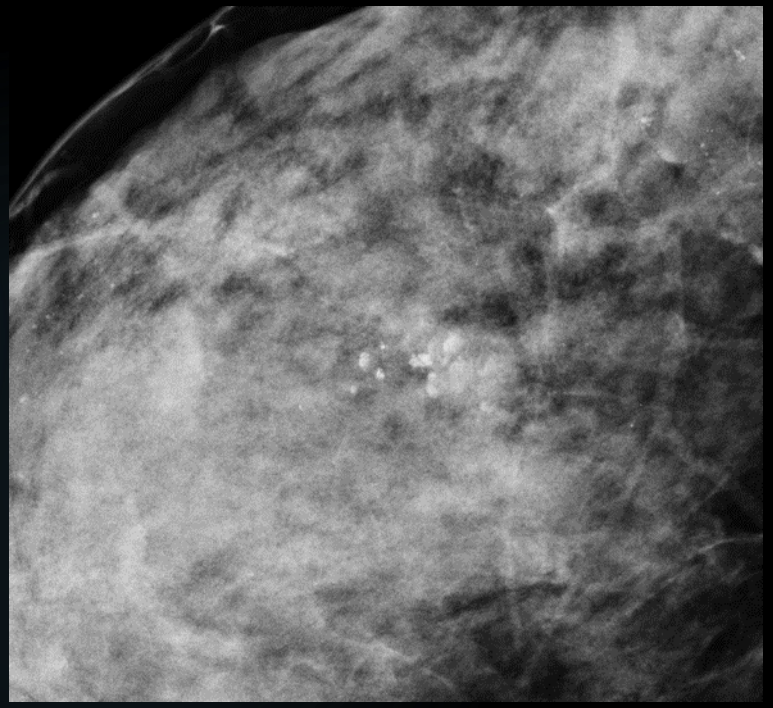
Punctate and round calcifications-FCC





Milk of Calcium

- Sedimented calcifications in cysts- usually grouped
- Change in shape on different mammography views
- Often less evident and appear indistinct on CC view



CC

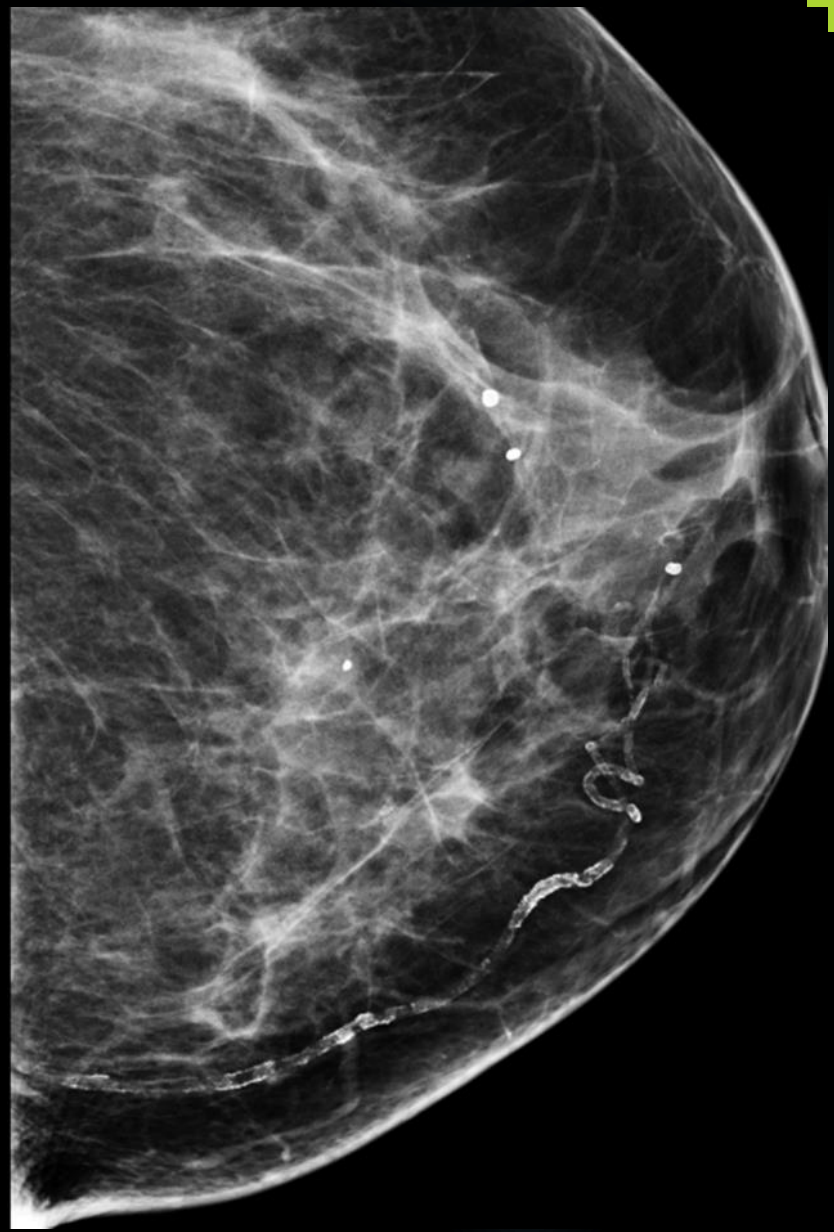
MLO

Milk of Calcium

- On the 90 lateral view
- More clearly defined
- Have crescent shaped, curvilinear, semilunar or linear appearance

Vascular Calcifications

- Parallel tracks or linear tubular calcifications
- Most often easy to identify, however if questionable, additional spot-compression and spot mag views may be needed to further characterize



Rim Calcifications

- Thin benign calcifications that appear as calcium deposited on surface of a sphere
- Benign non-grouped, range from smaller than 1mm to larger than 1cm or more
- Round or oval with smooth surfaces and lucent centers
- Fat necrosis and calcifications in the walls of cysts are most common rim calcs

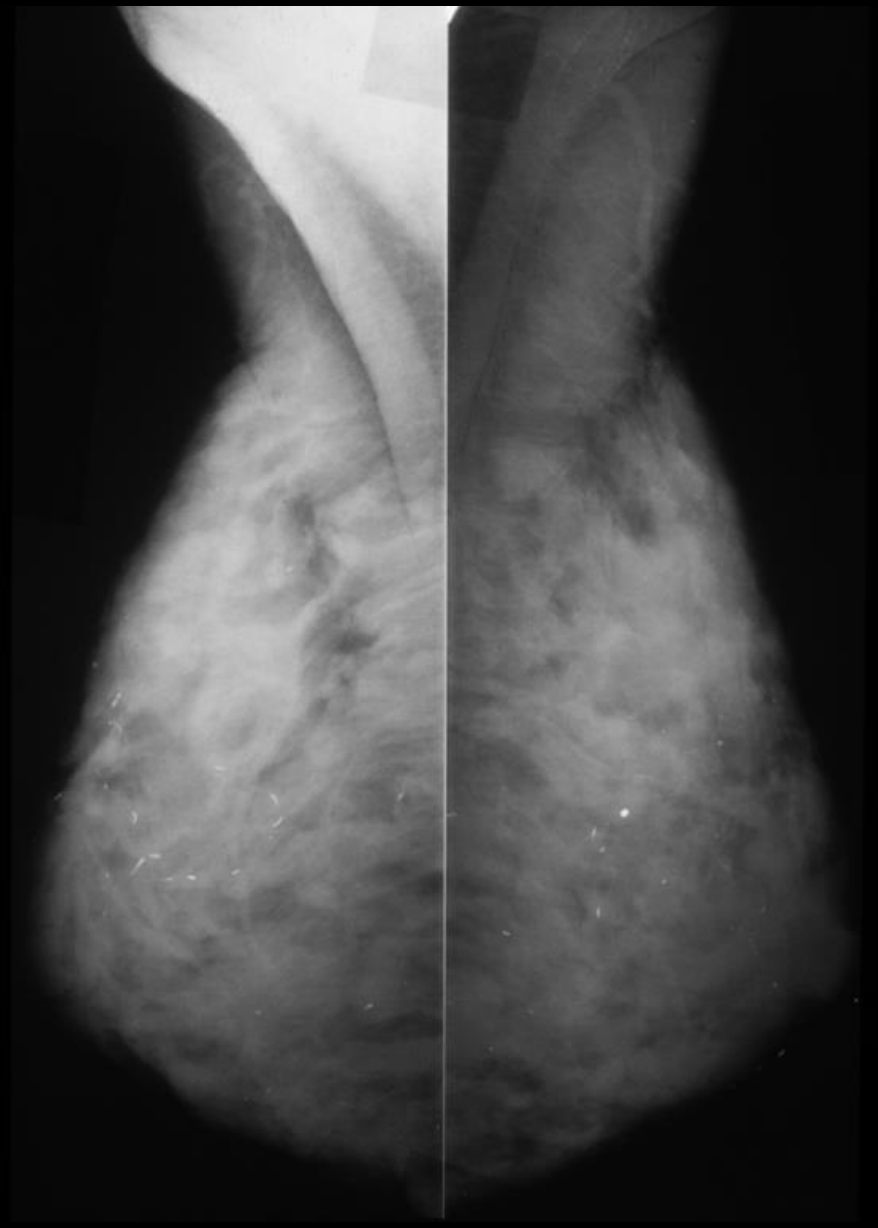
Rim calcifications- calcified oil cysts

Other - Calcifications Due to Pregnancy

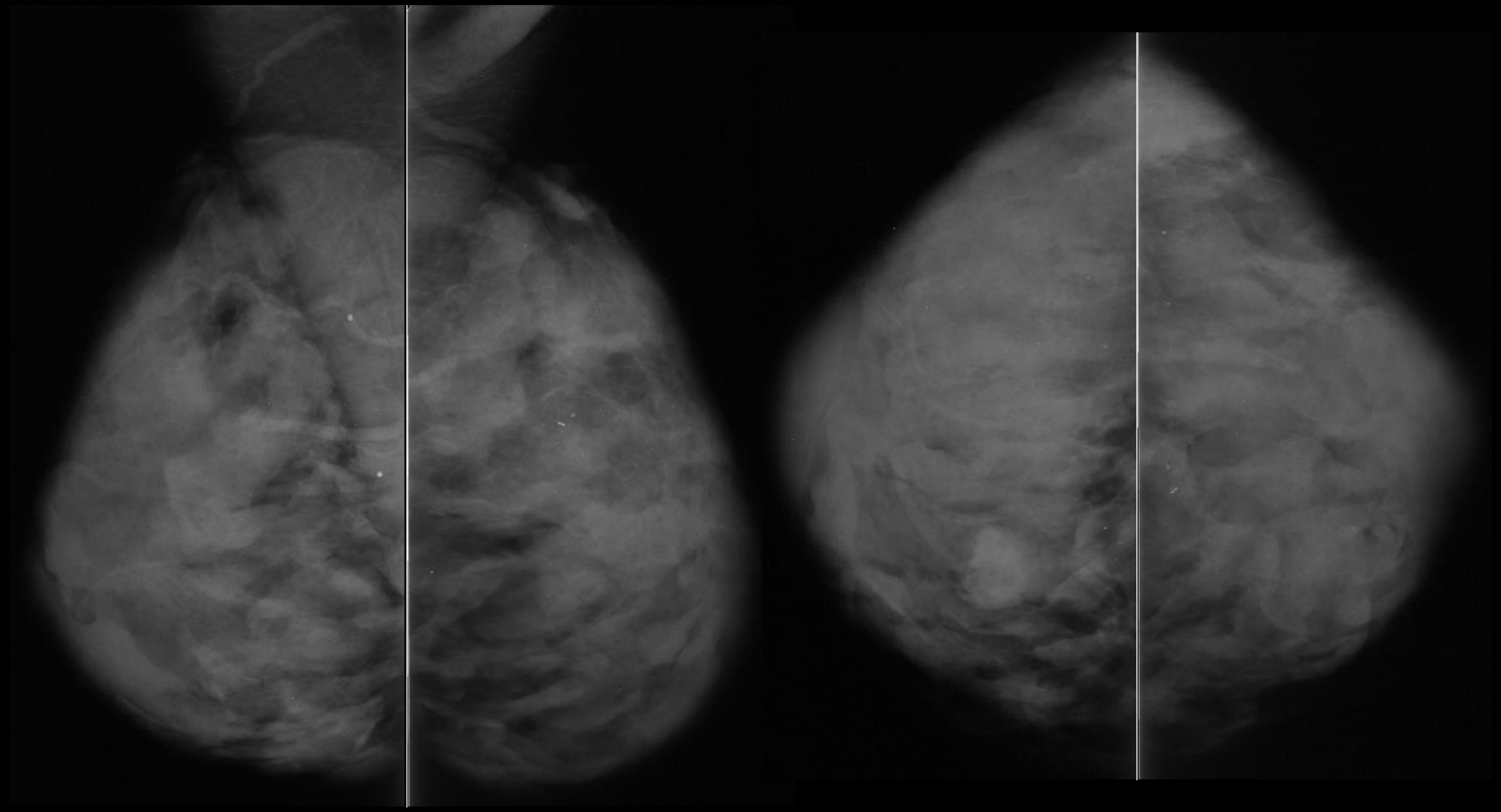
- Pregnancy is associated with changes in calcium metabolism to meet the requirements for fetal growth and for breast-milk production

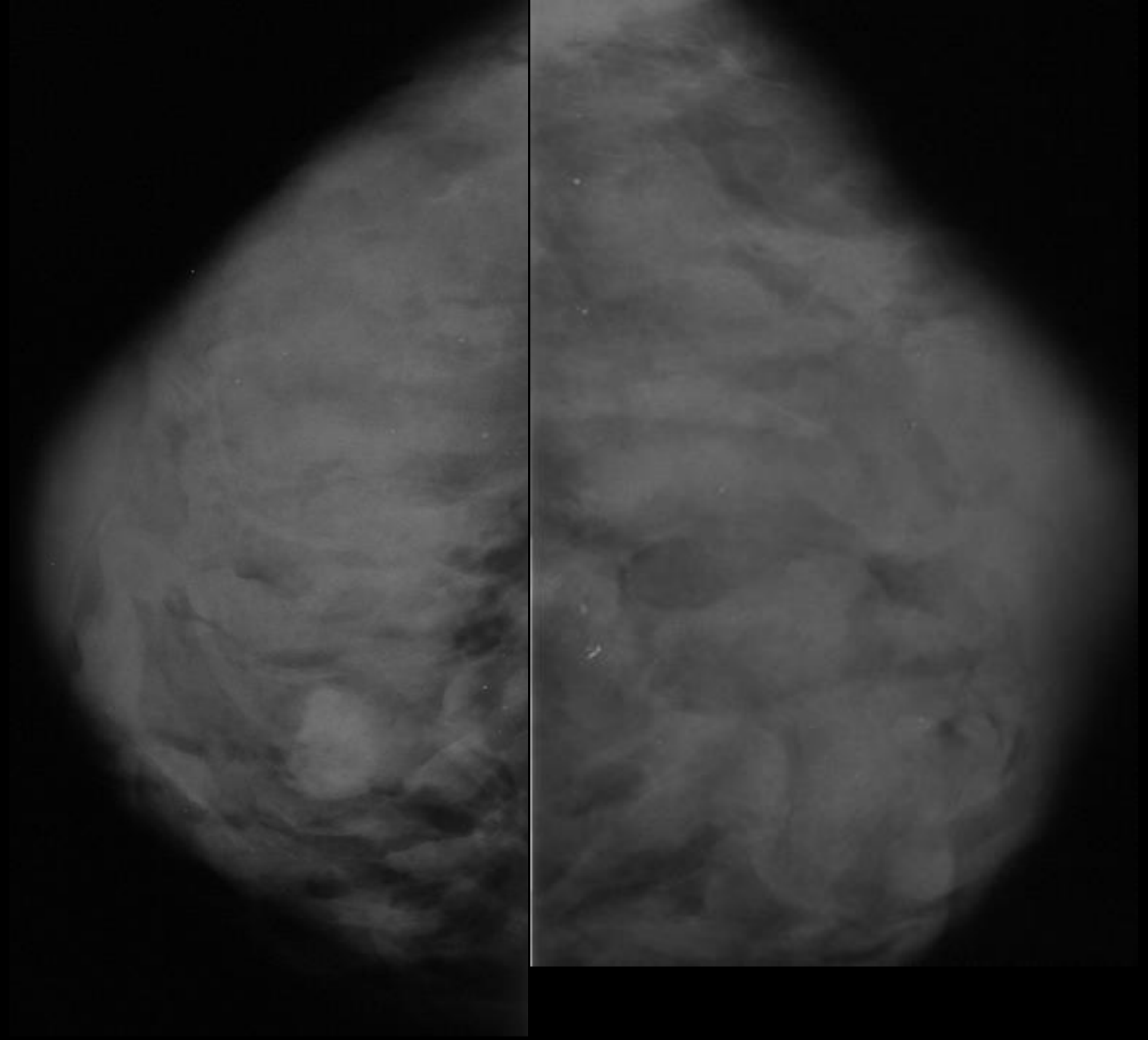
- Hypothesized that when calcium is more available in the breast circulation, as occurs during pregnancy and lactation, vascular smooth muscle cells can become activated and promote mineralization

Vascular calcifications due to pregnancy



38 year old presents for evaluation of bilat thickening; pt breastfeeding
Similar bilat calcs





Distributions

- Diffuse
  - Randomly throughout the breast
  - Punctate and amorphous diffuse/scattered usually benign and bilateral

- Regional
  - Scattered in large volume, greater than 2 cm
    - May involve most of a quadrant or more than single quadrant (leading to malignancy being less likely)

Distributions

- Grouped
  - At least five calcifications in a small volume of tissue no greater than 2 cm
- Linear
  - In a line formation
  - Can raise suspicion for malignancy as appears to be in a duct
- Segmental
  - Worrisome- raise suspicion for punctate and amorphous calcifications
  - Suggest in a duct
  - Branches raise possibility of extensive or multifocal cancer

Calcifications of Moderate Suspicion: BI-RADS 4B

- Amorphous Calcifications
- Coarse Heterogeneous Calcifications
- Fine Pleomorphic

Amorphous Calcifications

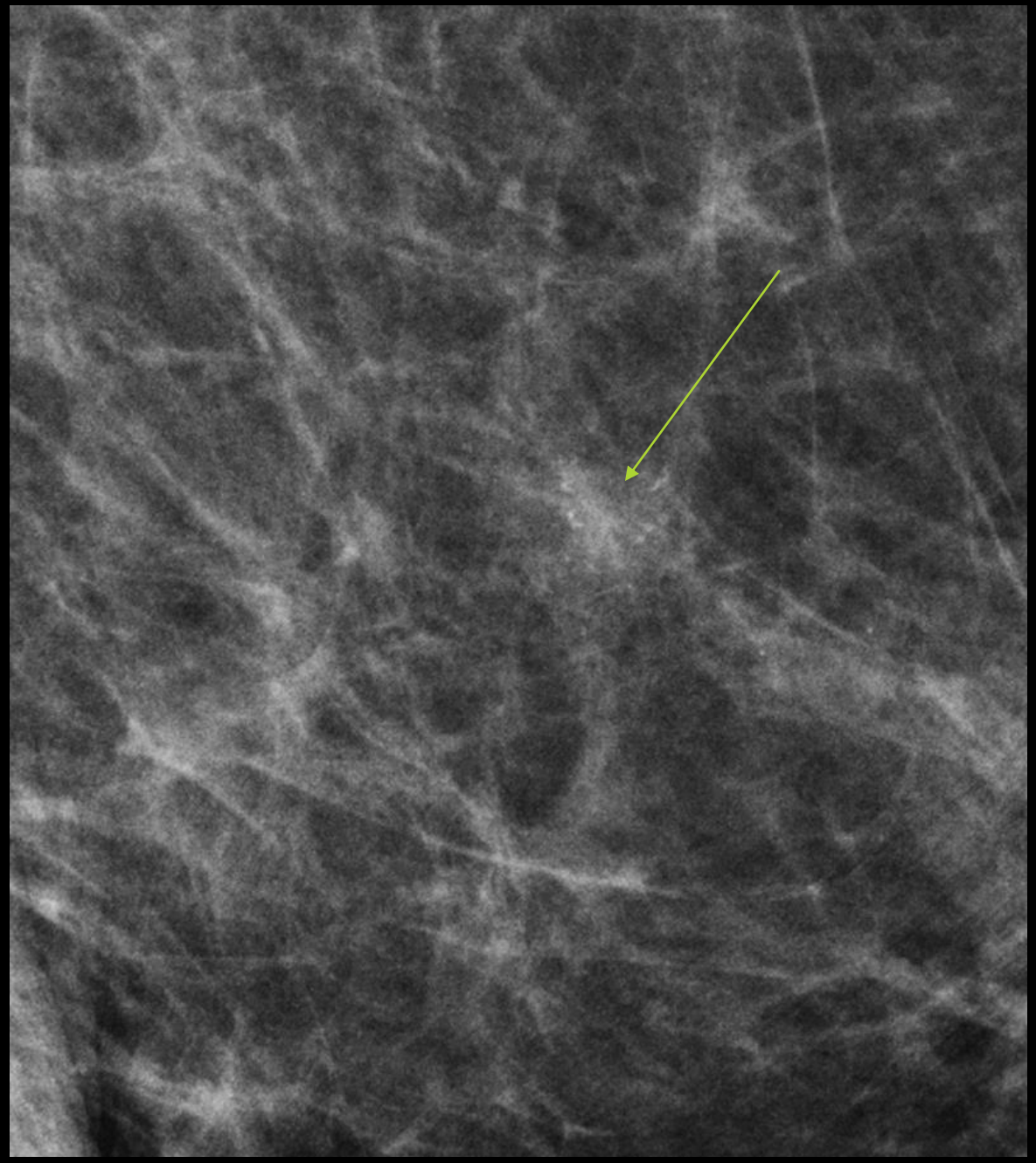
- Small, hazy in appearance, lack well-delineated shape
- Diffuse bilateral amorphous usually benign
  - Baseline magnification views may be helpful
- Grouped, regional, linear or segmental distribution more suspicious
  - Generally warrant biopsy

Amorphous Calcifications

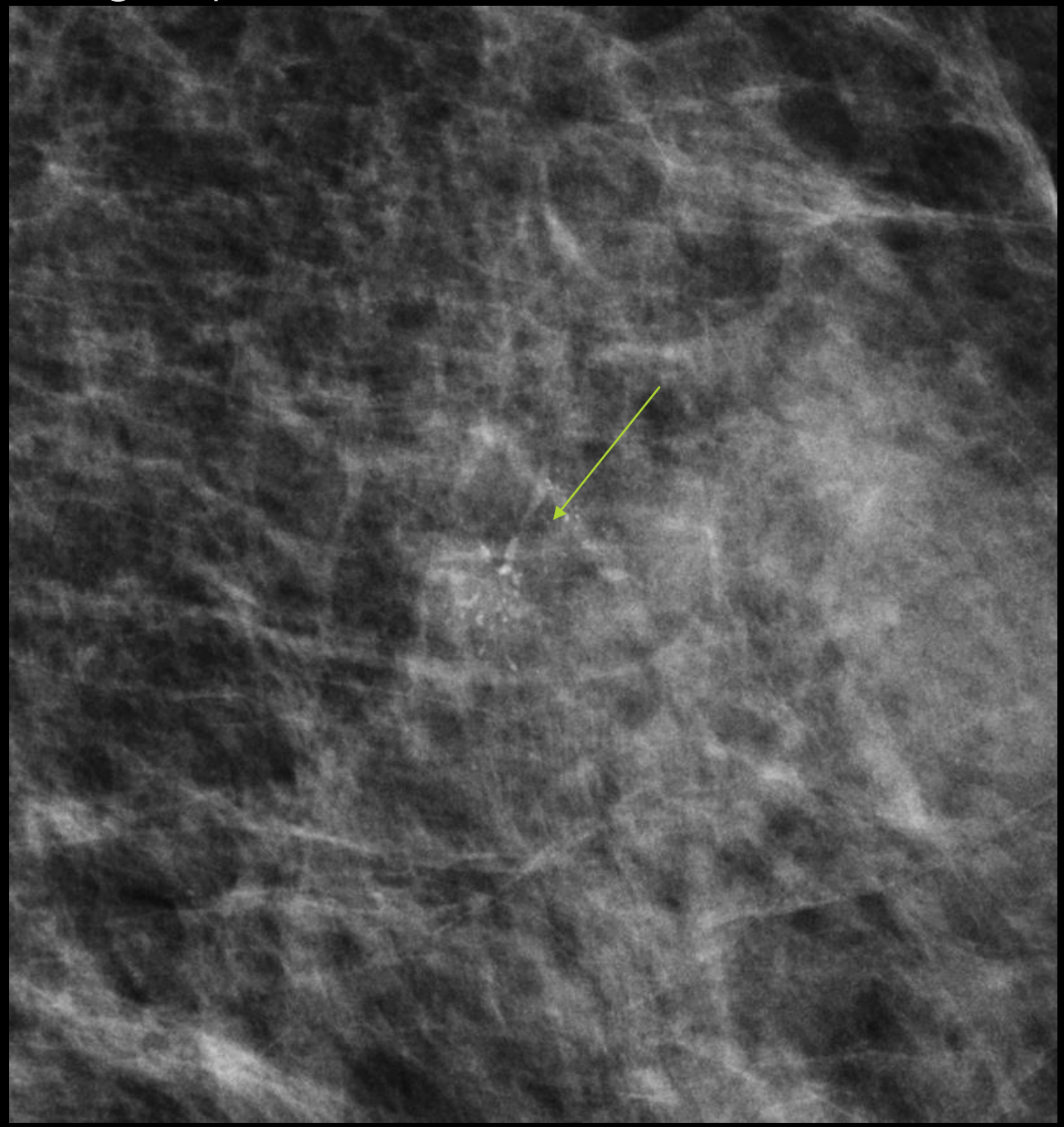
- Previous Studies have shown an avg of 20% are associated with low grade DCIS or IDC
- An additional 20% are associated with high-risk lesions (ADH or ALH) (Chen)
- A recent study by Oligane, et al. retrospectively studied 497 amorphous calcification lesions to see if biopsy of these are still necessary
  - Malignancy rate of 10.5% (52/497)
  - 29% (144/497) were high-risk, with 7 lesions upgrading to malignancy on excision.
- Malignancy rate supports biopsy of these lesions

Chen, et al: Segmental Breast Calcifications. AJR 2012; 199: W532-W542.
Oligane, H. C., Berg, W. A., Bandos, A. I., Chen, S. S., Sohrabi, S., Anello, M., & Zuley, M. L. (2018). Grouped amorphous calcifications at mammography: frequently atypical but rarely associated with aggressive malignancy. *Radiology*, *288*(3), 671-679.

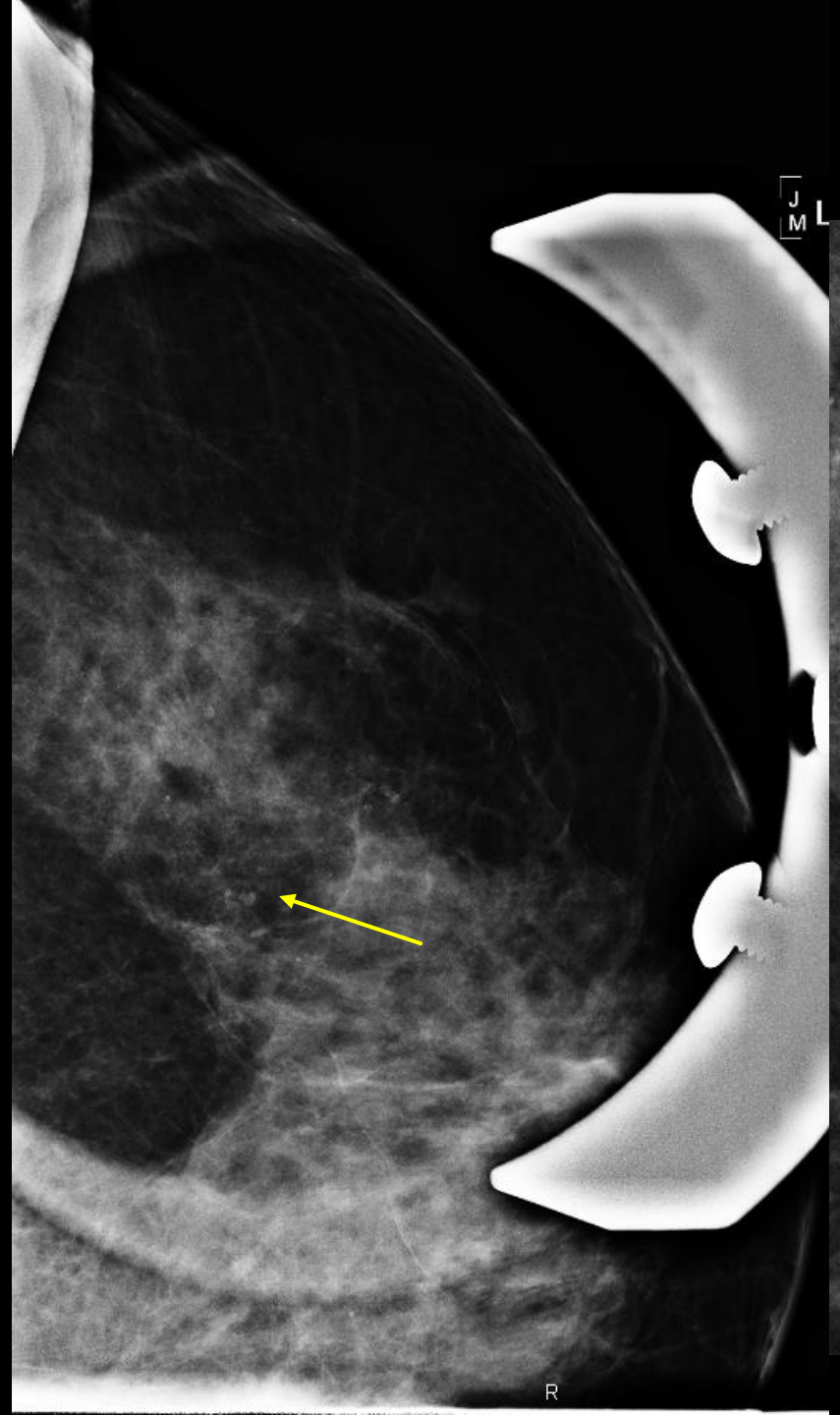
Amorphous group; DCIS

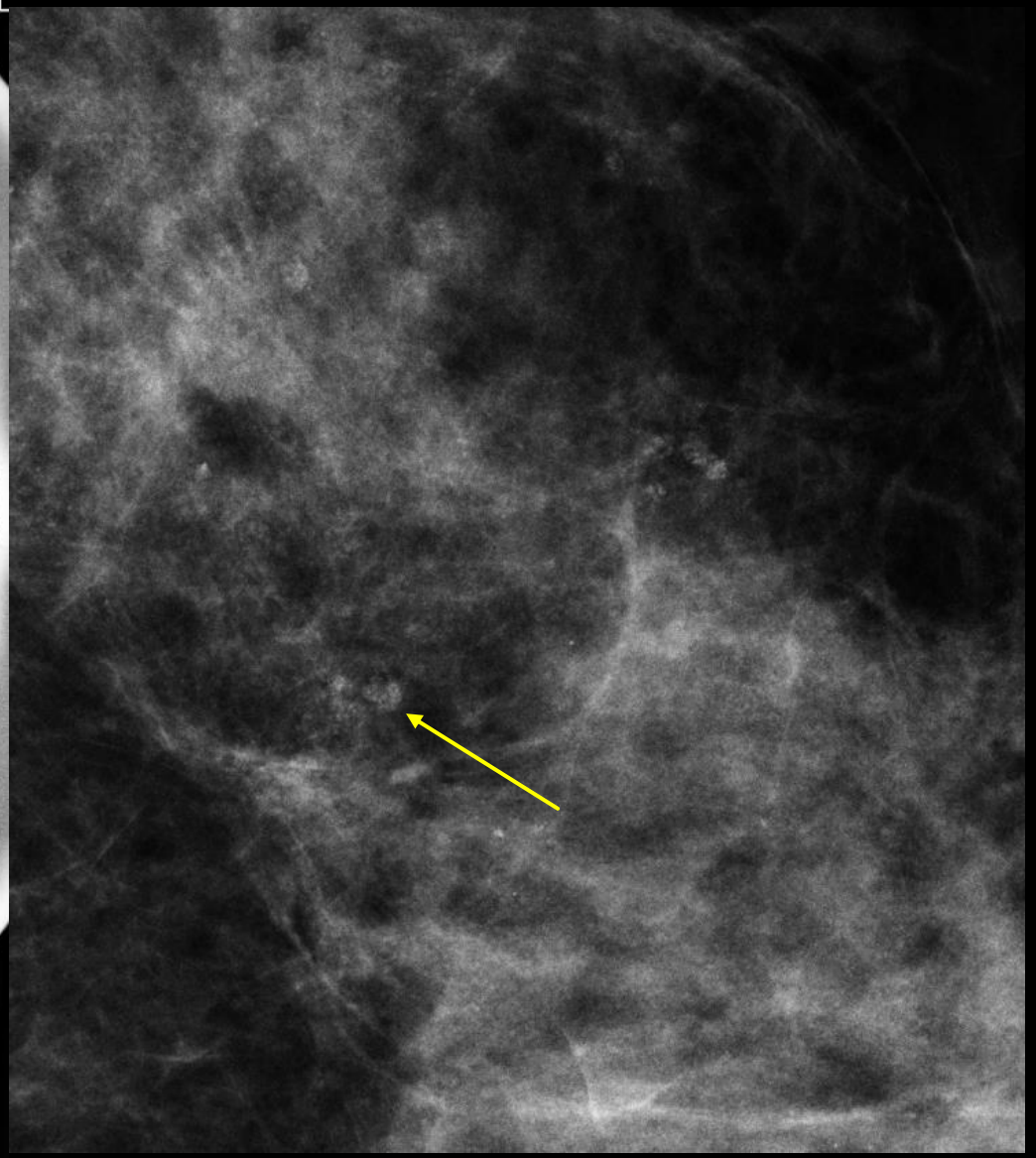


Amorphous group; DCIS

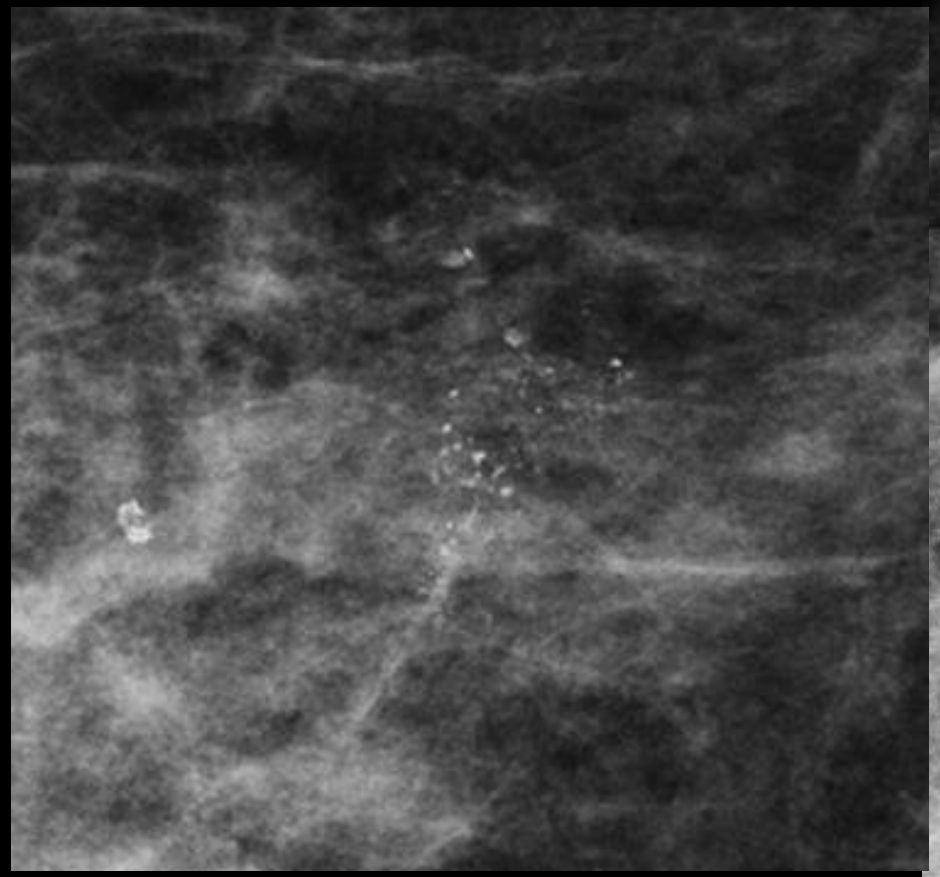


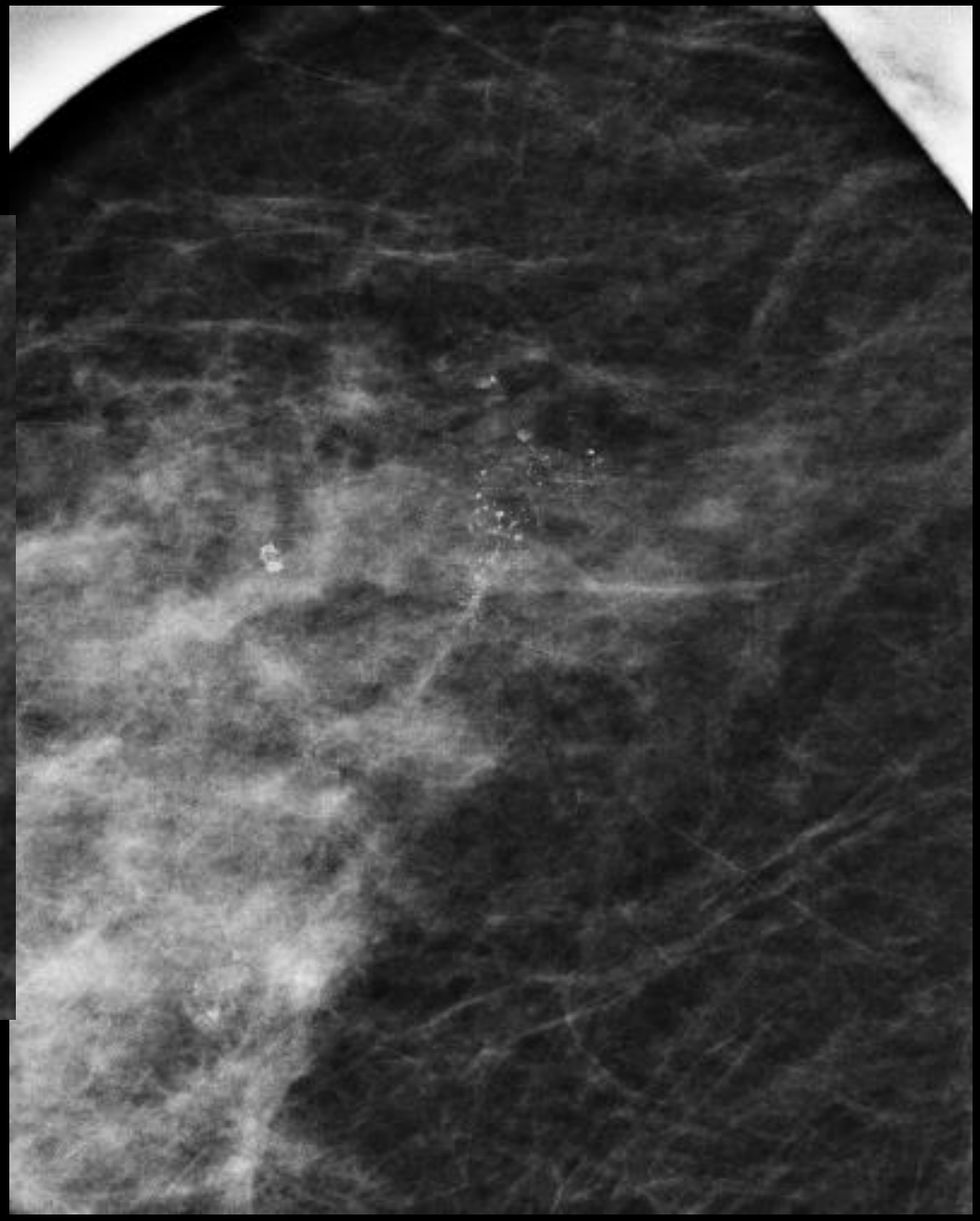
benign-type amorphous calcifications



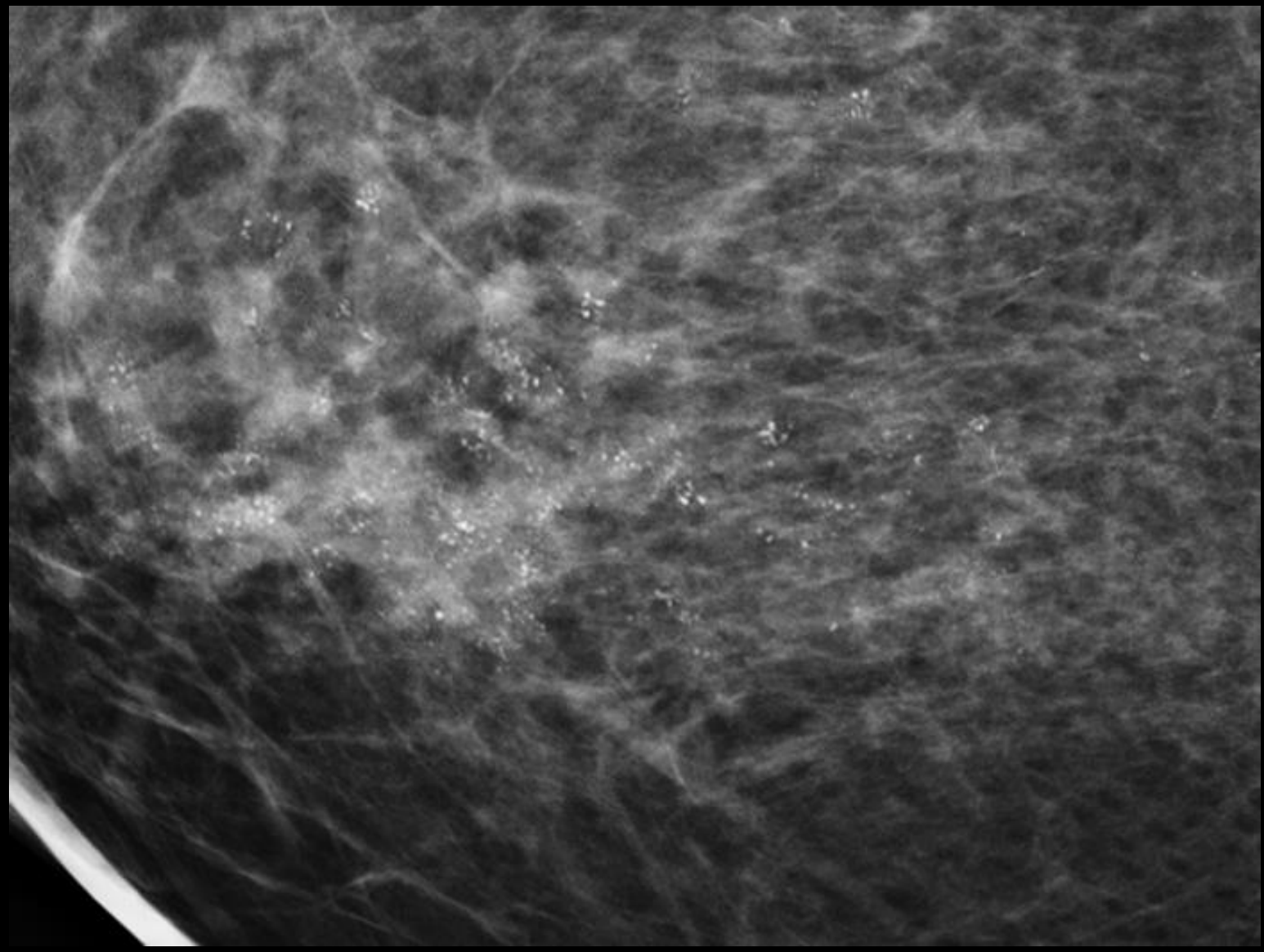


Amorphous grouped calcifications-FCC

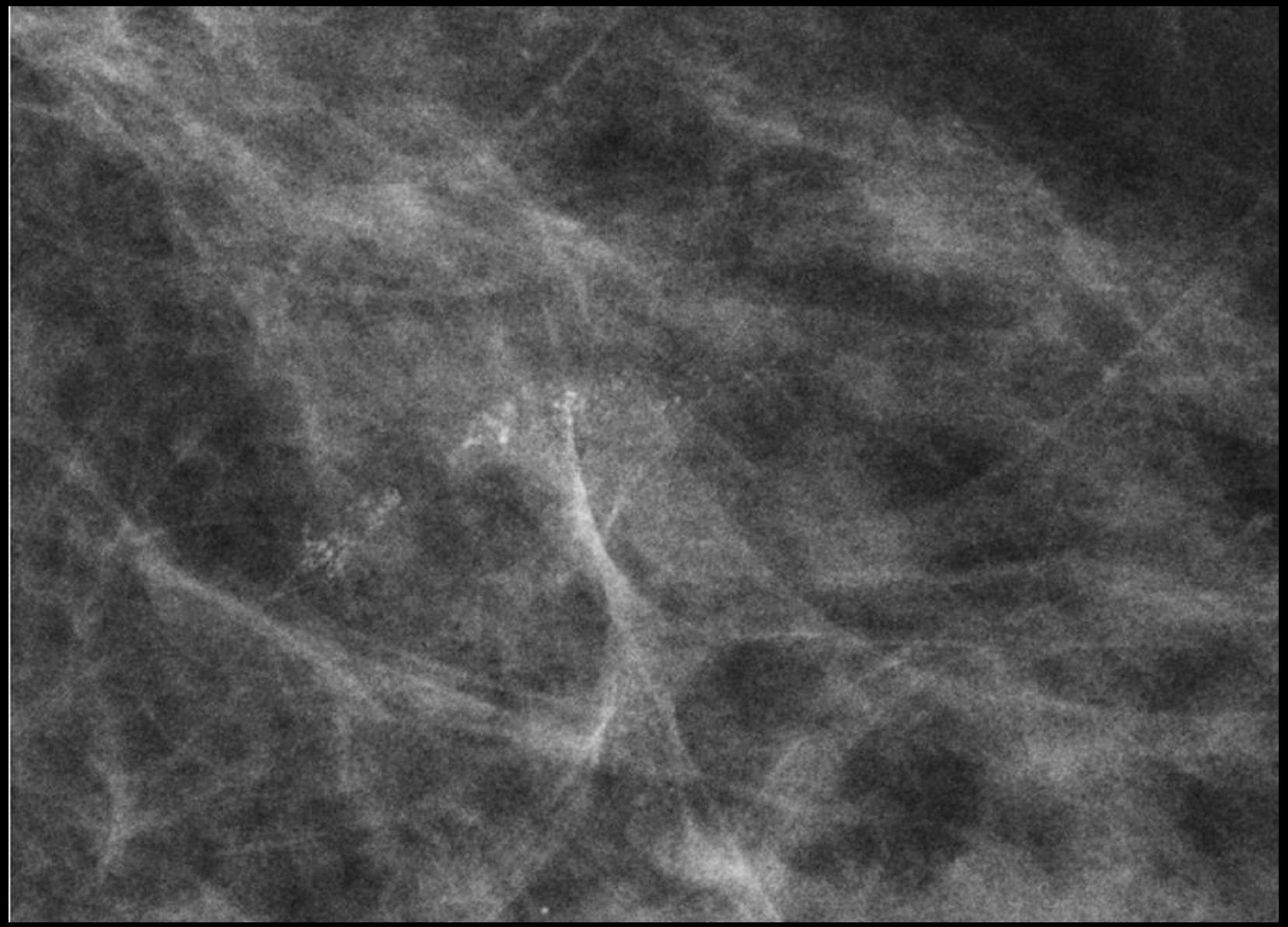




Diffuse amorphous calcifications-DCIS



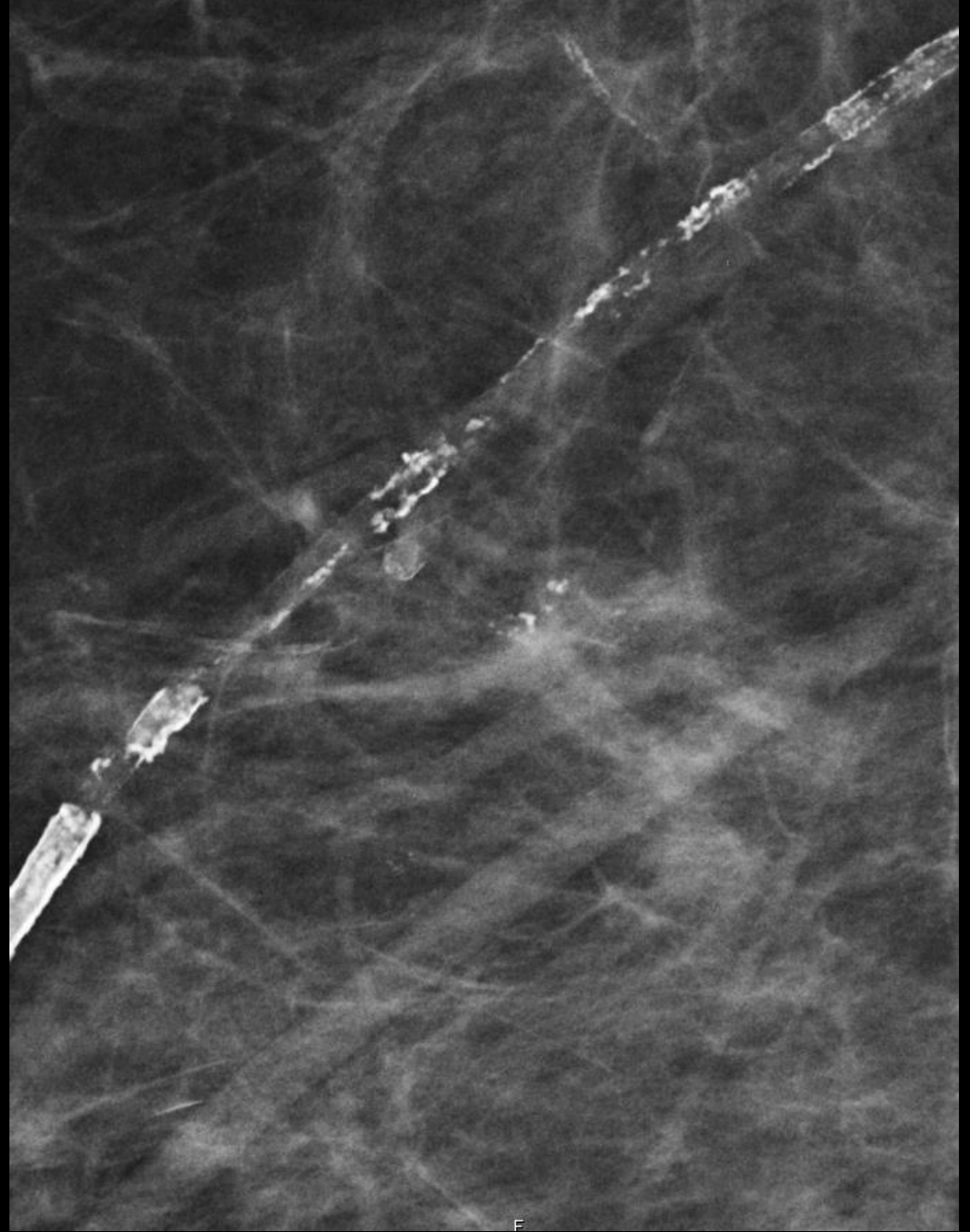
Linear amorphous calcifications-FCC with ductal hyperplasia



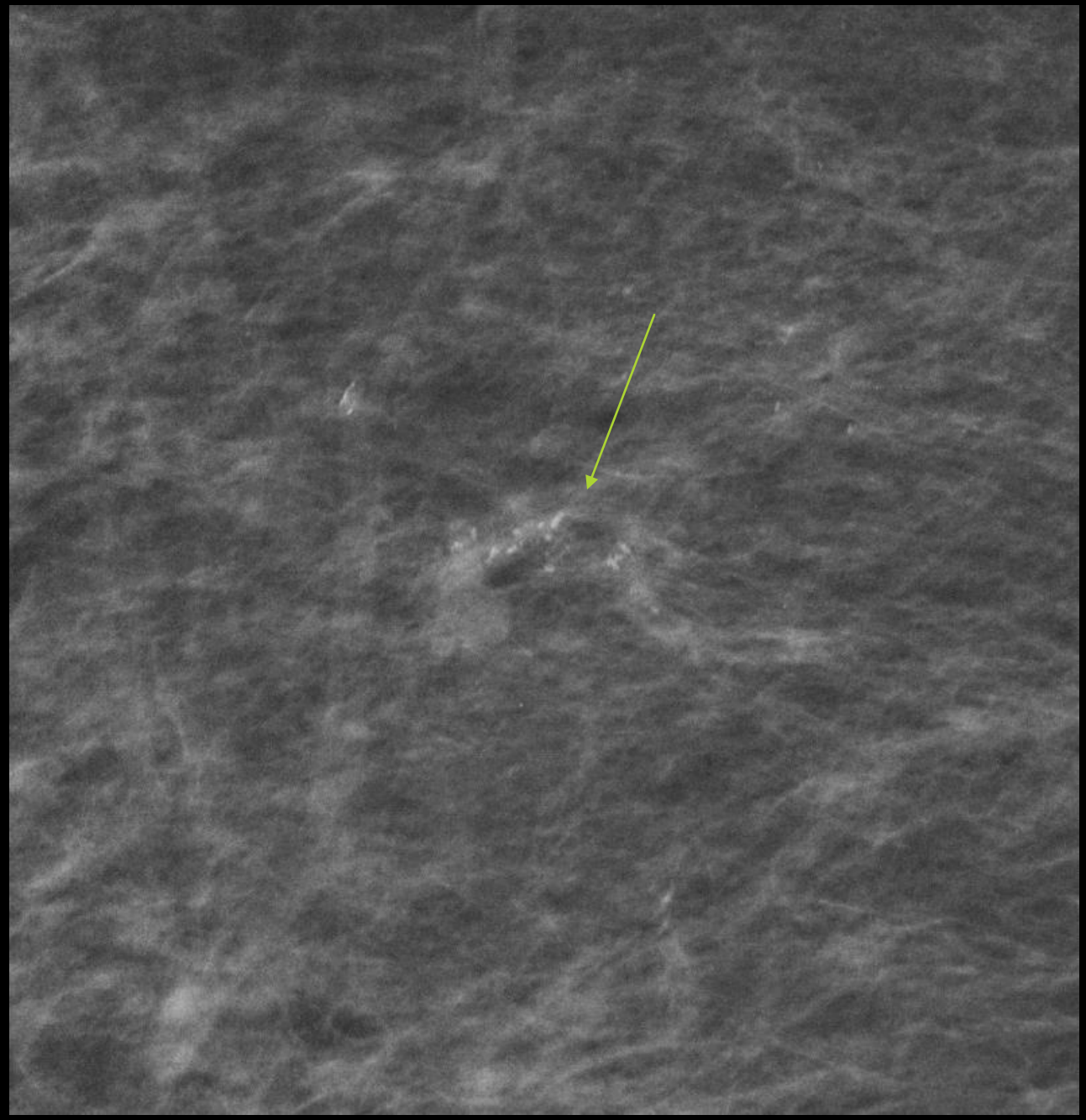
Coarse Heterogeneous

- Describes calcifications of intermediate concern, between 0.5mm and 1mm, and variable in size/shape
- Coarse heterogeneous in multiple bilateral groups are often due to fibrosis or fibroadenomas
  - Typically benign calcifications group
    - Up to 20% of biopsies reveal underlying malignancy
- Coarse heterogeneous in an isolated group more likely to be malignant

Coarse group-benign

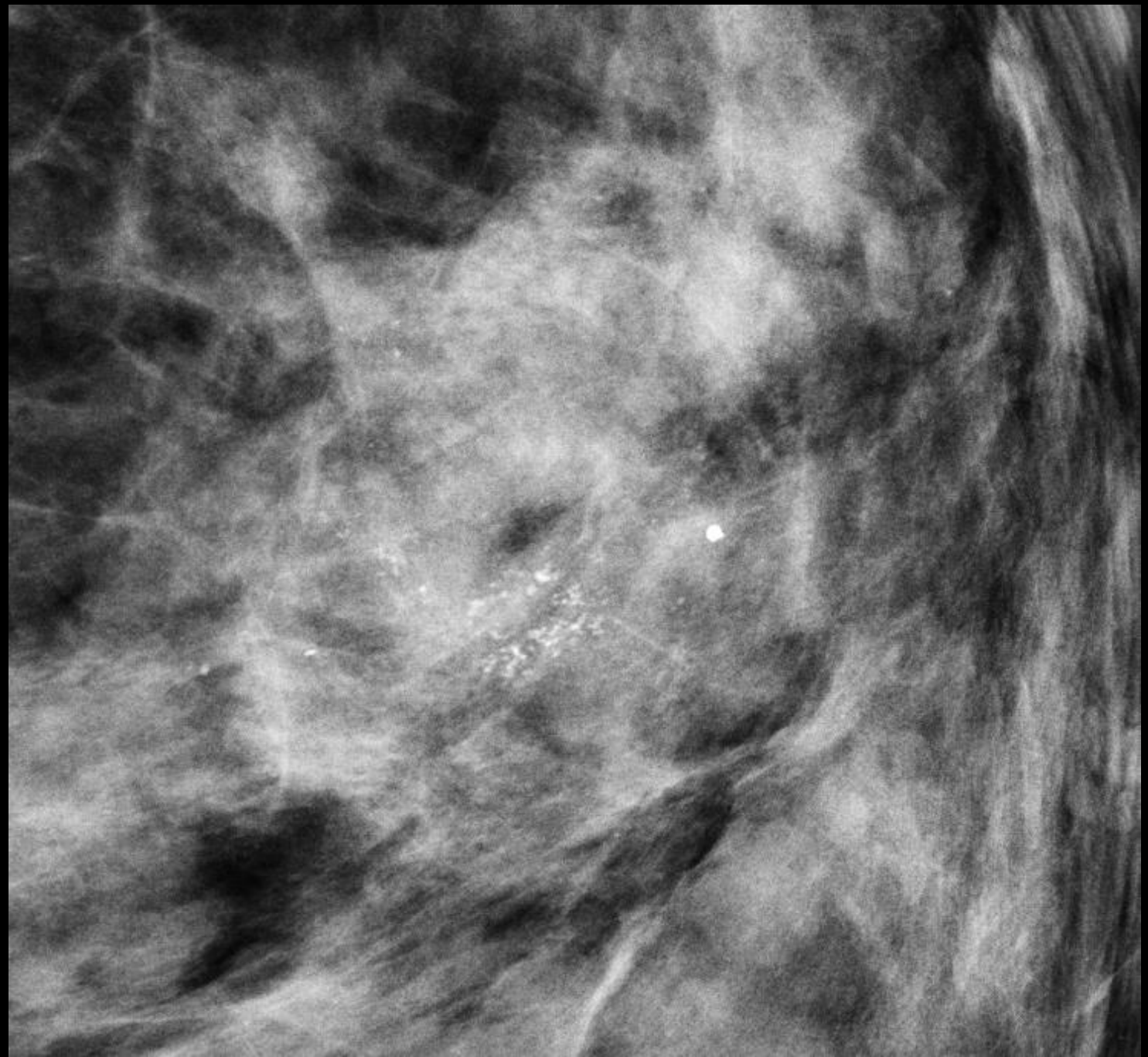


Coarse group-malignant
DCIS comedo type



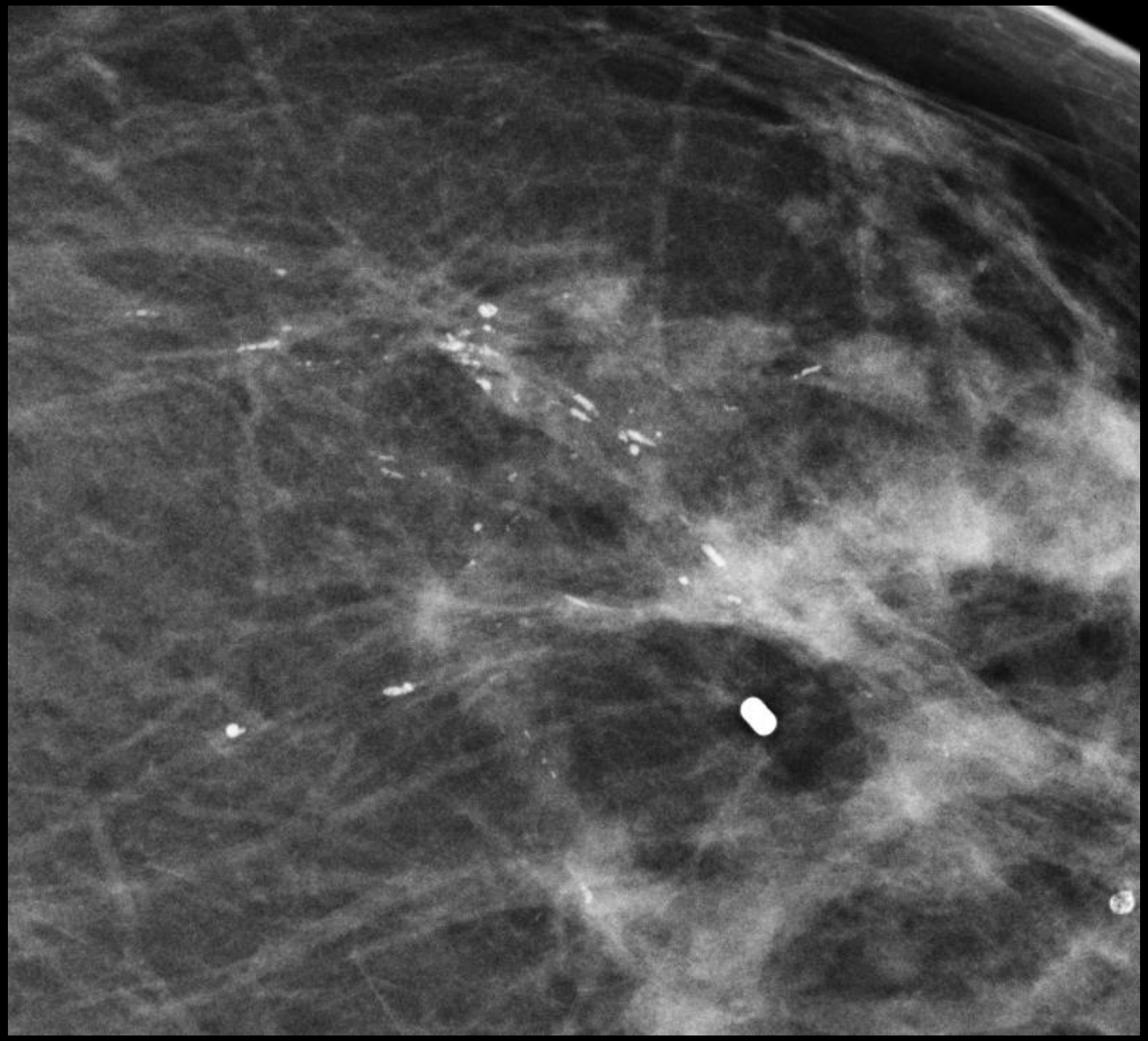
Fine Pleomorphic Calcifications

- Irregular, vary in size and shape
  - Usually smaller than 0.5mm
- More conspicuous than amorphous
  - Have a somewhat higher rate for malignancy(29%) than amorphous or coarse
- Suspicious for DCIS or IDC and require biopsy even if unchanged from prior studies

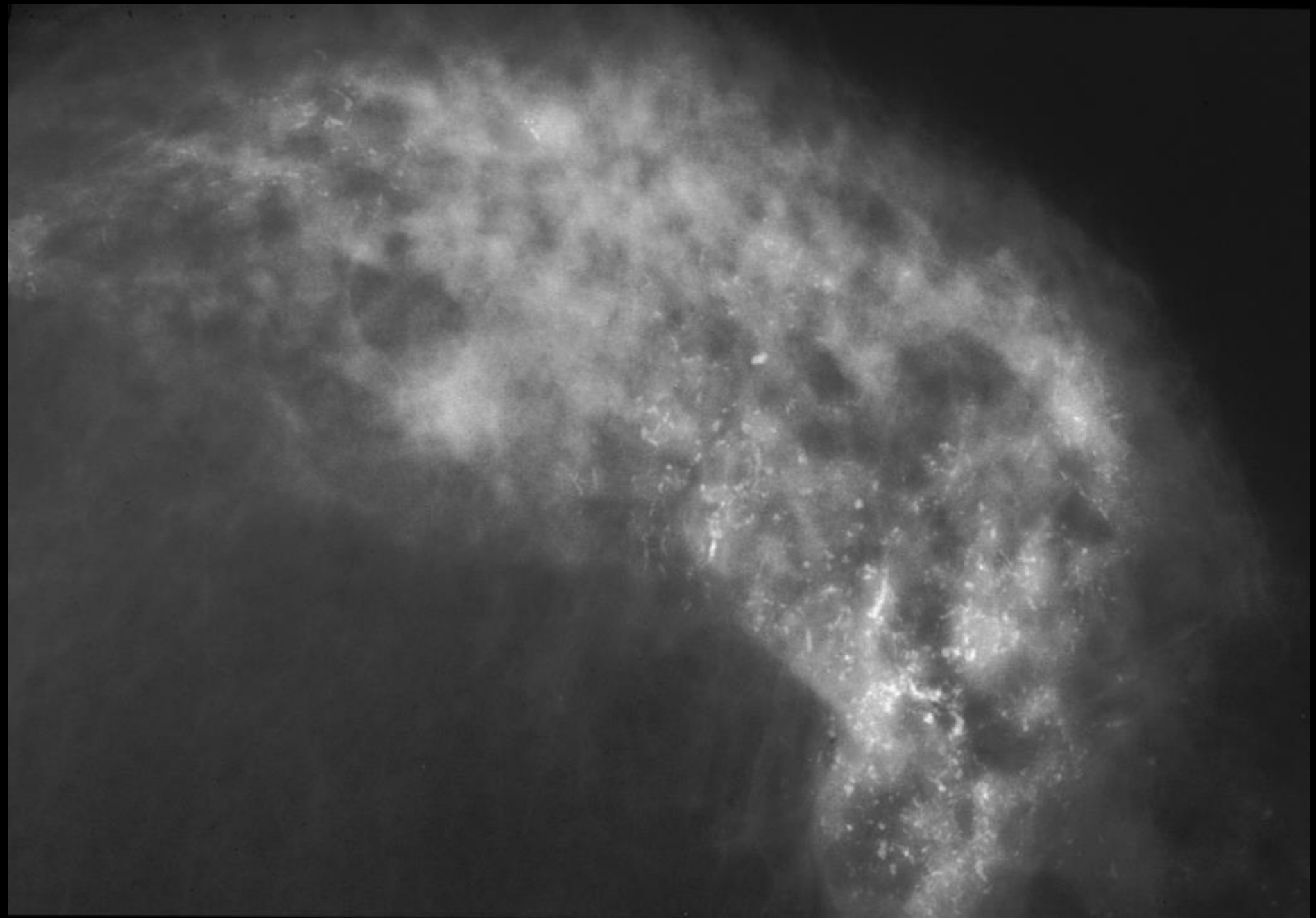


Pleomorphic calcifications; DCIS

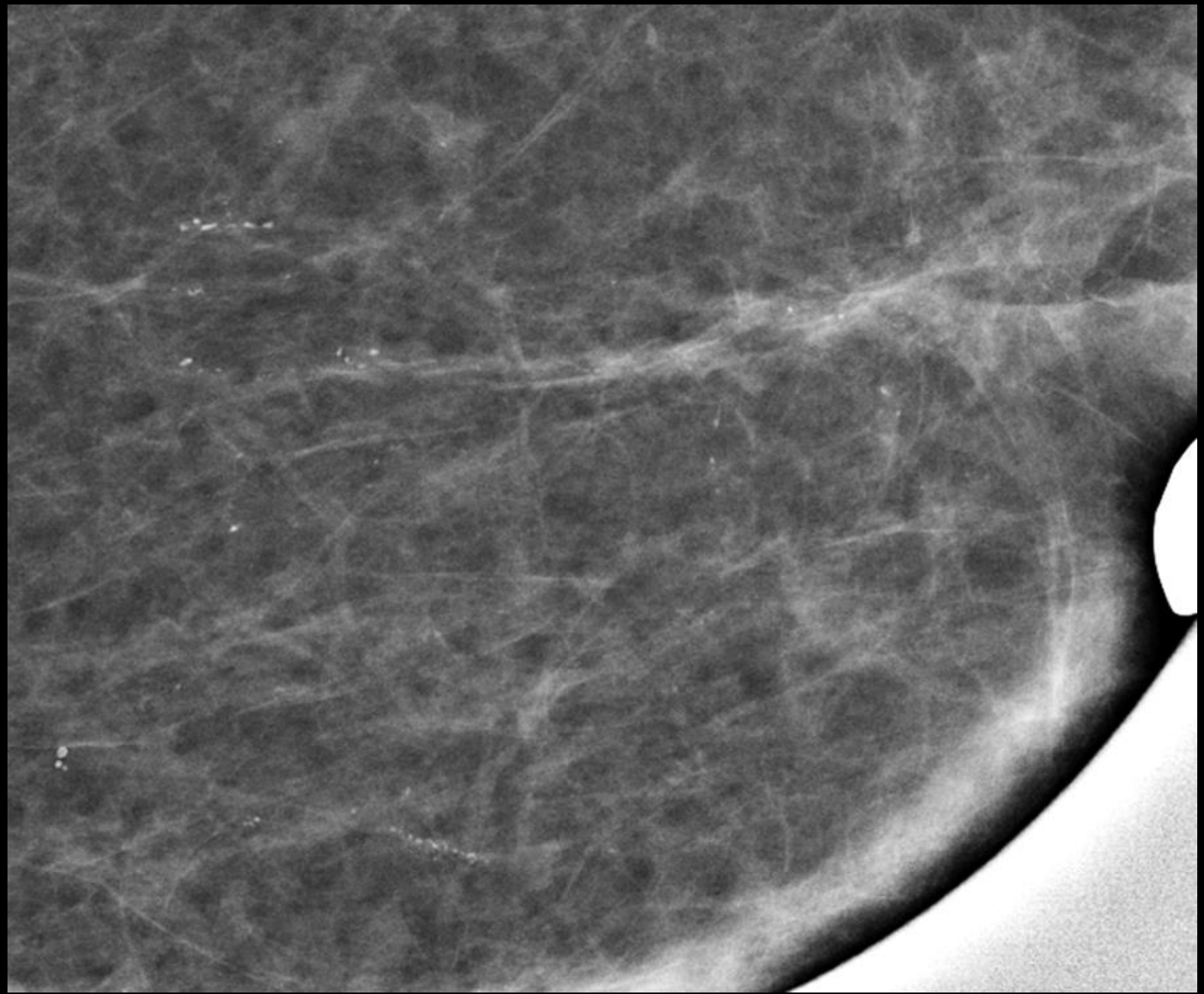
Pleomorphic linear calcifications



Pleomorphic, segmental distribution; DCIS



Pleomorphic linear; DCIS



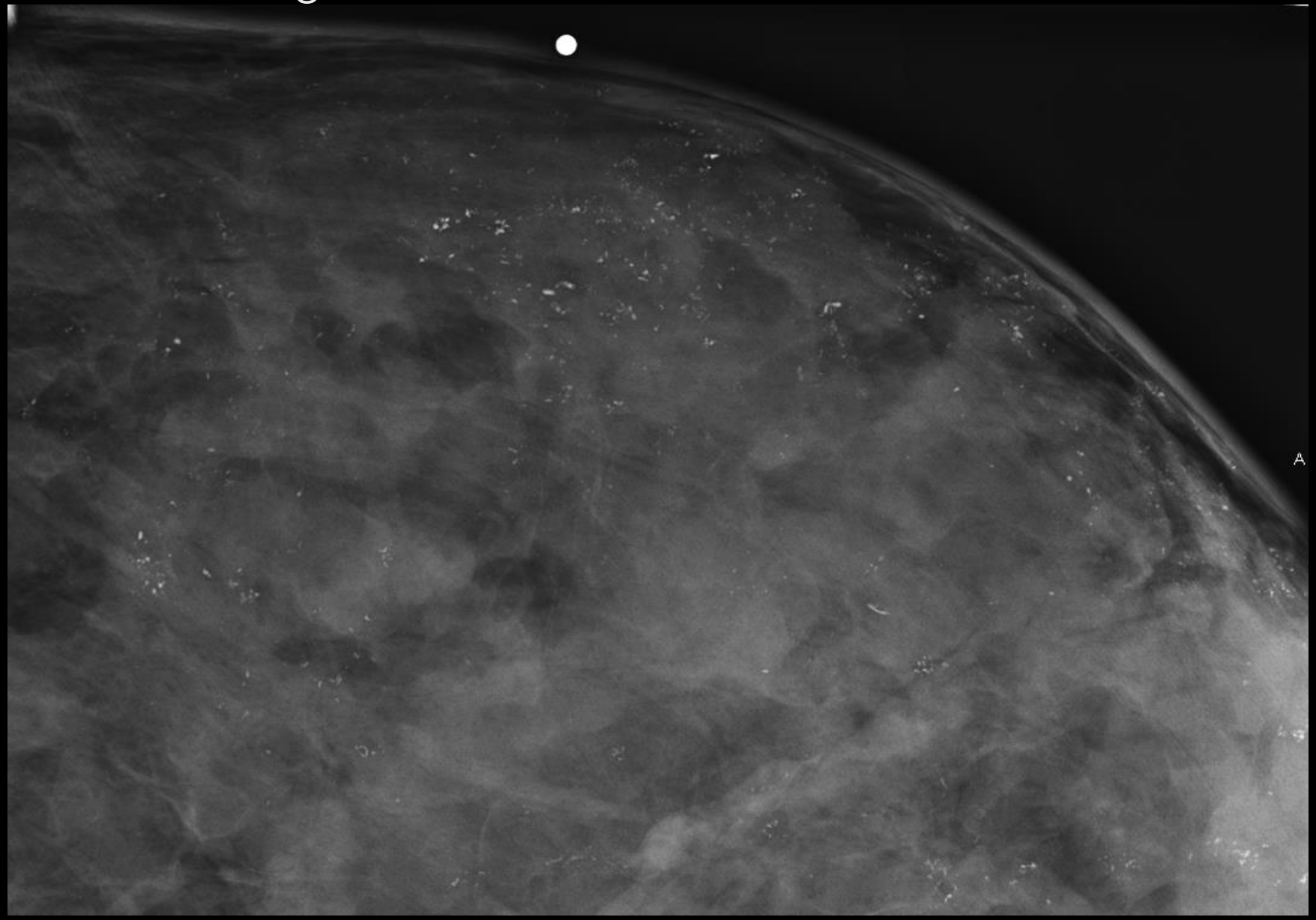
Calcifications of High Suspicion: BI-RADS 4C

- Fine Linear or Fine-Linear Branching Calcifications

Fine Linear and Fine Linear Branching

- Thin, linear, irregular
- Small (<0.5mm) discontinuous or dot-dash
- Sometimes branching
- May have a Y or V shape
- Highest rate for malignancy (70%)
- Often have segmental ductal distribution
  - New Fine Linear or Fine-linear Branching Calcifications appearing in a segmental distribution are highly suggestive of malignancy: **BI-RADS 5**

Linear, branching; Invasive ductal carcinoma



Problem Solving: Indeterminate Calcifications

- Spot Compression, spot magnification views
  - Involved breast- calcifications and glandular tissue
  - Opposite breast- similar calcifications?
- History: Previous biopsy, injury, infection?
- US: Mass?
- Skin: Artifact, skin lesion?
- Old Films: Calcifications stable? In pre-existing stable tissue?

Problem Solving: Indeterminate Calcifications

- Truly indeterminate- Core Needle Biopsy

Core Biopsy

- Can be used to biopsy both masses and microcalcifications
- Uses mammographic (stereotactic/DBT) or ultrasound guidance to accurately target an abnormality
- Can replace open surgical biopsy in most cases as most biopsies are benign

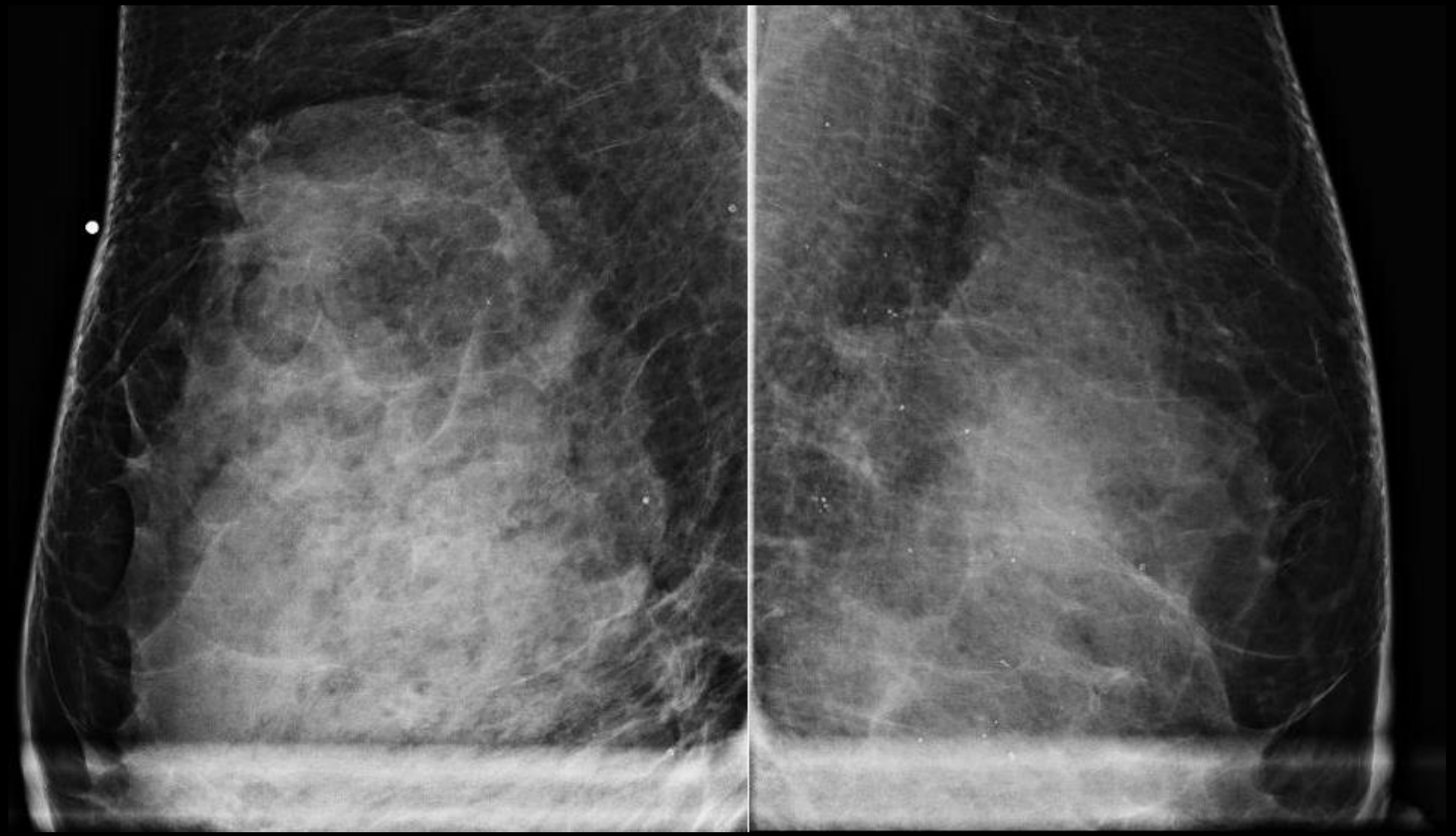
Stereotactic Biopsy/DBT

Prone stereotactic biopsy

Stereotactic Biopsy/DBT

- Upright biopsy
- Attaches to mammography system
- Allows the facility to perform mammograms on the unit when not in use
- Better use of facility space

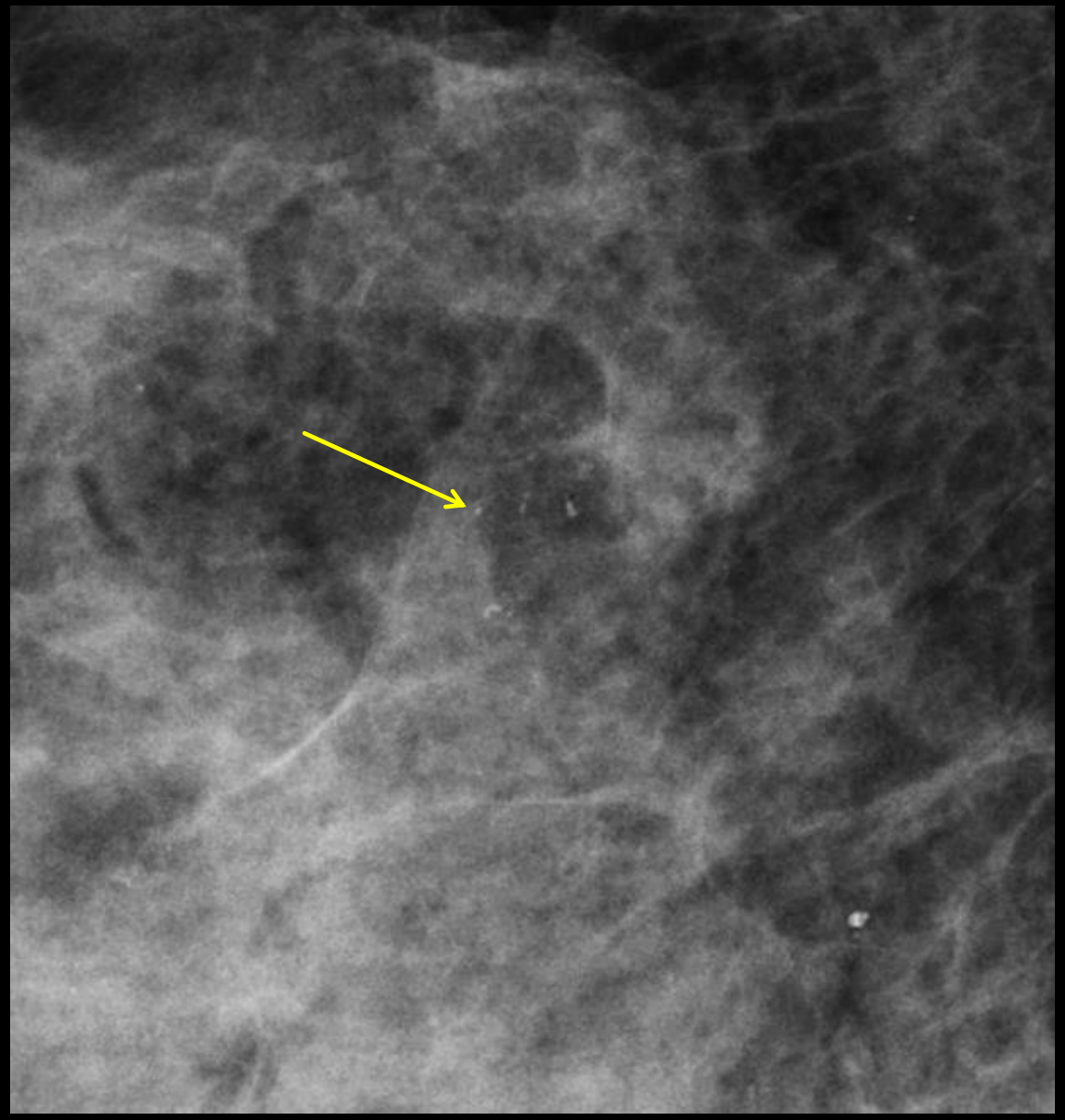
Bilateral magnification views-similar calcifications?



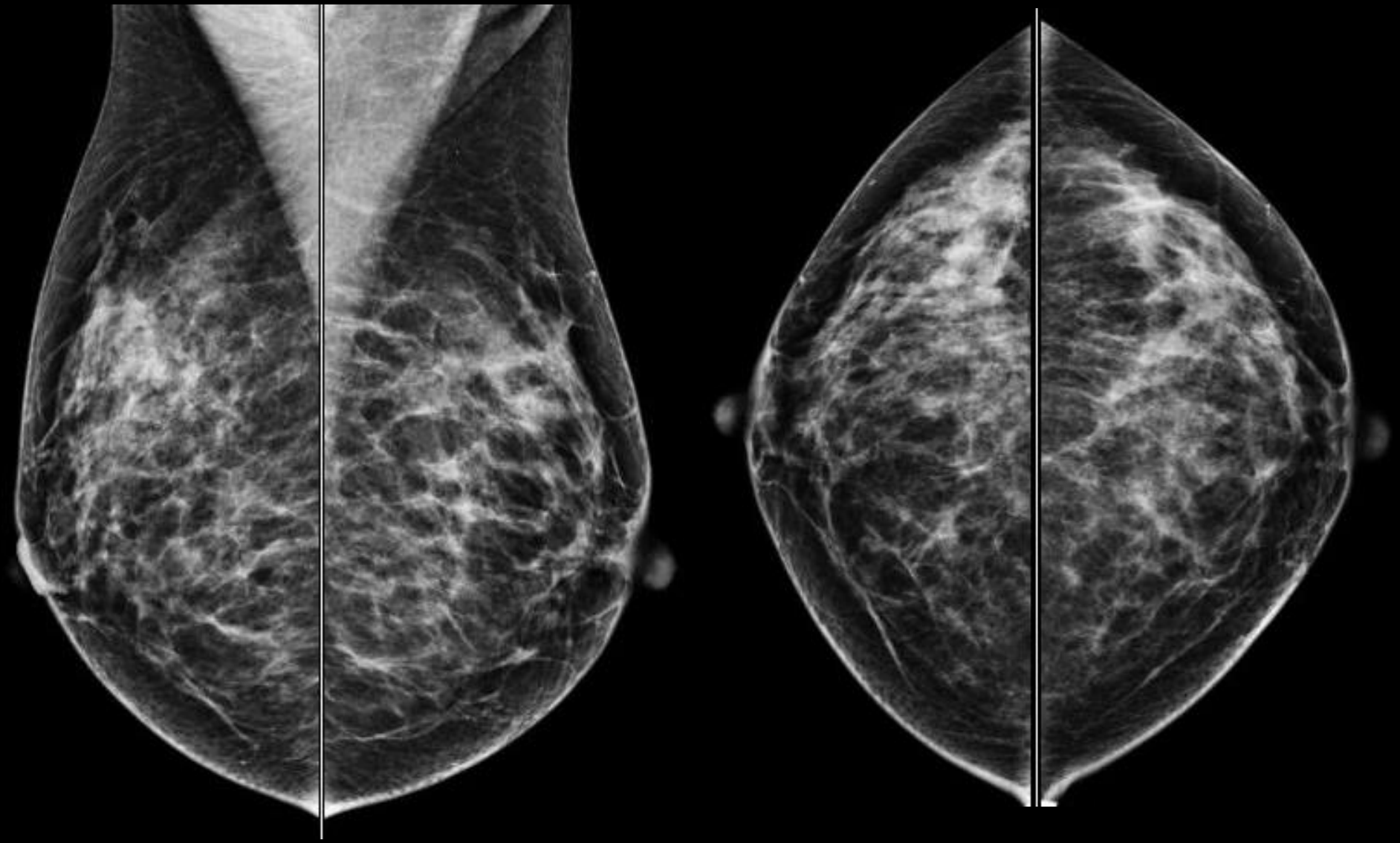
Right suspicious calcifications

Left breast scattered benign coarse calcifications which are round with lucent centers

Right suspicious amorphous calcifications- biopsy proven malignant

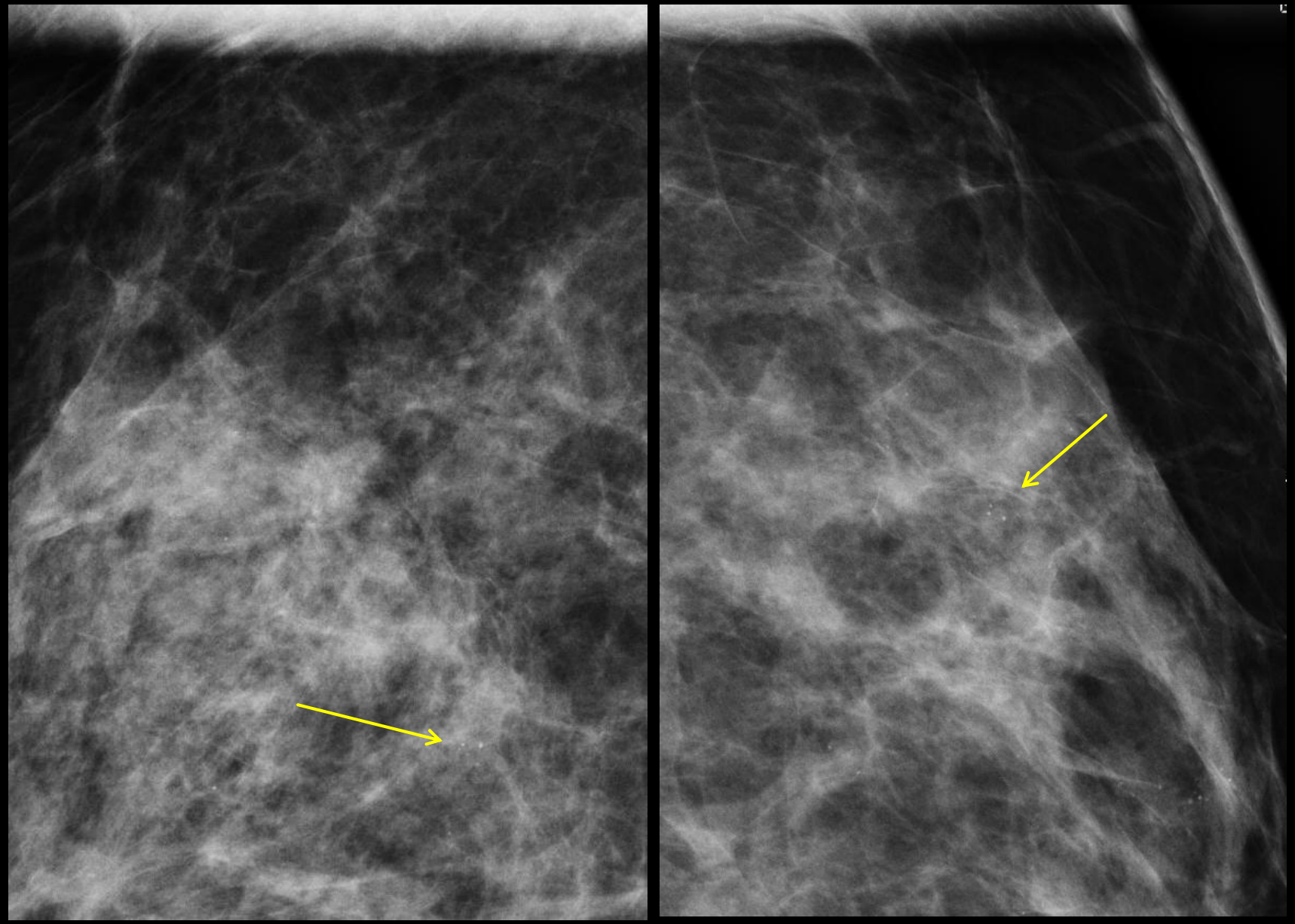


Patient presents as second opinion for calcifications

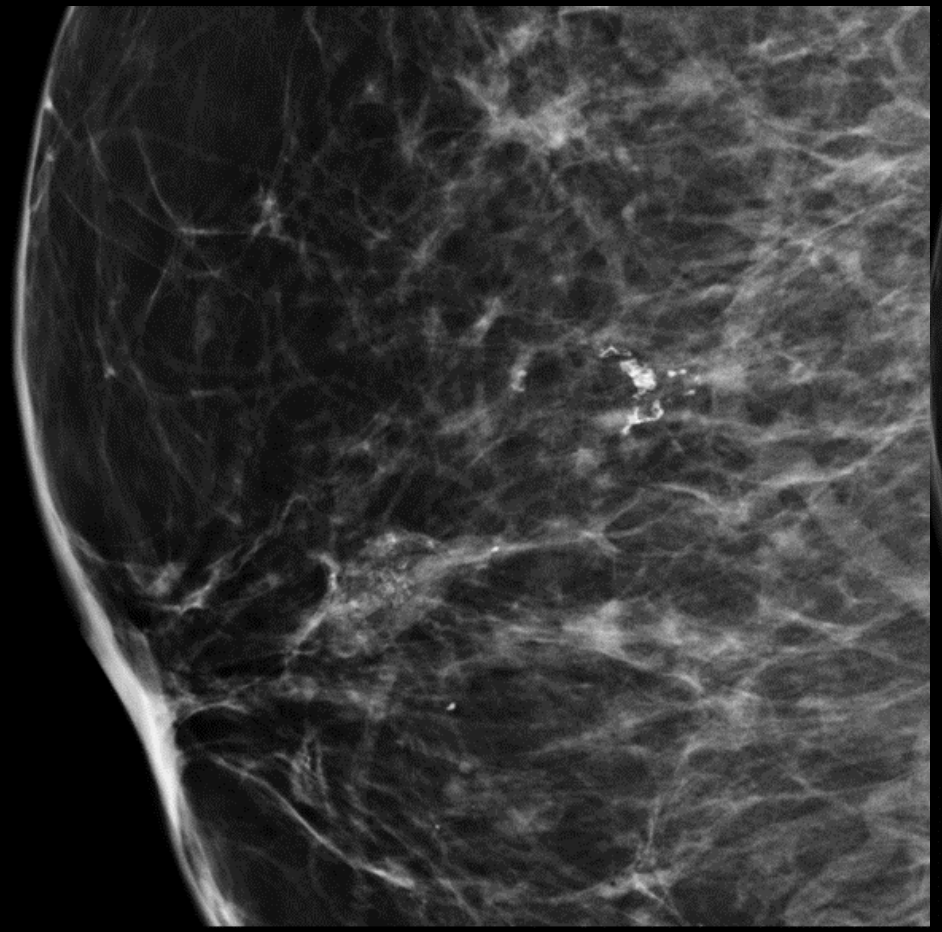


Dense glandular tissue

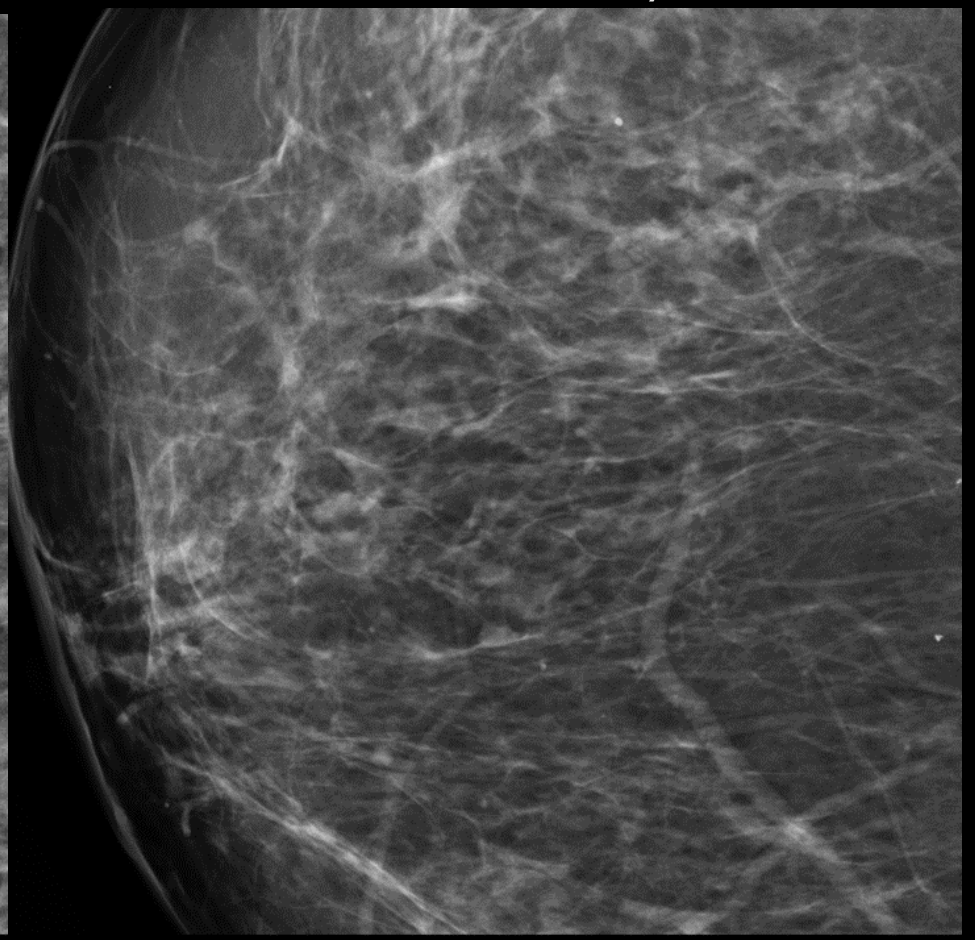
Magnification views: reveal bilateral similar calcifications



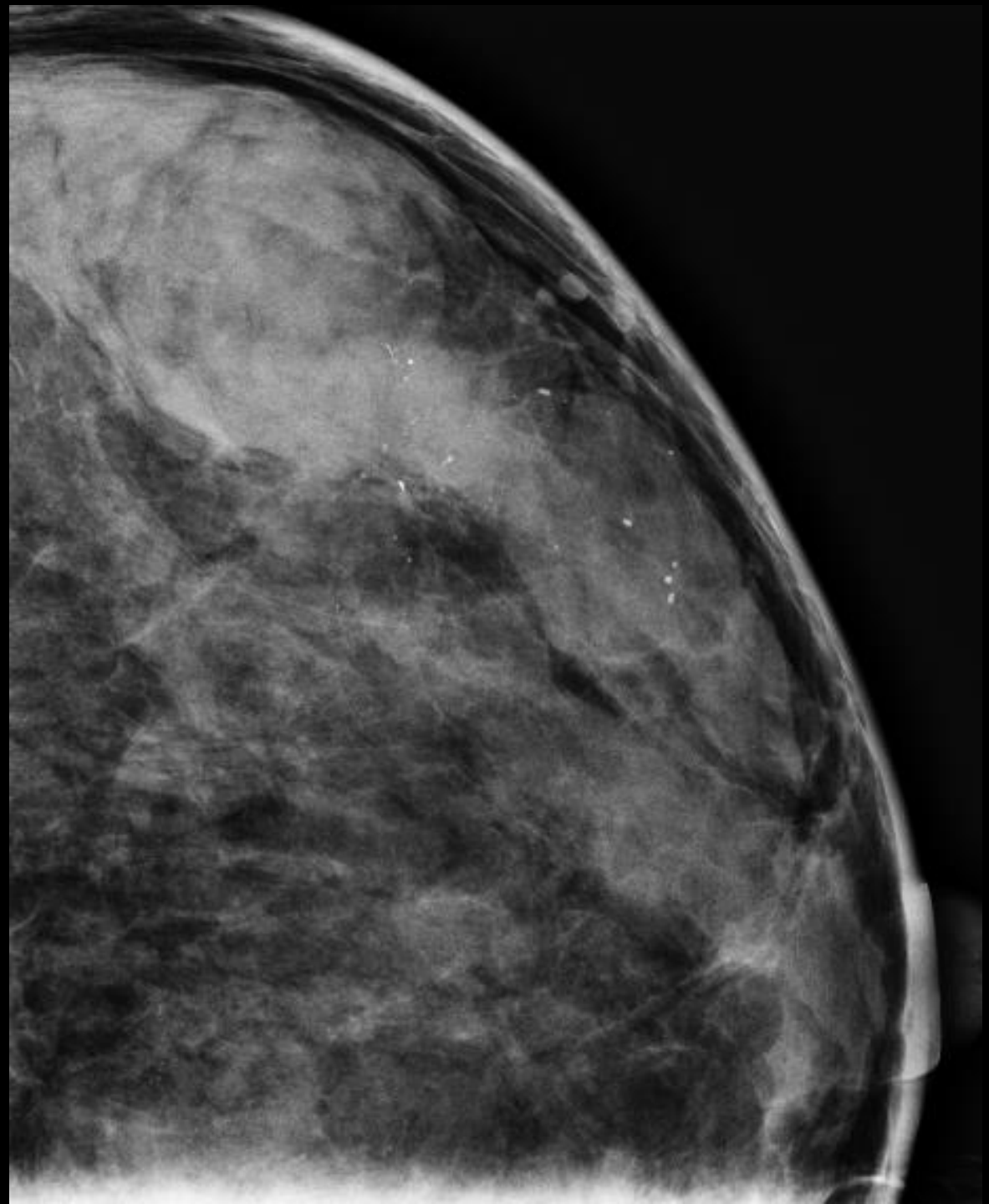
Screening mammogram-new calcifications



Prior year



Fat necrosis due to injury from seat belt

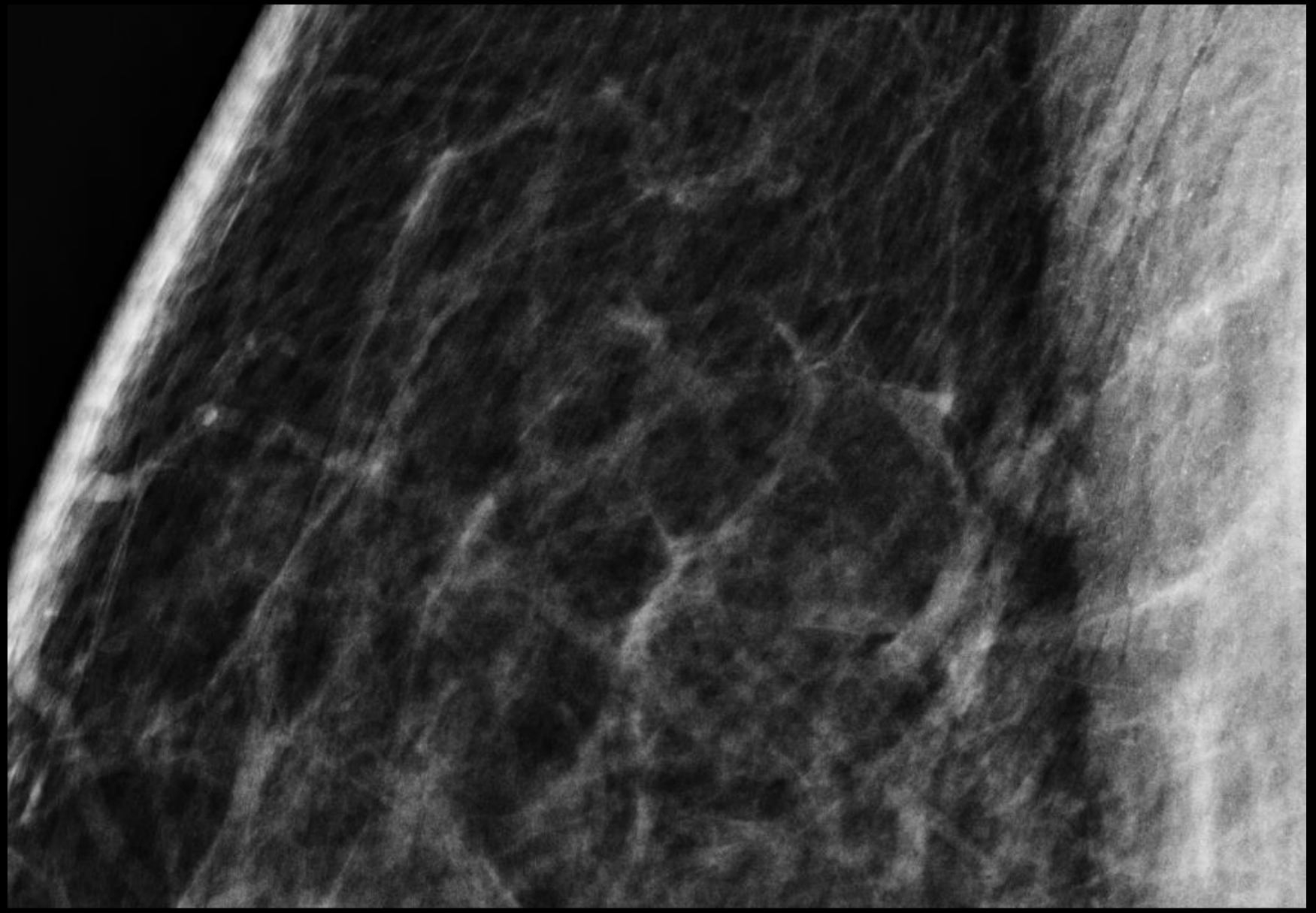


76 y/o patient presents for routine screening

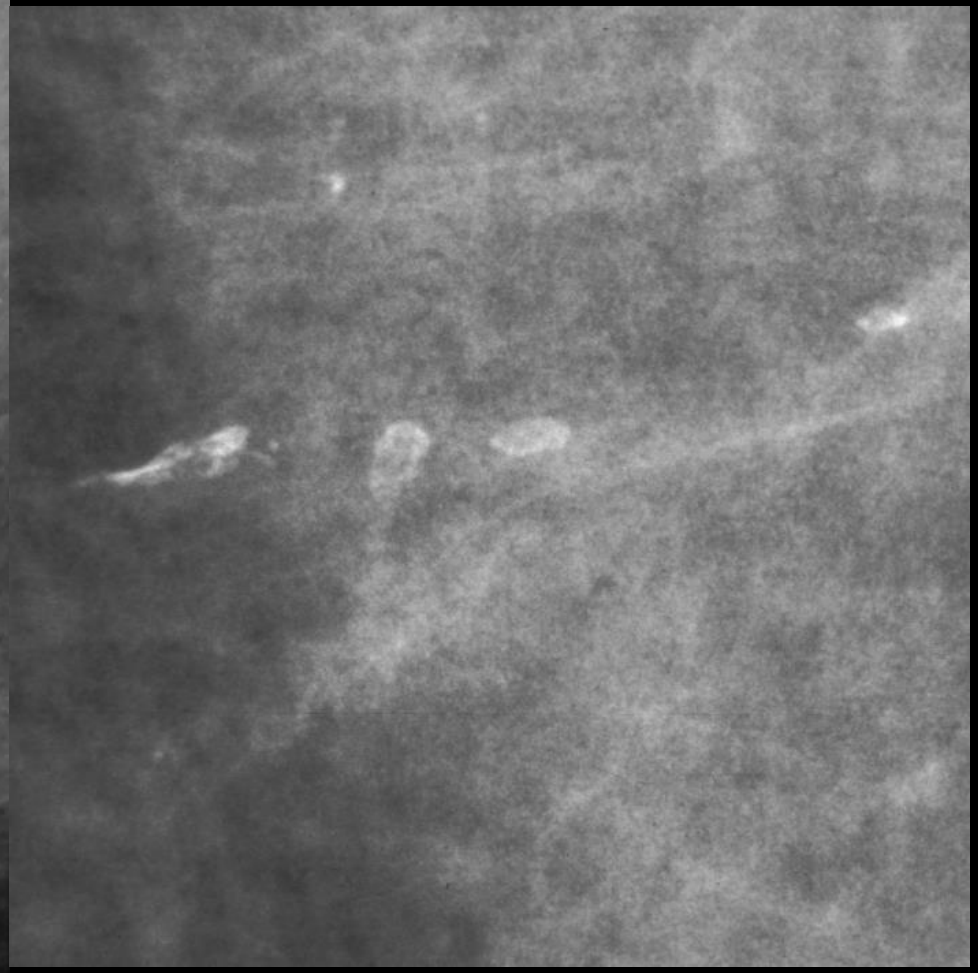
Amorphous calcifications seen in the left breast UOQ – A/D?

Irregular hypoechoic mass left breast 2:00, containing internal echoes consistent with calcifications - Biopsy proven IDC

Deodorant

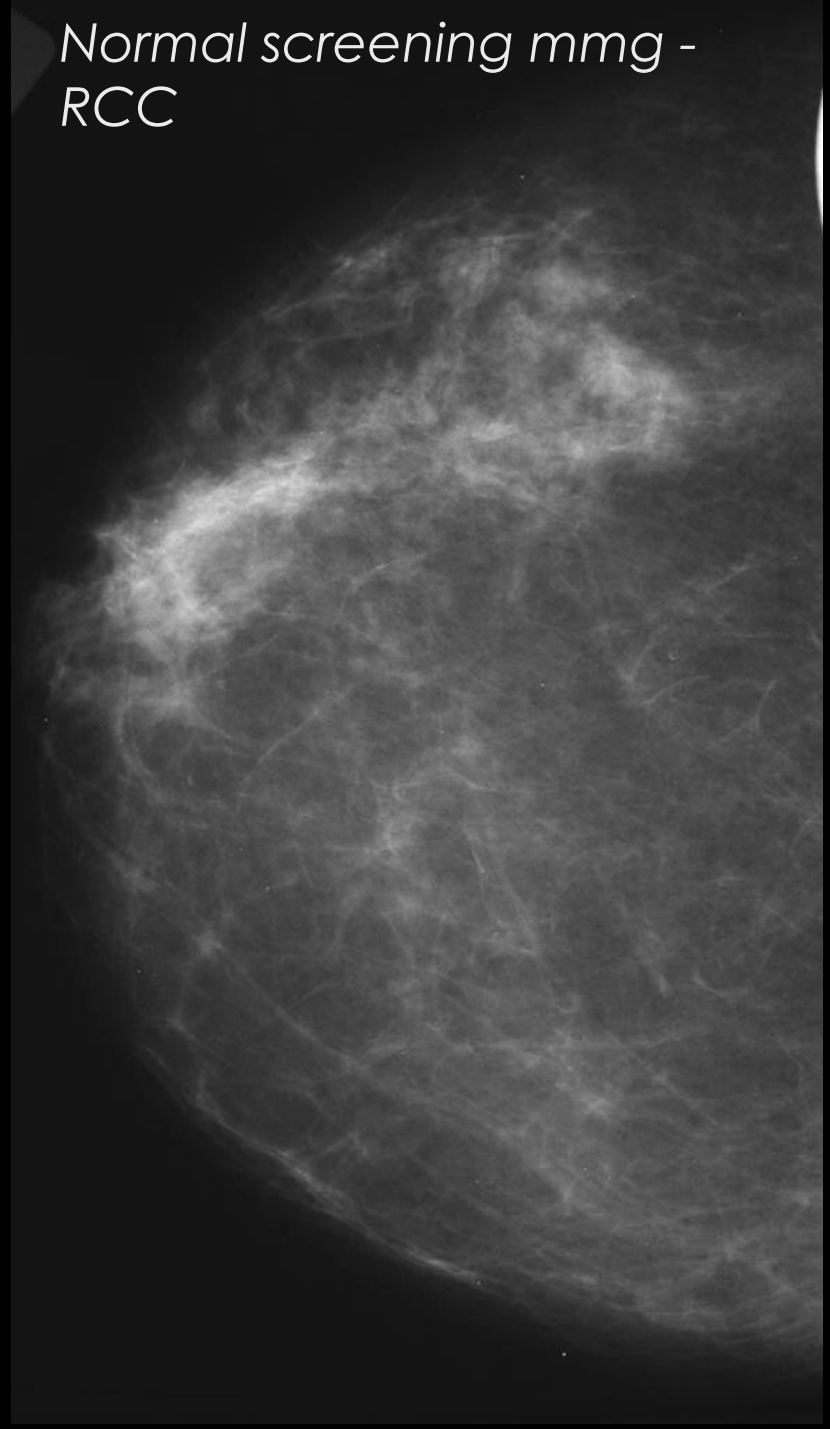


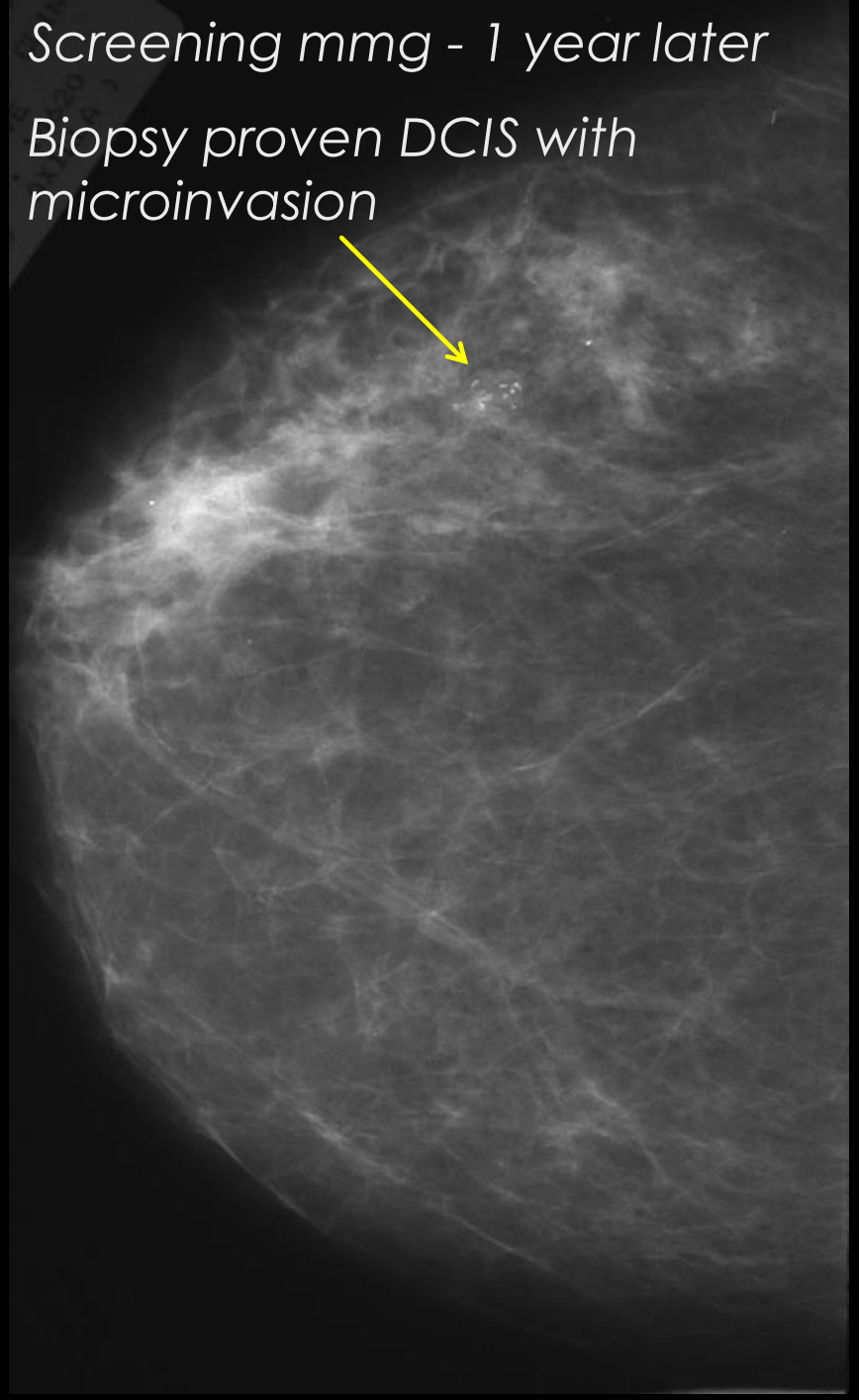
Patient presents for screening mammogram



linear skin calcifications

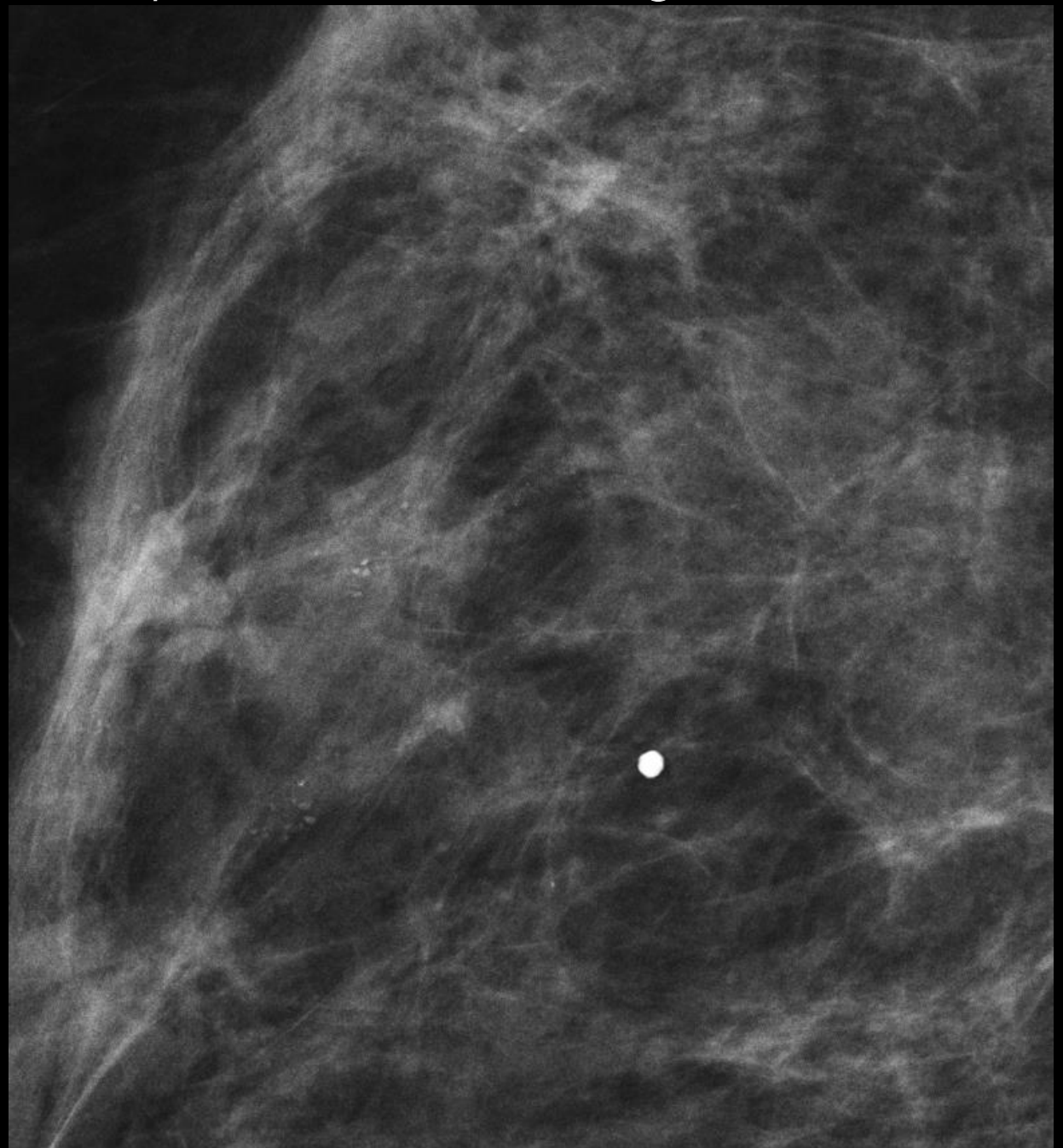
C-view Pseudo ca++ artifact


Normal screening mmg - RCC

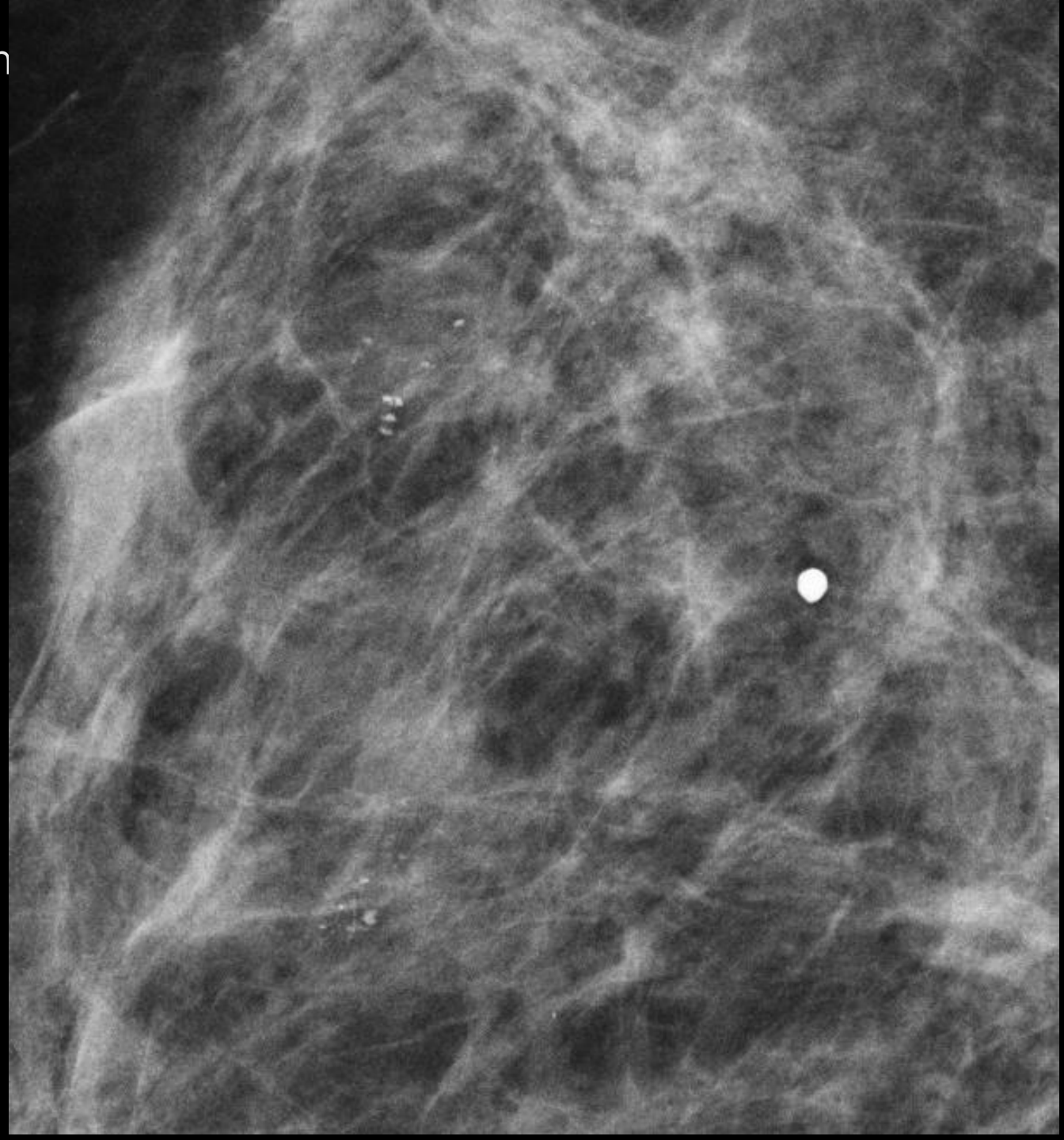

Screening mmg - 1 year later
Biopsy proven DCIS with microinvasion

Comparison to priors-stable or change?

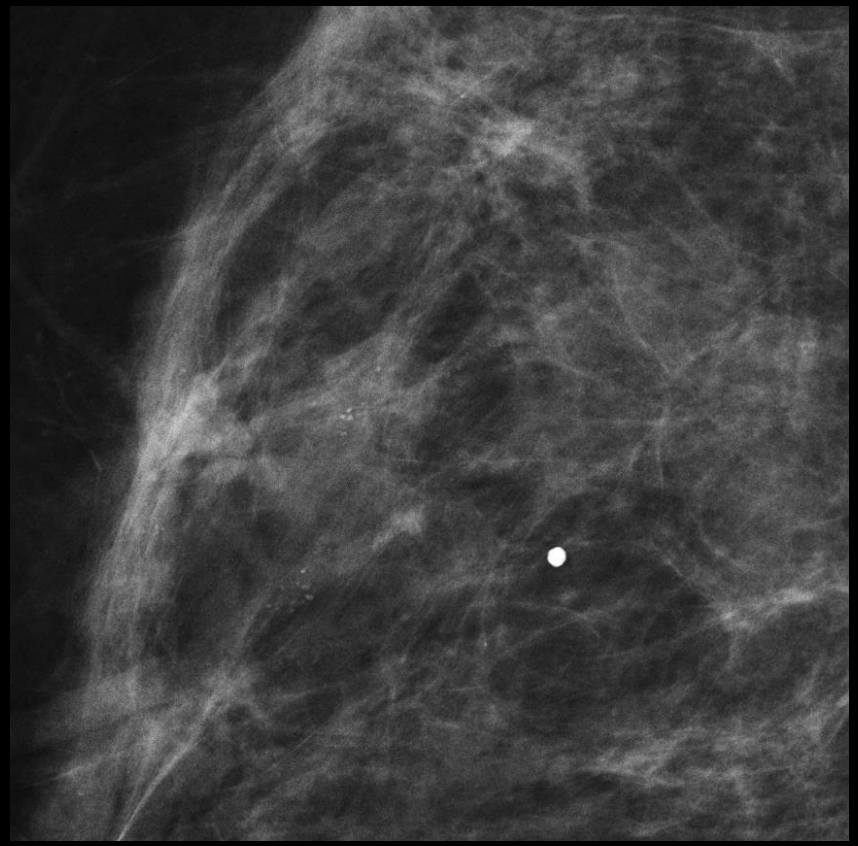
2008 mammogram



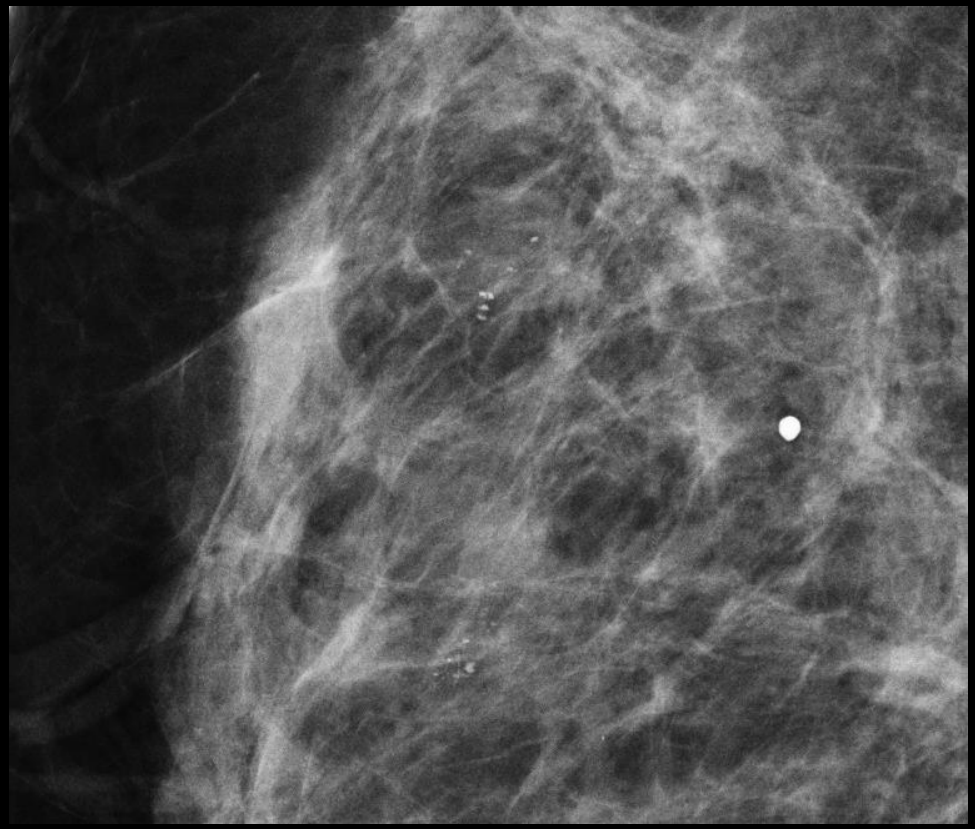
2009 mammogram



2008



2009



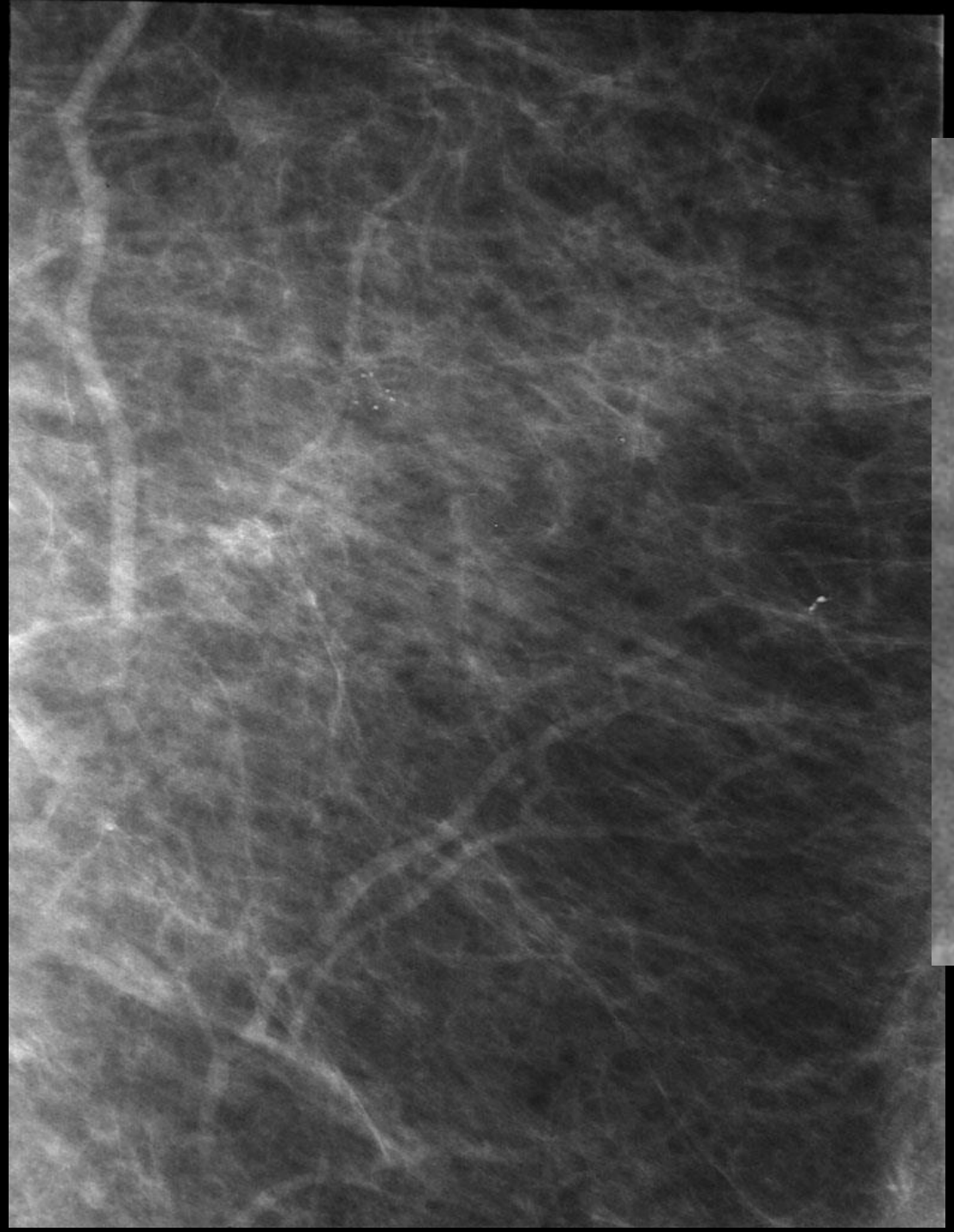
To evaluate for stability one needs to have diagnostic work up with magnification mammographic views

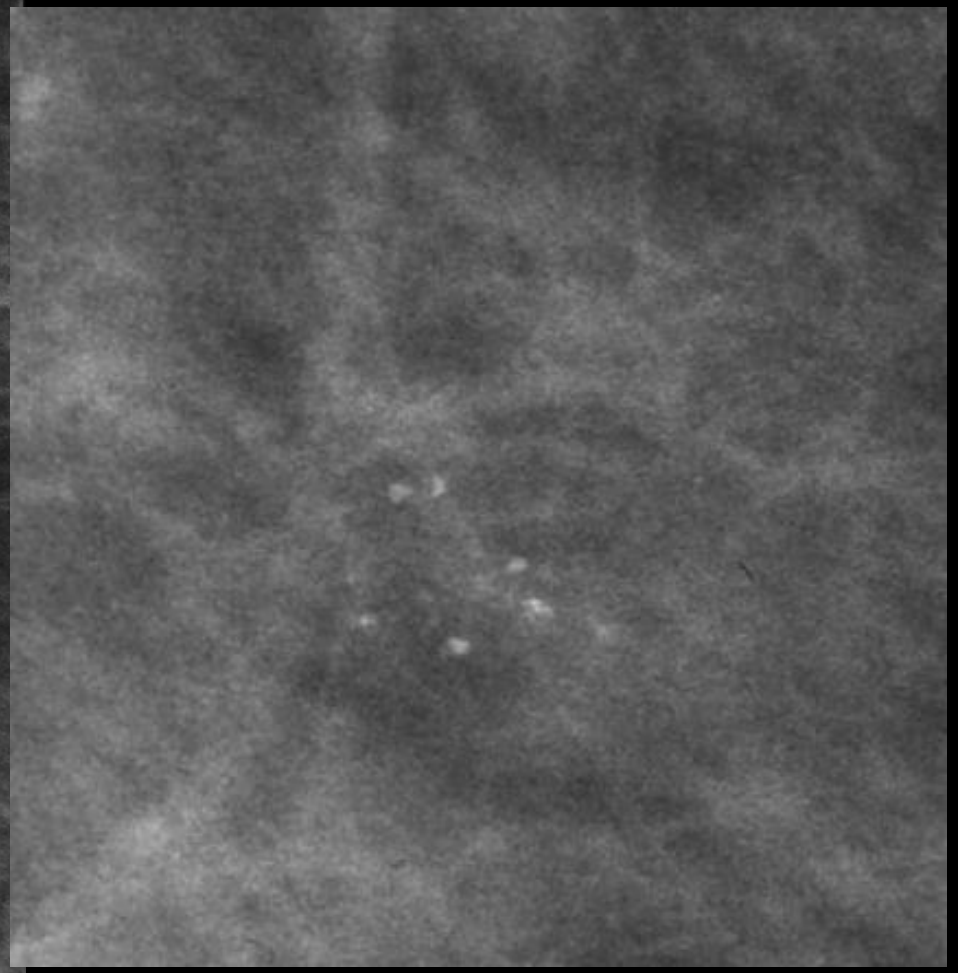
Biopsy

- Stereotactic guided biopsy used to sample calcifications
  - Has been shown to be highly accurate at calcifications retrieval
  - Specimens should be imaged to verify removal
  - Clip marker should be placed
    - For residual calcifications
    - Calcifications that have been completely removed

Clip Placement

- A clip/marker is placed in the breast after a biopsy procedure is performed to mark the area of interest





Benign looking ca++,
but malignant on core

Reporting

- When specific etiology cannot be given, a description of morphology and distribution should be provided
- Calcifications that are obviously benign do not always need to be discussed in the report
  - Note: They should be reported if there is the potential for another radiologist to misinterpret them

References

- ACR BI-RADS Atlas Breast Imaging Reporting and Data System 5th Edition, 2013
- Wahab RA, et al. A comparison of full-field digital mammograms versus 2D synthesized mammograms for detection of microcalcifications on screening. Eur J Radiol 2018; 107: 14-19.
- Warren Burhenne LJ, Wood SA, D'Orsi CJ, et al. Potential contribution of computer-aided detection to the sensitivity of screening mammography.
- Birdwell RL, Ikeda DM, O'Shaughnessy KF, Sickles EA. Mammographic characteristics of 115 missed cancers later detected with screening mammography and the potential utility of computer aided detection. Radiology 2001;219:192–202
- Kopans: DBT from Concept to Clinical Care; AJR2014;202: 299-308
- Bassett LW. Mammographic analysis of calcifications. Radiol Clin North Am 1992; 30(1):93-105.
- Zuckerman, S. P., et al. (2017). Imaging with synthesized 2D mammography: differences, advantages, and pitfalls compared with digital mammography. *American Journal of Roentgenology*, *209*(1), 222-229.
- Sickles EA. Breast calcifications: mammographic evaluation. Radiology 1986; 160(2):289-293.
- Chen, Ghosh, Slanetz, Eisenberg et al: Segmental Breast Calcifications; AJR2012; 199: W532-W542
- Prentice A. Maternal calcium metabolism and bone mineral status. Am J Clin Nutr 2000;71(5 suppl):1312S–1316S.
- Mass A, van der Schouw YT, Beijernick D, et al. Arterial Calcifications Seen on Mammograms: Cardiovascular Risk Factors, Pregnancy, and Lactation. Radiology 2006; 240(1): 33-38.
- Chen, et al: Segmental Breast Calcifications. AJR 2012; 199: W532-W542.
- Oligane, H. C., Berg, W. A., Bandos, A. I., Chen, S. S., Sohrabi, S., Anello, M., & Zuley, M. L. (2018). Grouped amorphous calcifications at mammography: frequently atypical but rarely associated with aggressive malignancy. *Radiology*, *288*(3), 671-679.
- Calhoun & Collins: Recommendationa for excision following core needle biopsy of the breast: a contemporary evaluation of the literature; Histopathology (2016), 68, 138-151
- Liberman L, Smolkin JH, Dershaw DD, et al. Calcification Retrieval at Stereotactic, 11-gauge, Directional, Vacuum-assisted Breast Biopsy. Radiology 1998; 208: 251-260.
- Jackman RJ, Rodriguez-Soto J. Breast microcalcifications: retrieval failure at prone stereotactic core and vacuum breast biopsy—frequency, causes and outcome. Radiology 2006; 239(1): 61-70.
- Lomoschitz FM, Helbich TH, Rudas M, et al. Stereotactic 11-gauge vacuum-assisted breast biopsy: influence of number of specimens on diagnostic accuracy. Radiology 2004; 232(3):897-903.

Thank You

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