Multimodality Biopsy

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Multimodality Imaging

- Mammography/DBT
- Ultrasound
- MRI

- Important to be able to biopsy a lesion the best way it is visualized

Background: Needle Core Biopsy

- Needle core biopsy has proven its benefit in comparison to open surgical biopsy
- Diagnostic test in which a sampling of tissue from the breast is removed using a needle and sent for pathologic evaluation
- Tissue sampling recommended when a suspicious lesion has been identified on mammography, US or breast MRI
  - Can be used on masses and microcalcifications, distortions, asymmetries
  - Uses mammographic (stereotactic/DBT) or US guidance to accurately target an abnormality

Benefits: Needle Core Biopsy

- Allows access to lesions detected only on mammogram
- Rapid time to diagnosis and treatment
- Minimize risk factors
- Less expensive than incisional surgical biopsy
- In women with biopsy-proven benign lesions, excision is generally not needed
- Shorter recovery time than equivalent surgical biopsy
- Facilitates early detection
- Little or no scarring

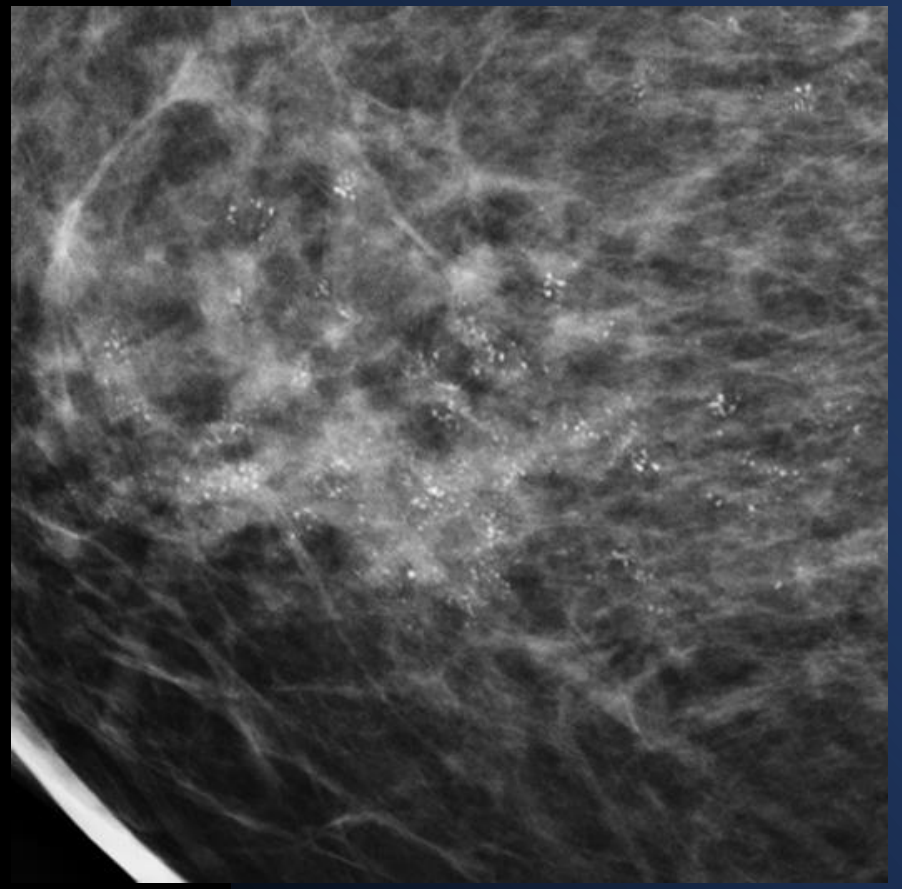
Process: Needle Core Biopsy

- Discuss indications and alternatives
- Informed consent
- Positioning - targeting
- Sampling
- Specimen radiograph (calcifications)
- Tissue marker clip placement
- Post-procedure mammogram
- Post-care instructions
- Communicating results
- Follow-up imaging

Stereotactic Core Biopsy

- Most appropriate biopsy technique for calcifications and lesions not visible on ultrasound

- Uses mammography to localize abnormality and sample tissue



Successful Results

- Communicate with patient throughout the procedure
- Optimize patient comfort
- Communication between doctor and technologist

Contraindications

- Inability to visualize the lesion mammographically
- Patient ability to lie prone
  - Spinal fusion, arthritis, pregnancy
- Patient weight
  - Tables have weight limits
  - Difficulty with positioning
- Patient body habitus/small breast size and negative needle stroke margin
- Allergies
- On aspirin or anticoagulant, history of bleeding diathesis

Positioning Challenges

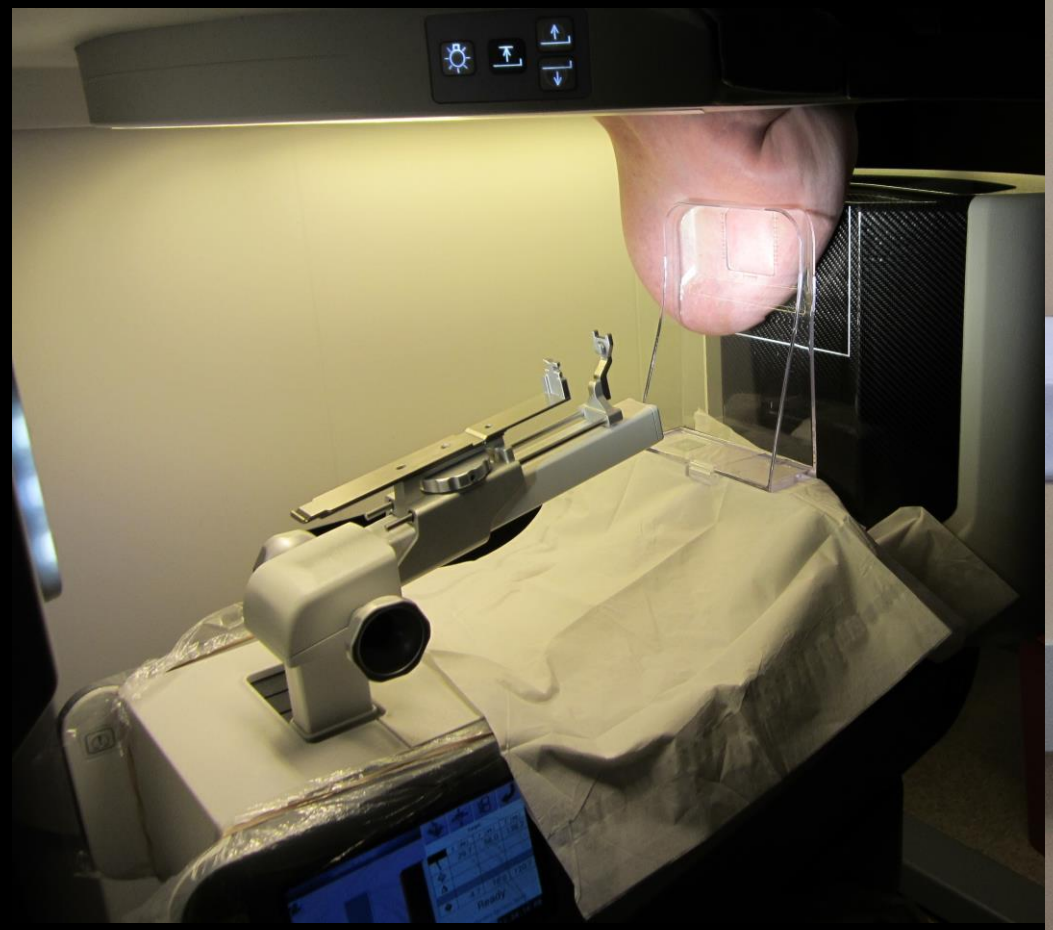
- Thin breast compression
- Breast Implants
- Extreme lesion location
  - Anterior (near nipple)
  - Posterior (chest wall)
  - Superficial (near skin)
- *DBT only findings—need tomo biopsy capability*

Prone Stereotactic Biopsy/DBT

Prone stereotactic biopsy

Affirm breast biopsy guidance system

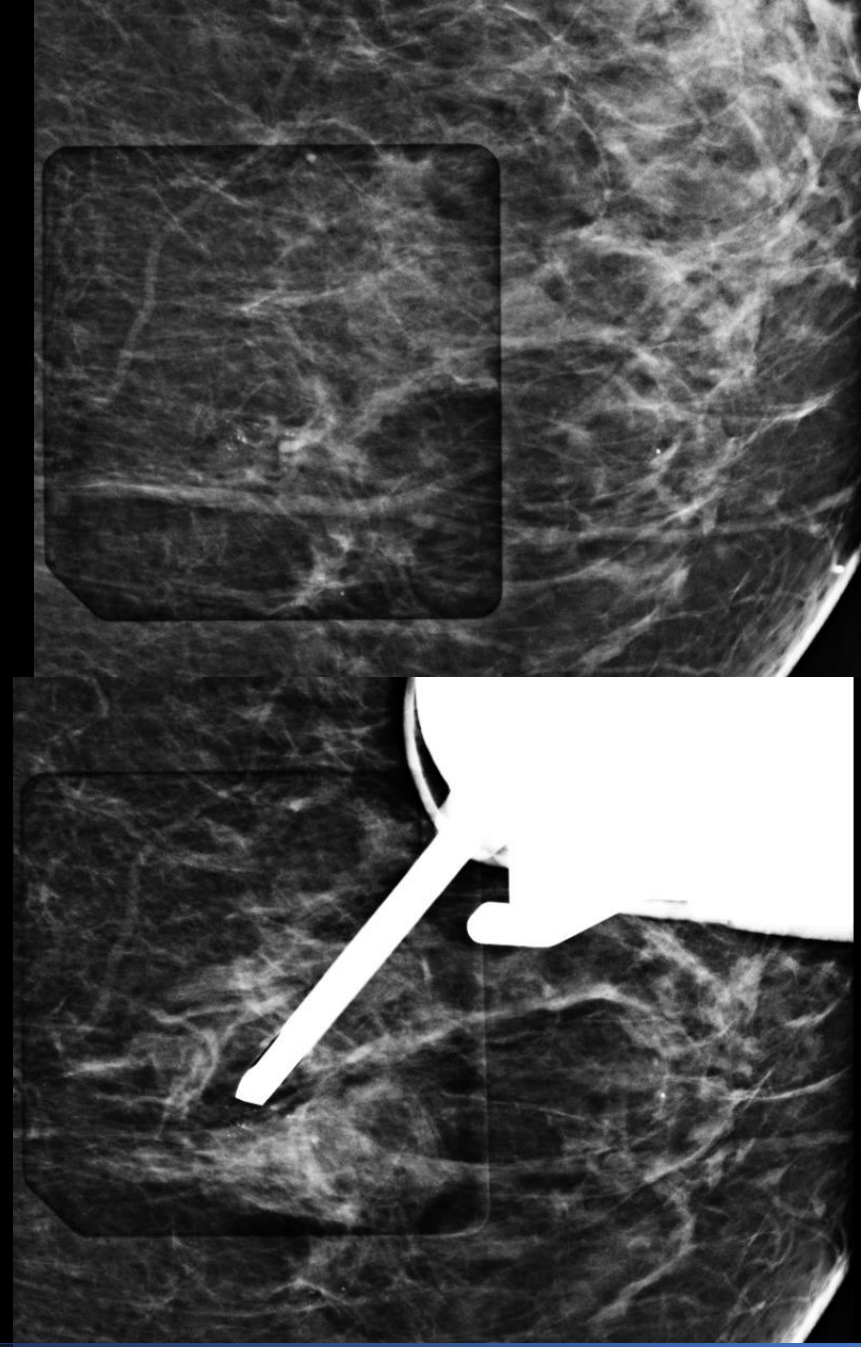

Scherer, Maureen
Target
X (mm)
Y (mm)
Z (mm)
29.7
56.0
138.2
-4.7
4.4
120.7
Ready
Eviva Standard 9gx13cm, 20mm
12:11:30 PM



Once the patient is tolerably comfortable, a scout image of the lesion is obtained with the fenestrated compression device

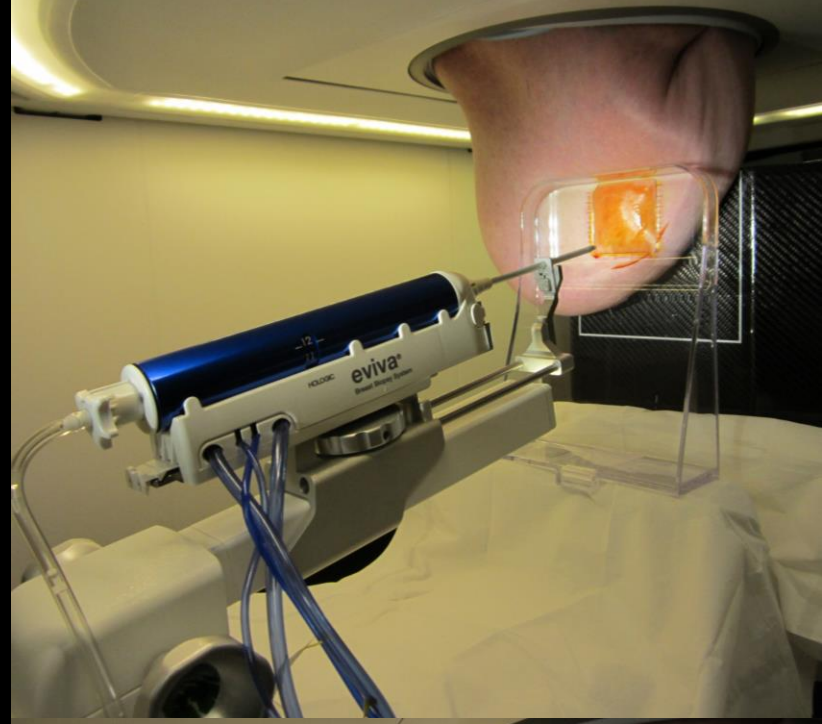
Lesion Targeting

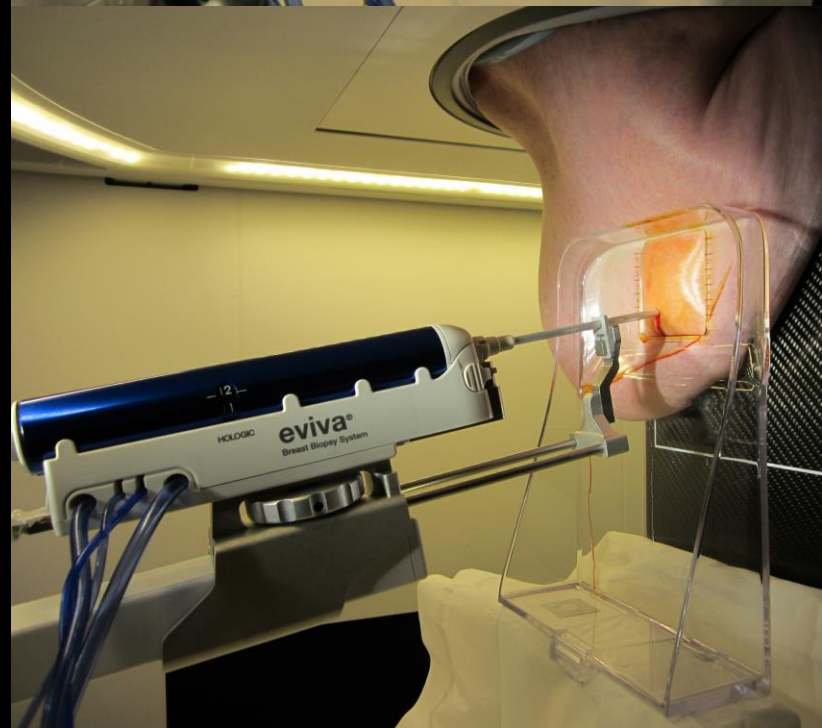
- The lesion is targeted on each of the stereo images and the coordinates of the lesion within the breast are obtained
- These coordinates provide the target for the biopsy needle
  - The Cartesian method (X (horizontal), Y (vertical), and Z (depth) axis) and the polar method (H (horizontal), V (vertical) and D (depth)) are the two coordinate systems used with current stereotactic biopsy devices

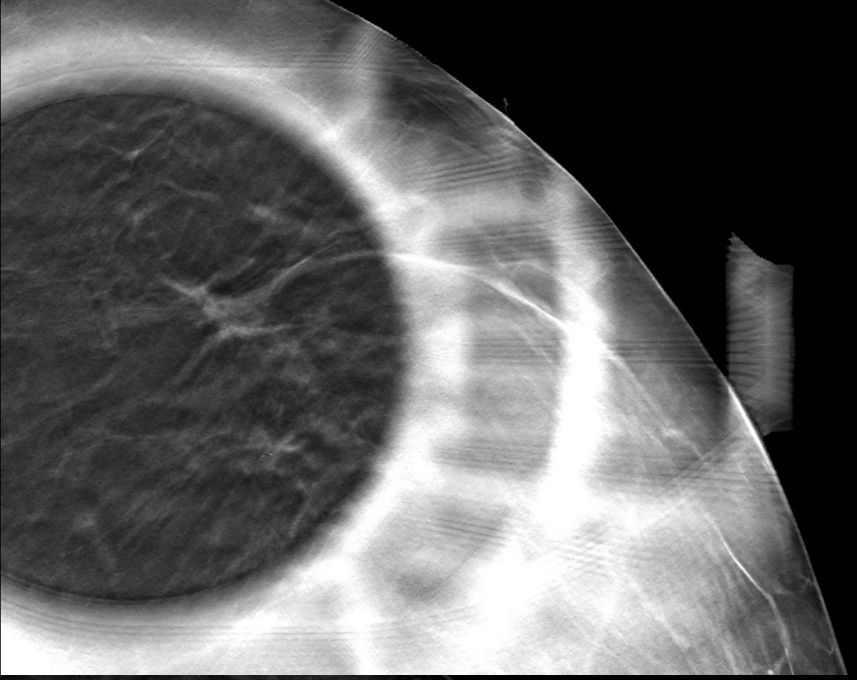


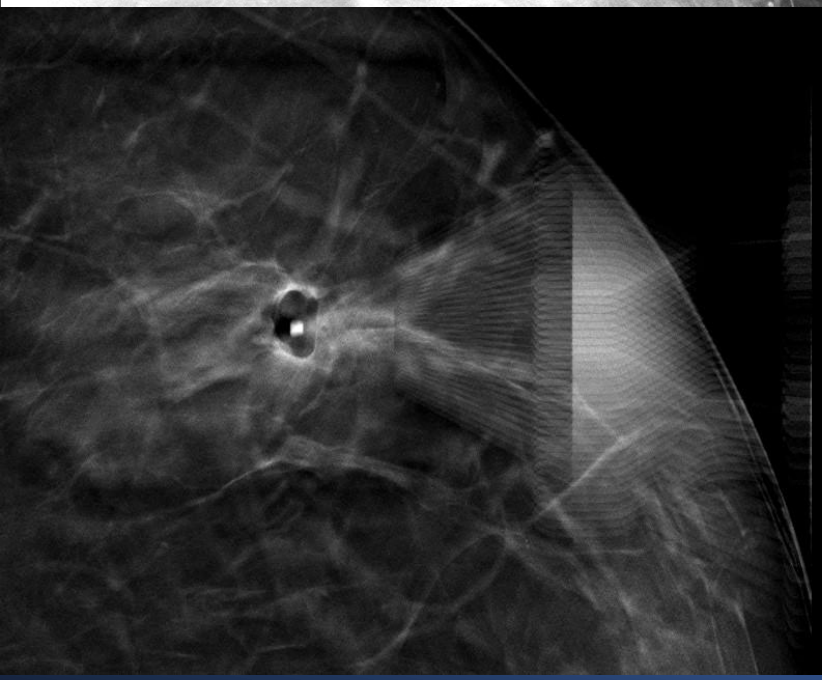
Tomosynthesis Lesion Targeting and Sampling

- After biopsy needle is in place acquire tomo pre-fire image
  - Scroll through to verify needle position at lesion
  - Image may not be as crisp due to biopsy needle and lidocaine artifact
  - Make needle adjustments if necessary
    - TIP: If the lesion has moved slightly - DO NOT ADJUST









Tomosynthesis Lesion Targeting

- Post-fire tomo image or stereo 2D pair
  - Scroll through projection images to identify the lesion
- Nice feature allows the selected target to project on the Post-fire image

DBT-Guided Biopsy Advantages

- Familiar look
  - Selenia Dimensions screen and detector
  - Same look as diagnostic images
- Quicker re-scouting due to clear compression paddle
- Automatic targeting
- Overall shorter procedure time

DBT-Guided Biopsy Disadvantages

- Similar disadvantages to any stereotactic biopsy
  - Bleeding
  - Lidocaine obscuring the lesion
    - TIP: Trust your targeting prior to bleeding or lidocaine
- Posterior lesions: prone table disadvantage
  - Due to sensitivity of the detector, need to have a finger width between the top of the detector and the table to avoid any injury to the detector
    - TIP: May need to remove table padding to image posterior lesions

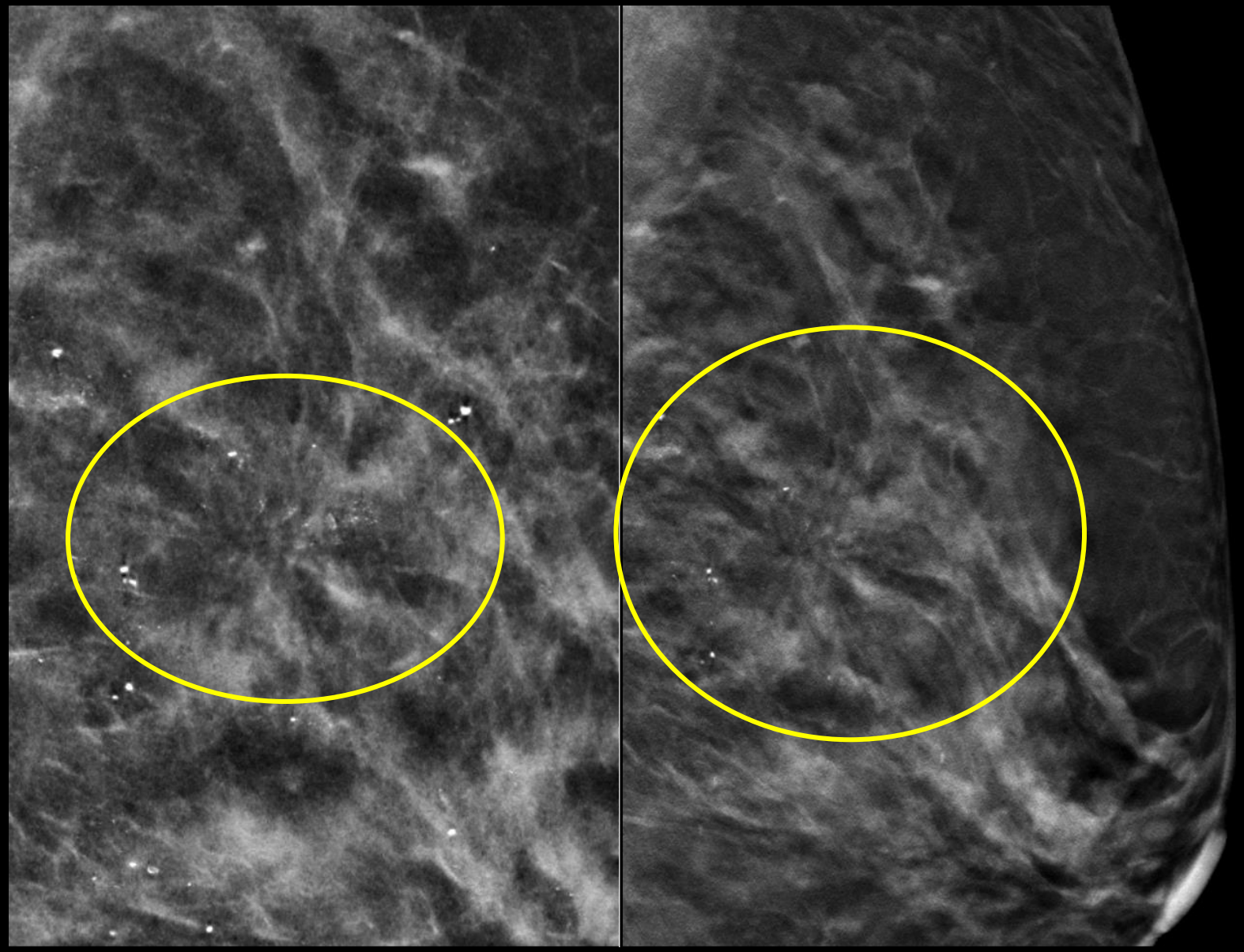
Increase in Distortions detected by DBT

- The increased use of DBT has resulted in the increased frequency of suspicious findings such as architectural distortion that are visualized only on DBT

- DBT breast biopsy (DBT VAB) allows biopsy of findings seen better or exclusively on DBT, including architectural distortion

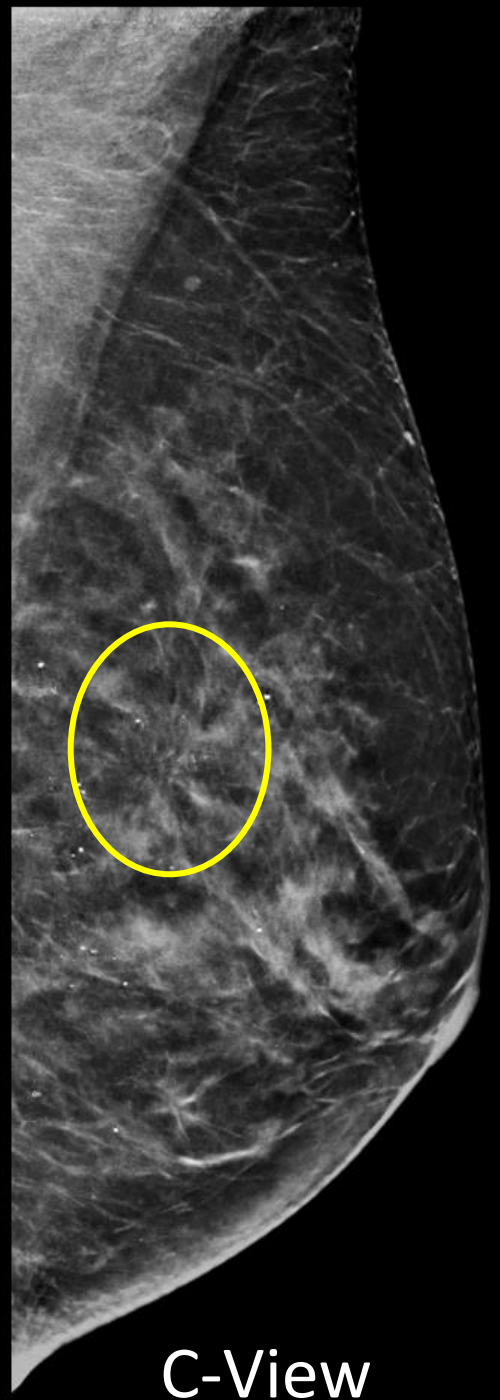
Rochat CJ, et al. Digital mammography stereotactic biopsy versus digital breast tomosynthesis-guided biopsy: differences in biopsy targets, pathologic results, and discordance rates. *Radiology*2020; 294:518–527.
Ambinder EB, et al. Tomosynthesis-Guided Vacuum-Assisted Breast Biopsy of Architectural Distortion Without a Sonographic Correlate: A Retrospective Review. AJR 2021; 217(4): 845-854.

Left MLO

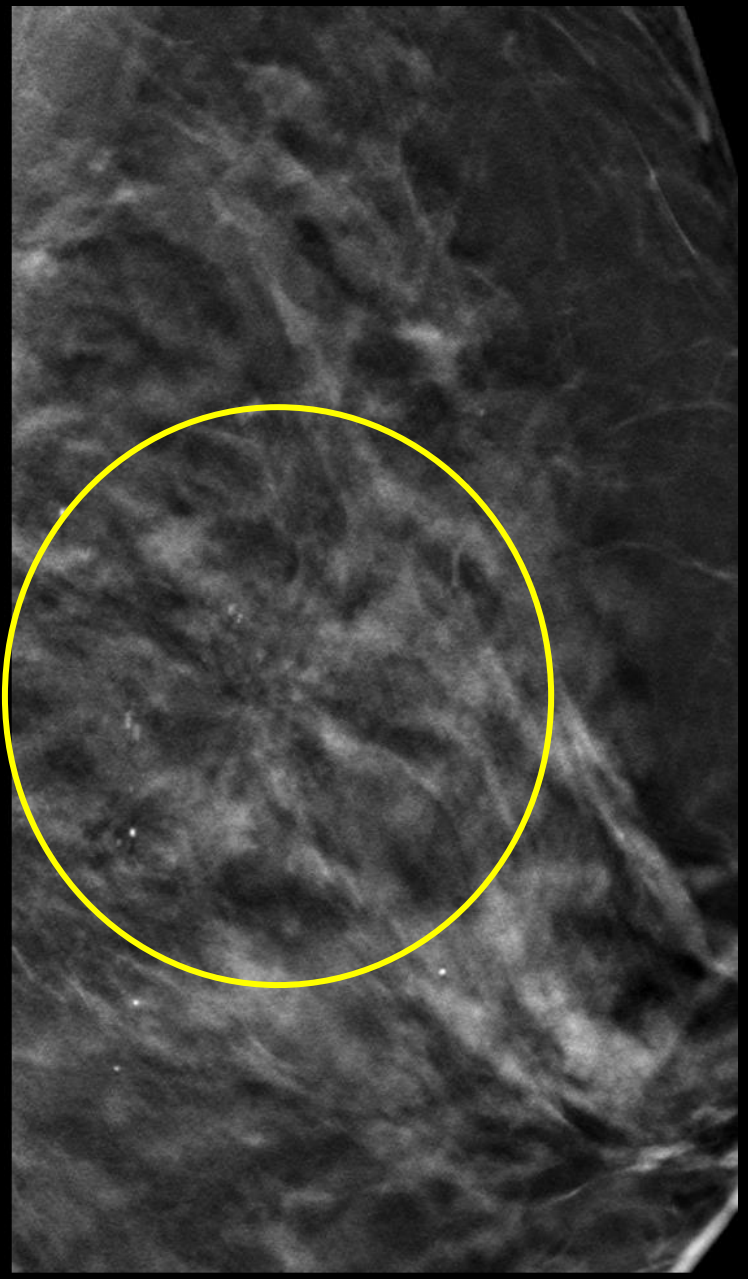


C-View

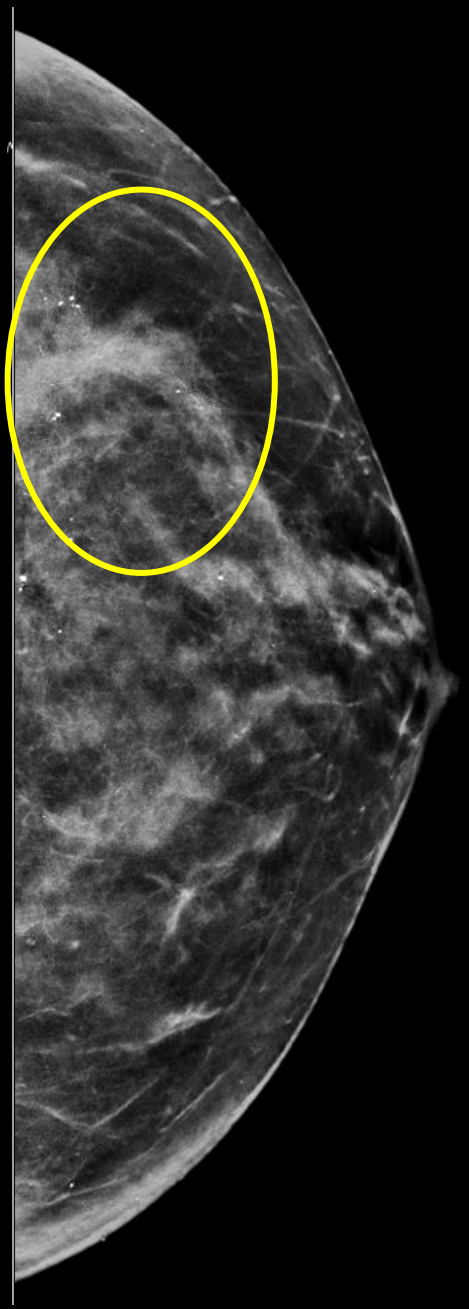
DBT Slice



C-View

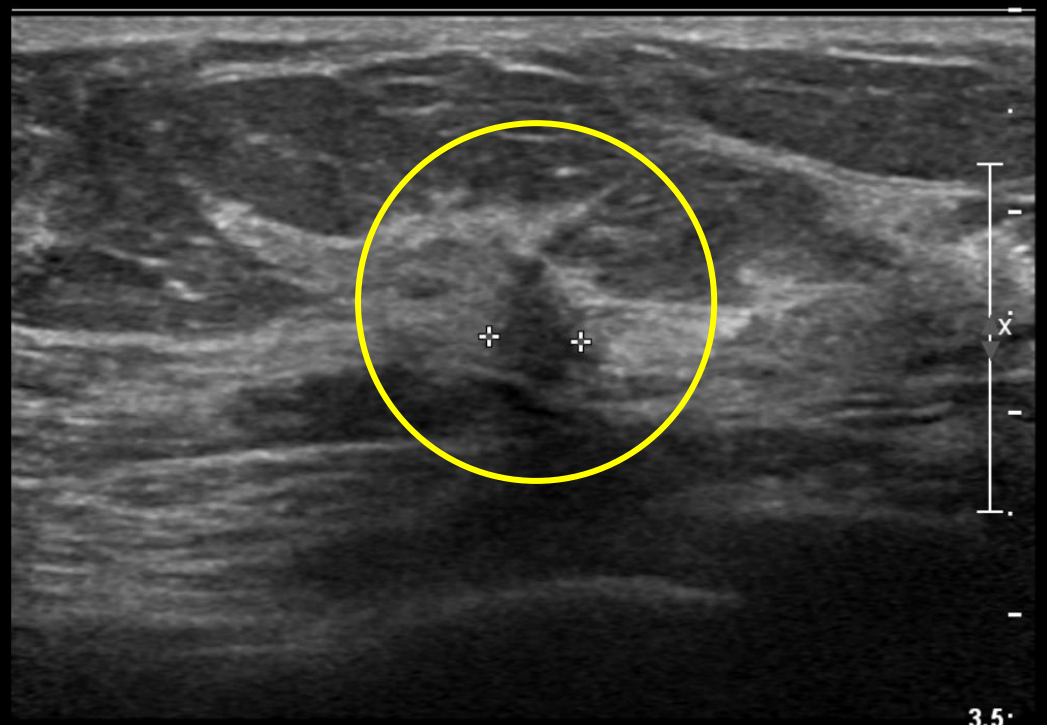


DBT slice



C-View

DBT slice



US-Guided biopsy: IDC

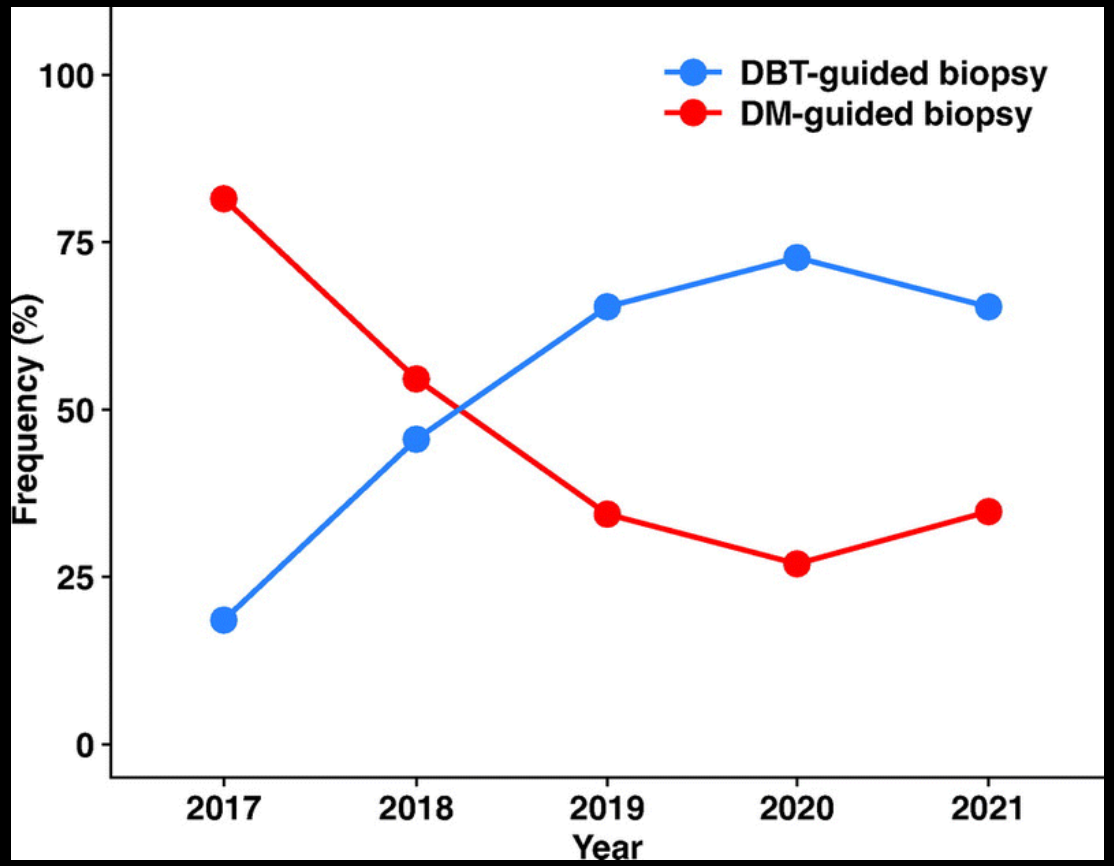
Schrading et al: DBT-guided VAB

- PS VAB retargeting took longer in comparison to DBT VAB
- Tissue sampling time was similar for both

	DBT VAB	PS VAB
Number of lesions	51	165
Success rate	100%	93%
Avg. time	13 min	29 min
Vasovagal reaction	1	1

DBT-guided Biopsy of Breast Calcifications

- Purpose of study was to compare performance and outcomes of DM- and DBT-guided biopsy of suspicious calcifications
  - total of 348 (26%) biopsies used DM guidance, and 1006 (74%) used DBT guidance



Nguyen DL, et al. Comparison of Diagnostic Mammography-Guided Biopsy and Digital Breast Tomosynthesis-Guided Biopsy of Suspicious Breast Calcifications: Results in 1354 Biopsies. AJR 2023; 220: 212-223.

Results

- Mean procedure time significantly lower for DBT-guided (14.9 ± 8.0 min) than DM-guided (24.7 ± 14.3 min) biopsy ($p<.001$)
- Mean number of exposures significantly lower for DBT-guided (4.1 ± 1.0) than DM-guided (9.1 ± 3.3) biopsy ($p<.001$)
  - Time and exposures remained significant (both $p<.001$) when controlling for the effect of the radiologist performing the biopsy
- No significant differences (all $p>.05$) between DM-guided and DBT-guided biopsy in malignancy rate on initial biopsy (20% vs 19%), high-risk lesion upgrade rate (14% vs 22%), or final malignancy rate (23% vs 22%)

DBT Prone vs. Upright

- 282 patients in the study: 215 patients (76.2%) underwent prone DBT-guided biopsy, and 67 (23.8%) underwent upright
- Prone and upright DBT-guided biopsies have similar clinical performance
- Other factors, such as room utilization and patient comfort, should be considered when deciding between prone and upright DBT-guided biopsies

TABLE 2: Biopsy Characteristics for Prone and Upright Digital Breast Tomosynthesis–Guided Biopsies

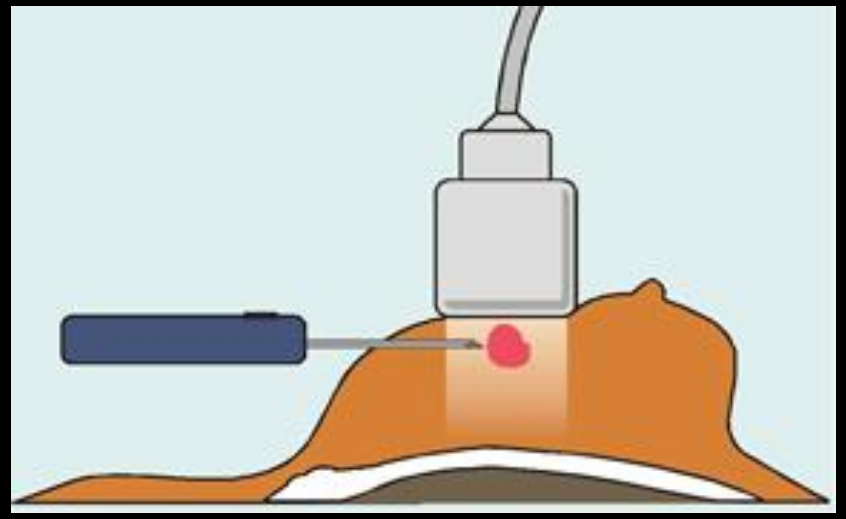
Characteristic	Prone (n = 215)	Upright (n = 67)	p
Needle type			0.61
Petite	19 (8.8)	4 (6.0)	
Standard	196 (91.2)	63 (94.0)	
No. of exposures, mean (range)	4.9 (2–14)	4.0 (1–8)	< 0.001
No. of samples, mean (range)	9.4 (5–36)	9.5 (3–18)	0.26
Total procedure (min), mean ± SD	19.4 ± 7.4	20.0 ± 9.0	0.67
Targeting time (min), mean (range)	10.2 (1–29)	10.3 (1–20)	0.47
Sampling time (min), mean (range)	9.3 (3–52)	10.6 (3–59)	0.64
Percentage of calcifications removed[a]			0.31
< 50%	35 (23.8)	12 (36.4)	
50–89%	31 (21.1)	5 (15.2)	
≥ 90%	81 (55.1)	16 (48.5)	
Complications			0.56
No	213 (99.1)	66 (98.5)	
Yes	2 (0.9)	1 (1.5)	

Note—Unless indicated otherwise, results are number of biopsies with percentages in parentheses.
[a]There were 147 patients with calcifications in the prone biopsy group and 33 patients with calcifications in the upright biopsy group.

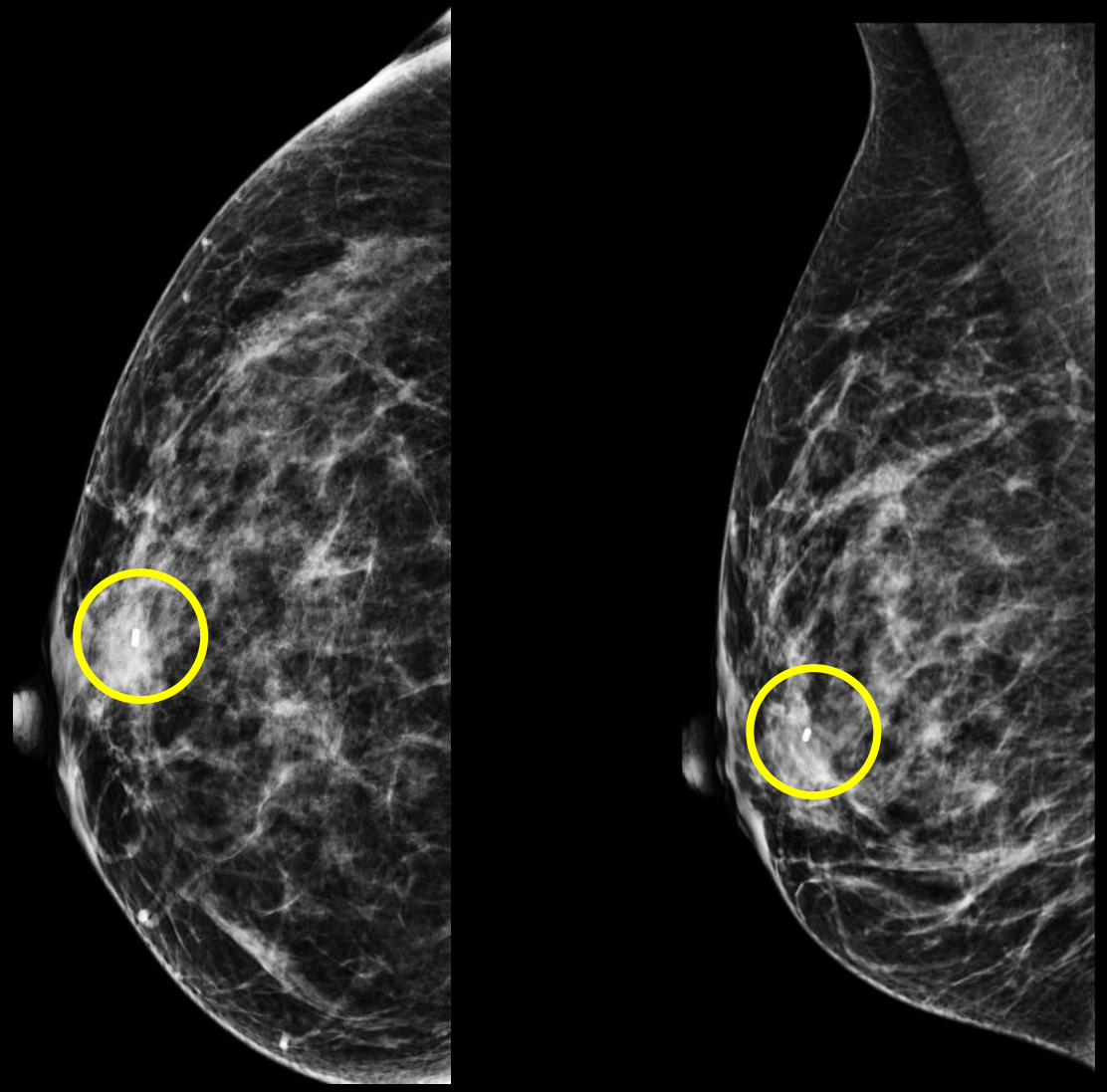
Choudhery S et al. Prone Versus Upright Digital Tomosynthesis-Guided Biopsy. AJR 2020; 215(3): 760-764.

US-guided Biopsy

- Well established biopsy method for lesions seen on ultrasound imaging
- US imaging used to target the area of interest for tissue sampling
  - Multiple tissue specimens are taken using a hand-held biopsy device
- Local anesthesia utilized

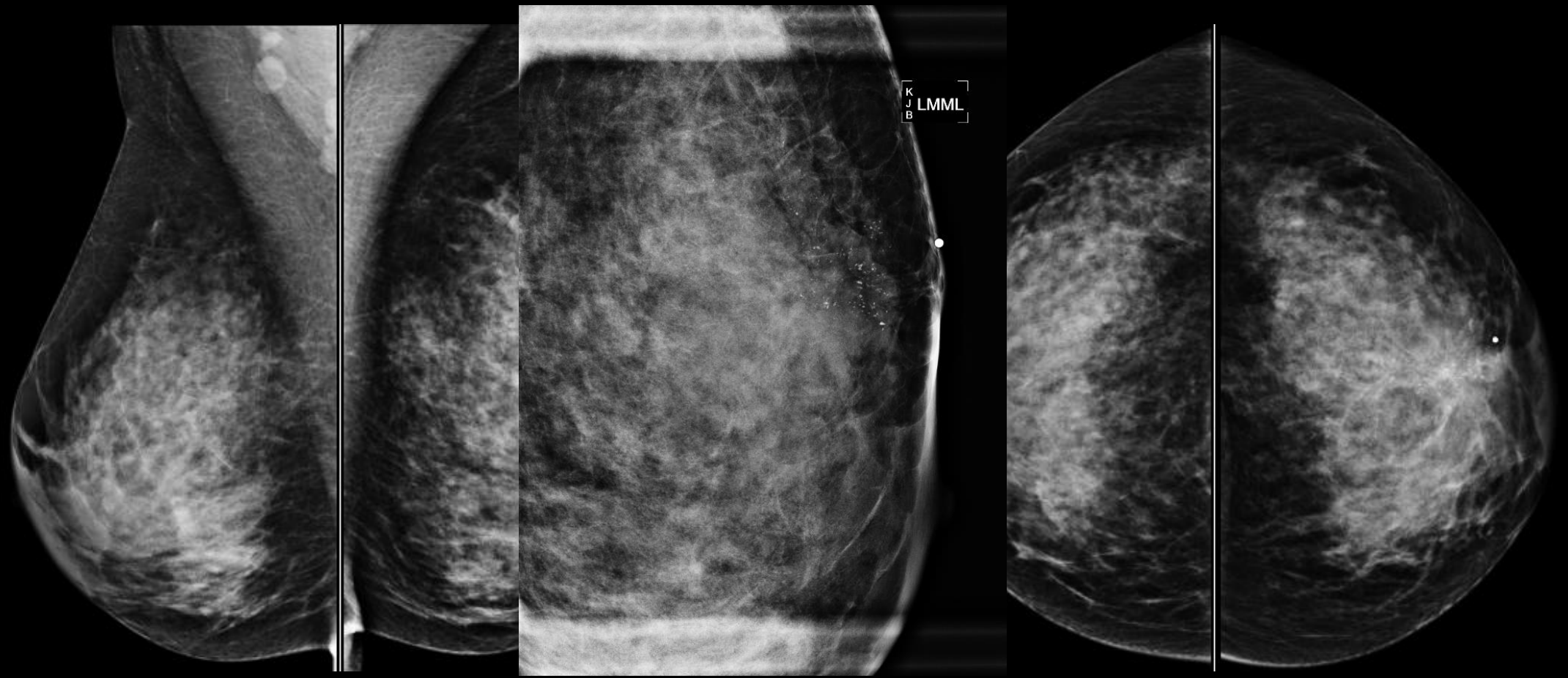


US-guided Core Biopsy

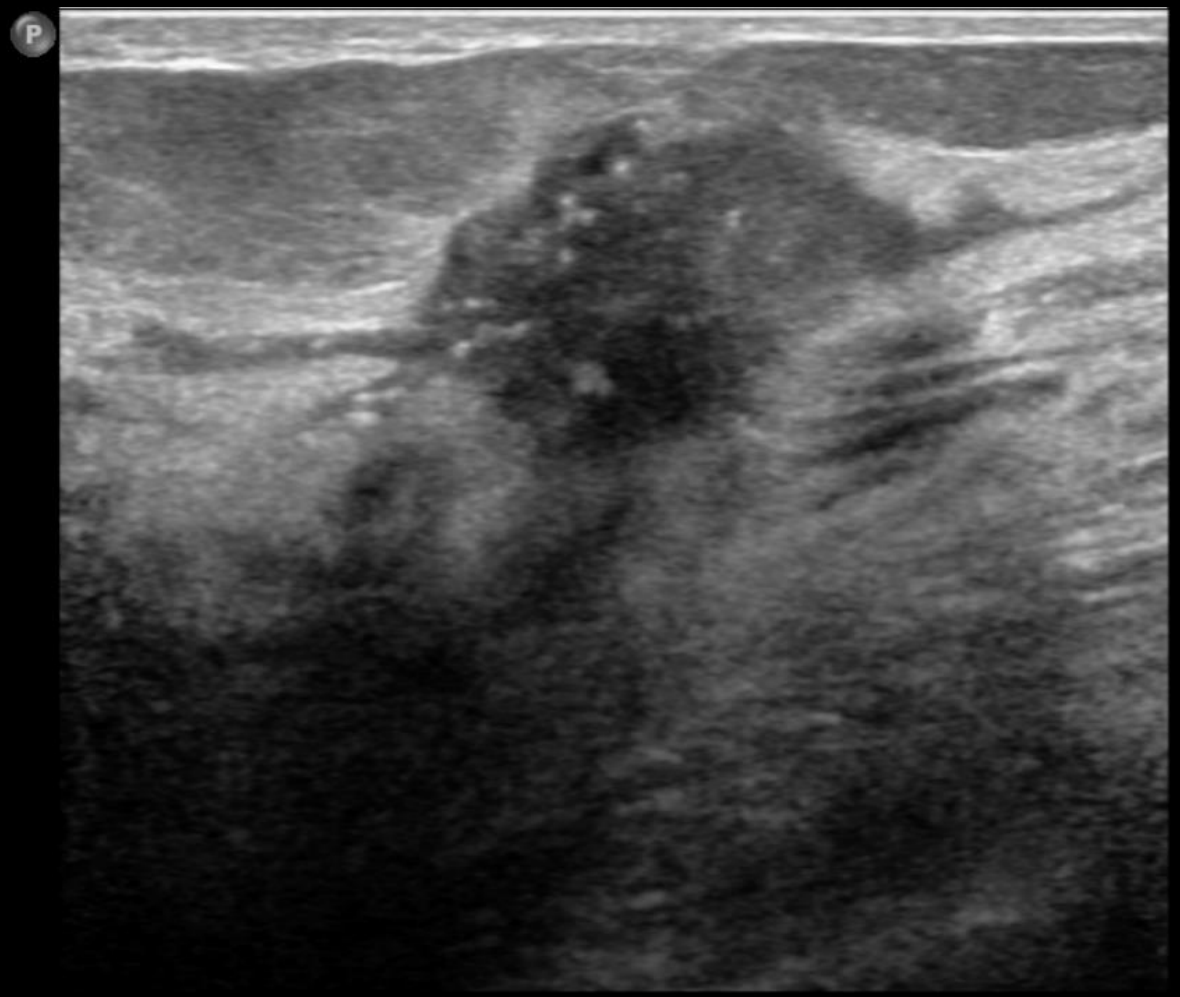


Clip placed after tissue sampling

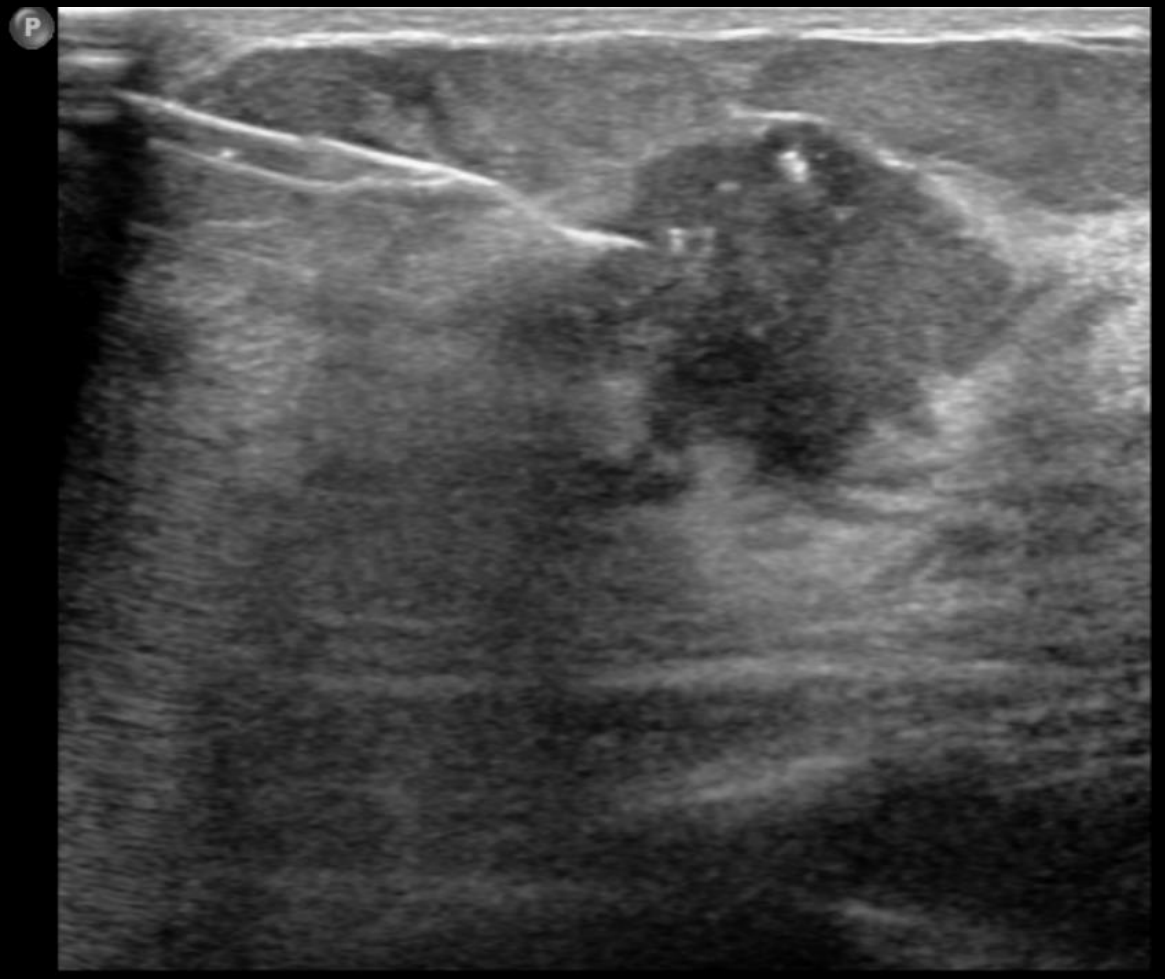
38-year-old patient presents with left lump



A/D with pleomorphic calcs

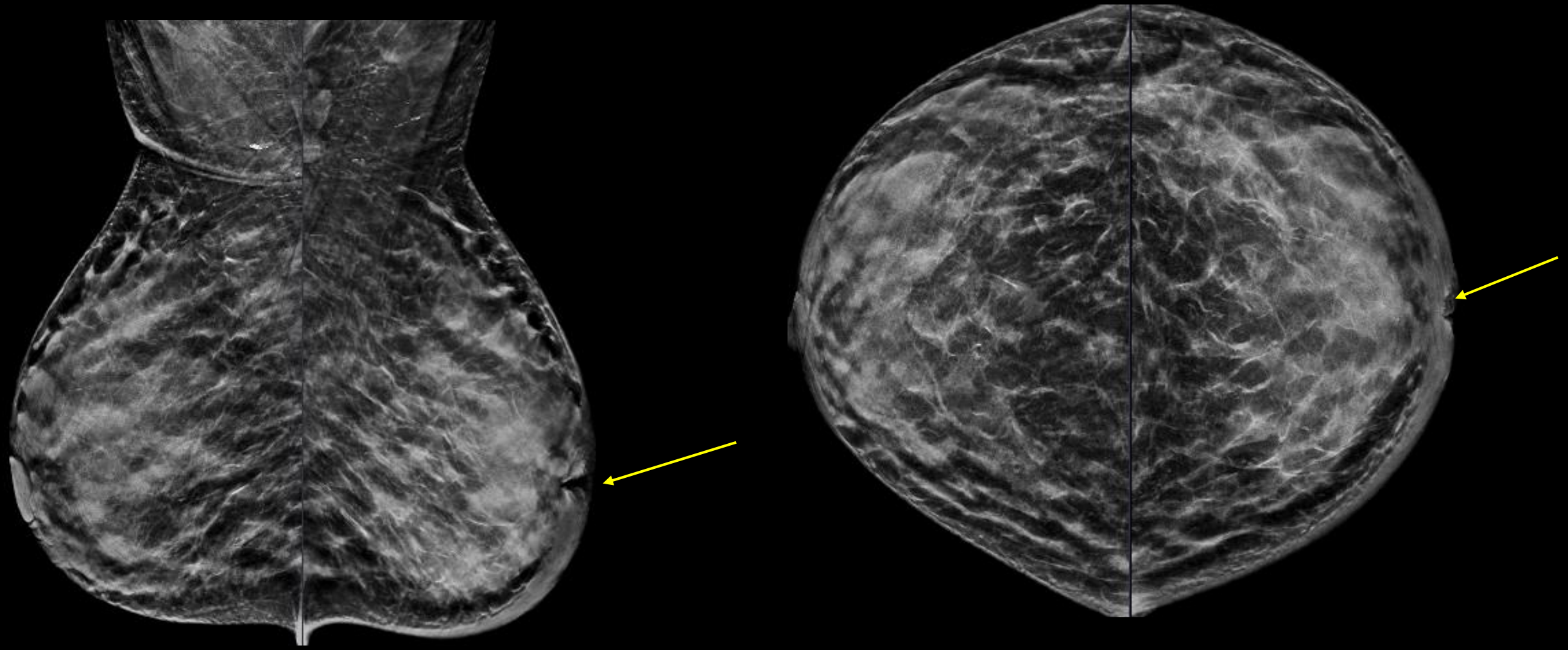


Irregular hypoechoic mass left 12:00 in the area of palpable lump with echogenic foci (calcs)

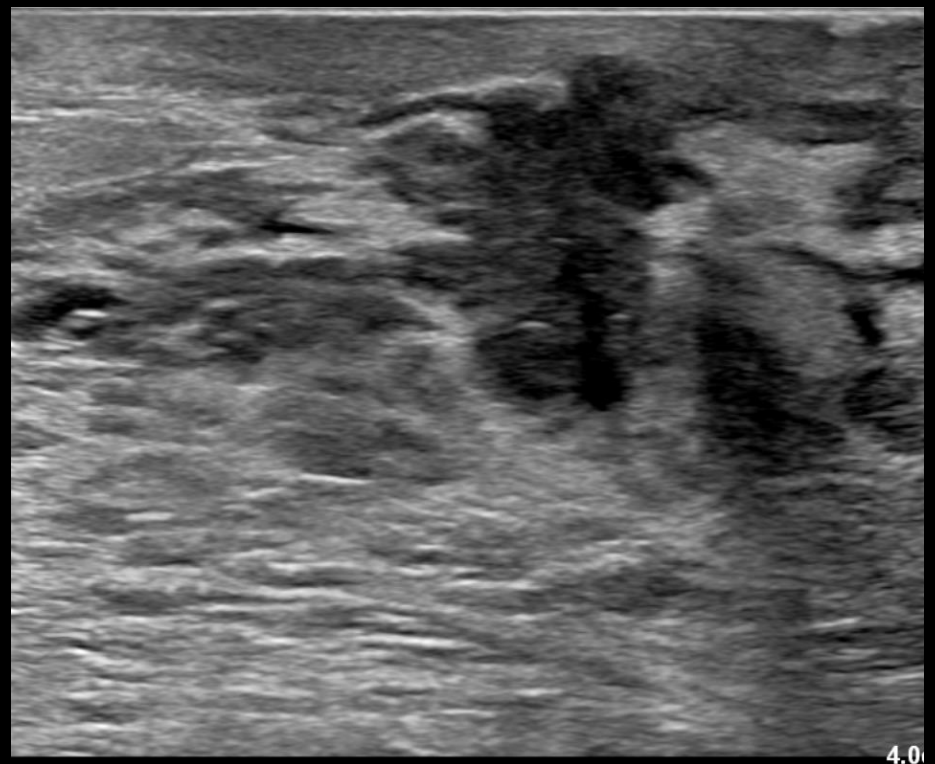


US guided biopsy= Invasive ductal carcinoma

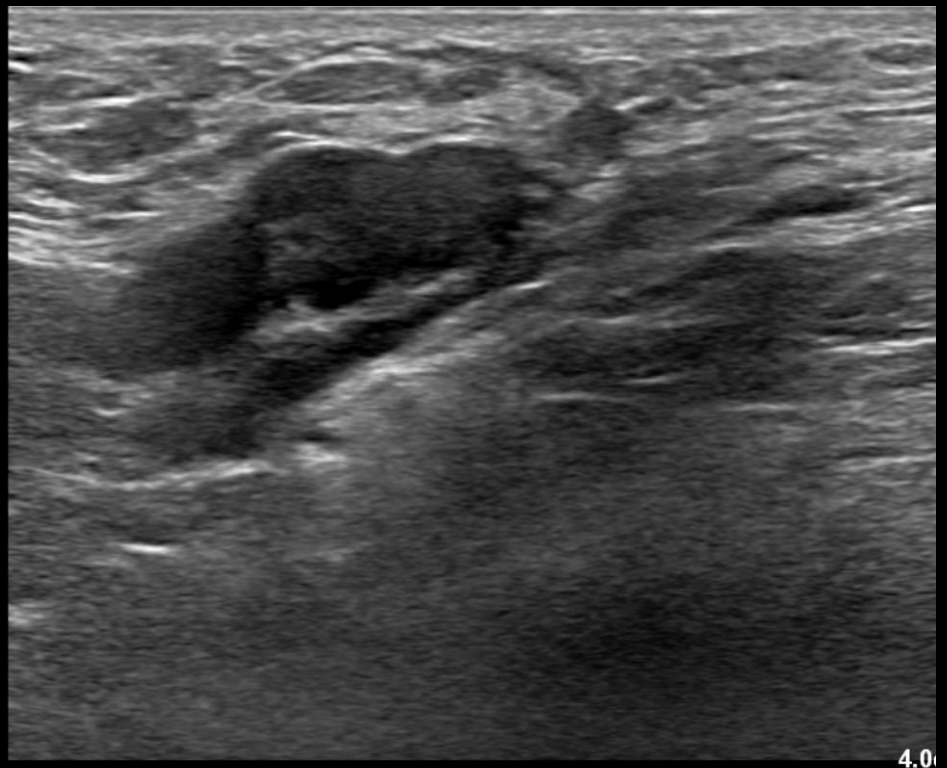
32-year-old 16 weeks pregnant presents for evaluation of probable left mastitis



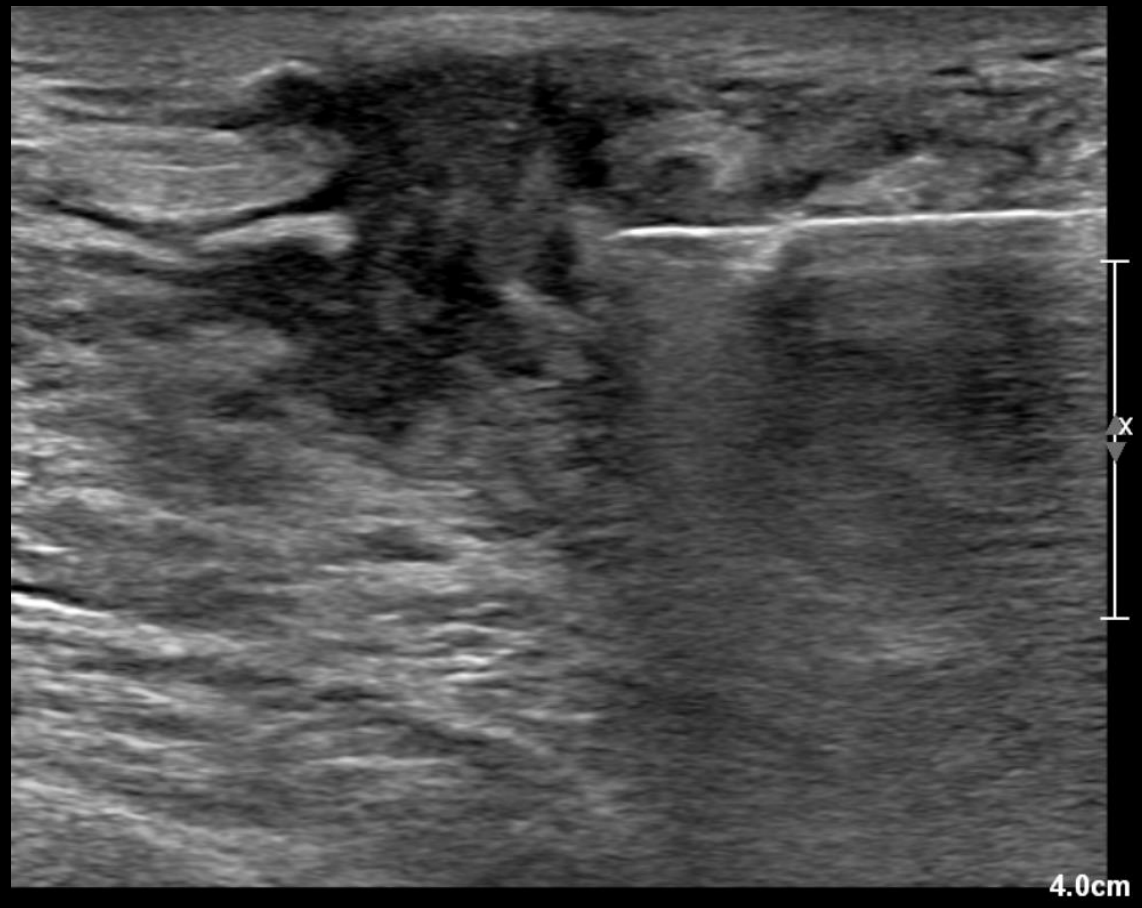
Left nipple inversion, skin thickening, question of distortion SA



LEFT **BREAST SA Trans**

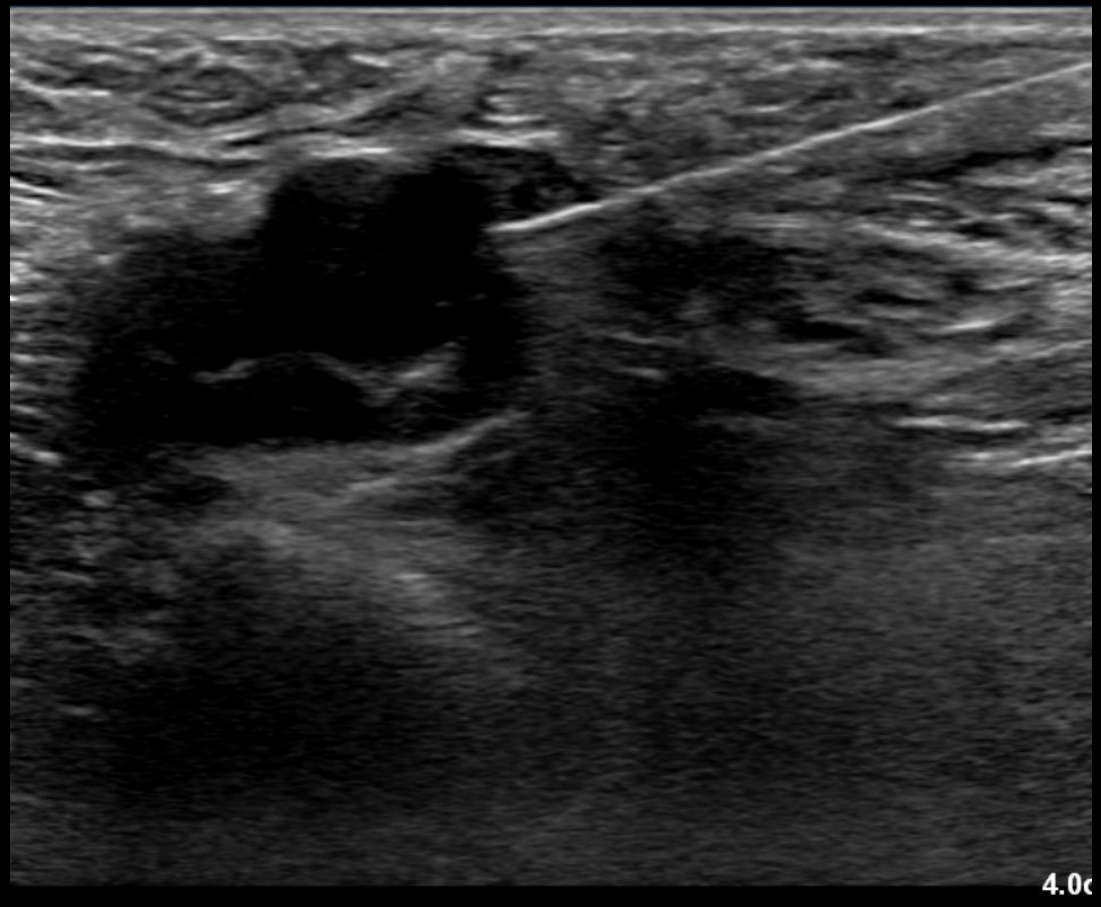


LEFT **BREAST Axilla**



LT BREAST SA Trans PRE BX

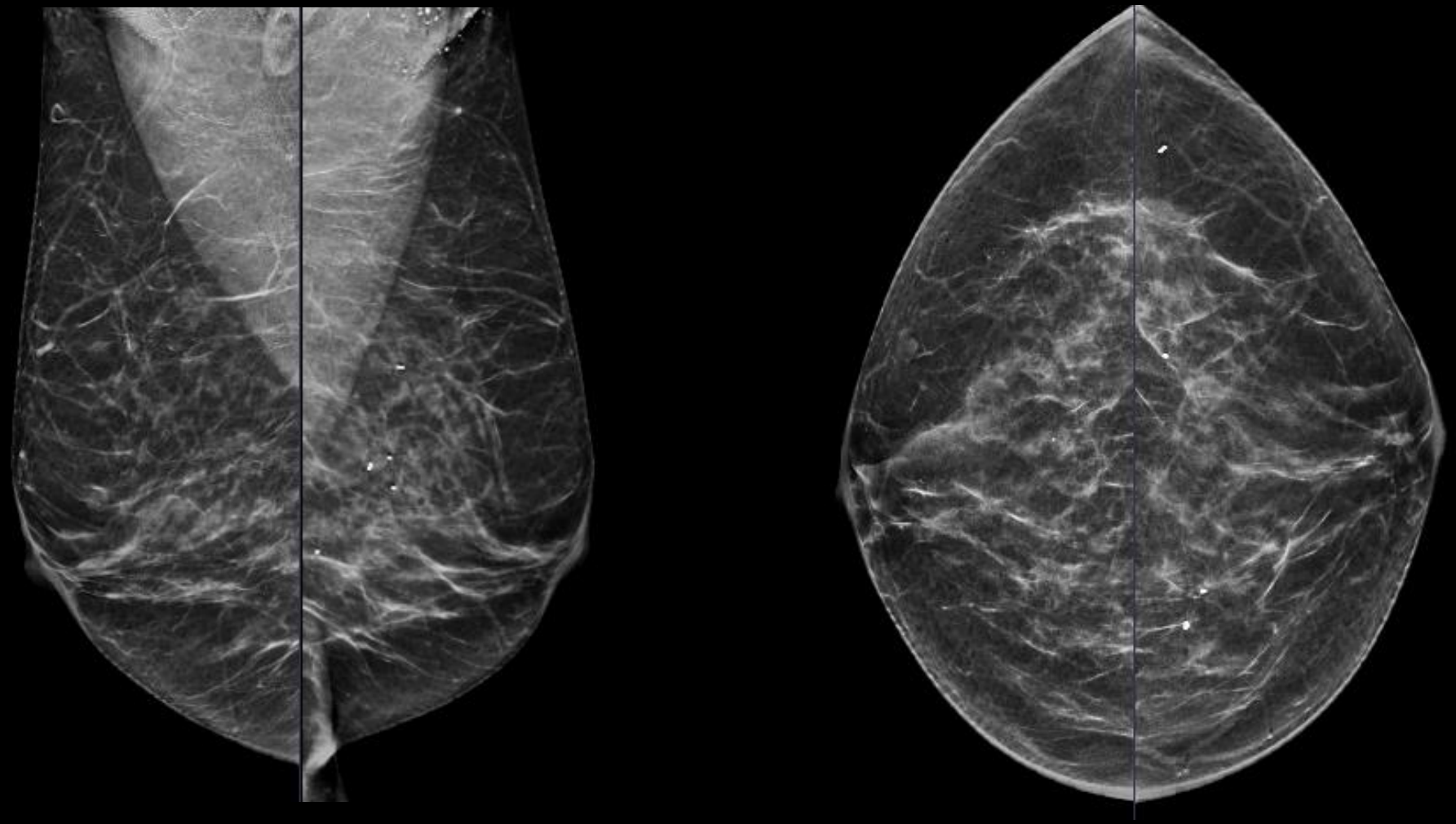
Left SA – Invasive ductal carcinoma gr 2
ER positive, PR positive, Her2 negative

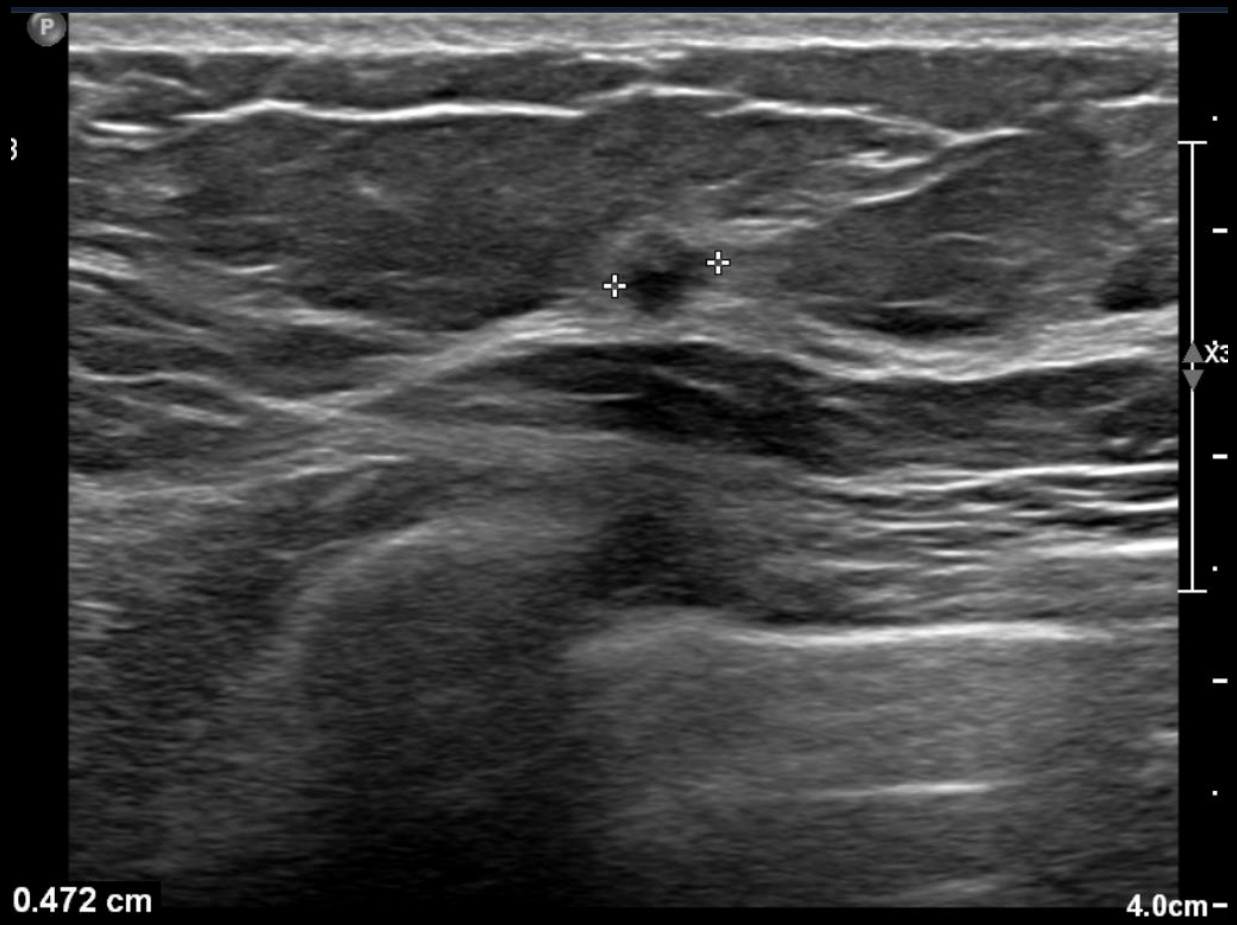


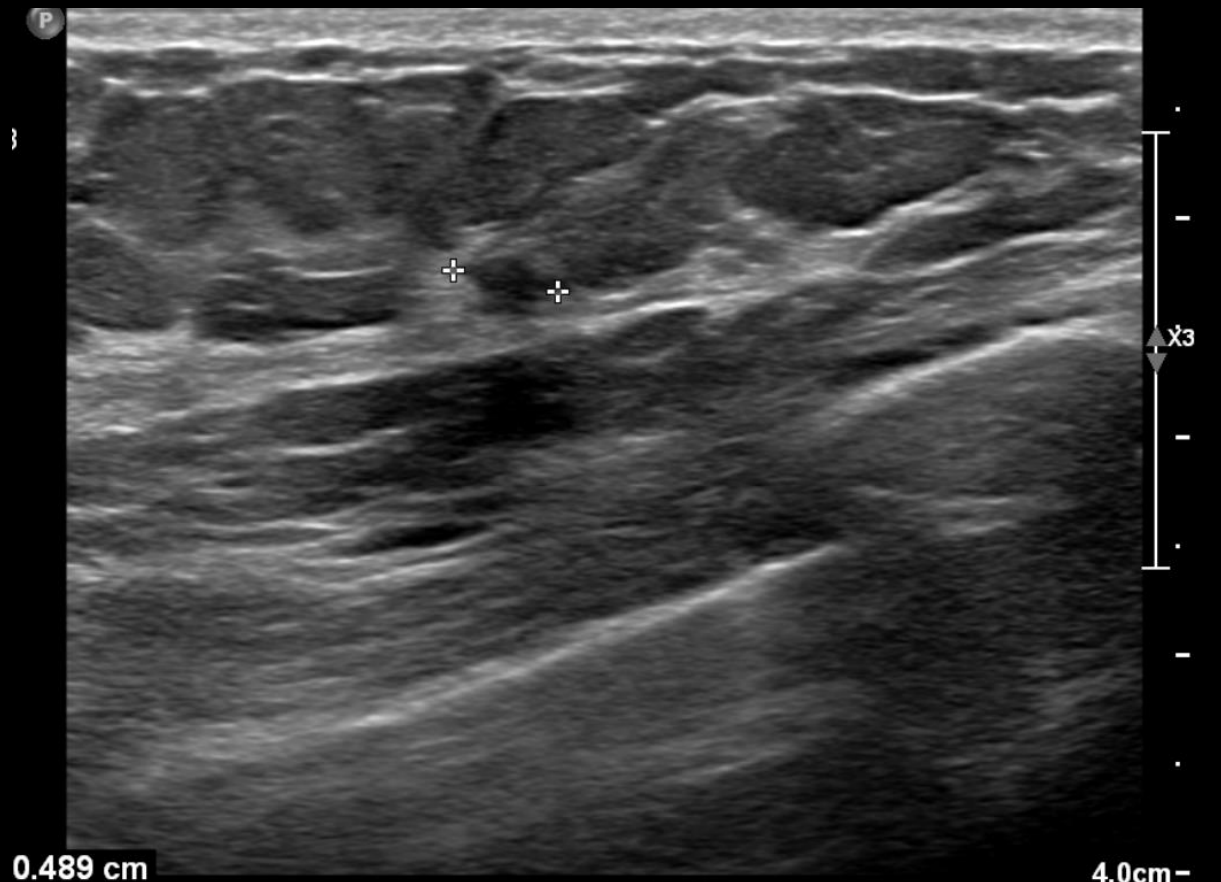
LT BREAST Axilla Trans PRE BX

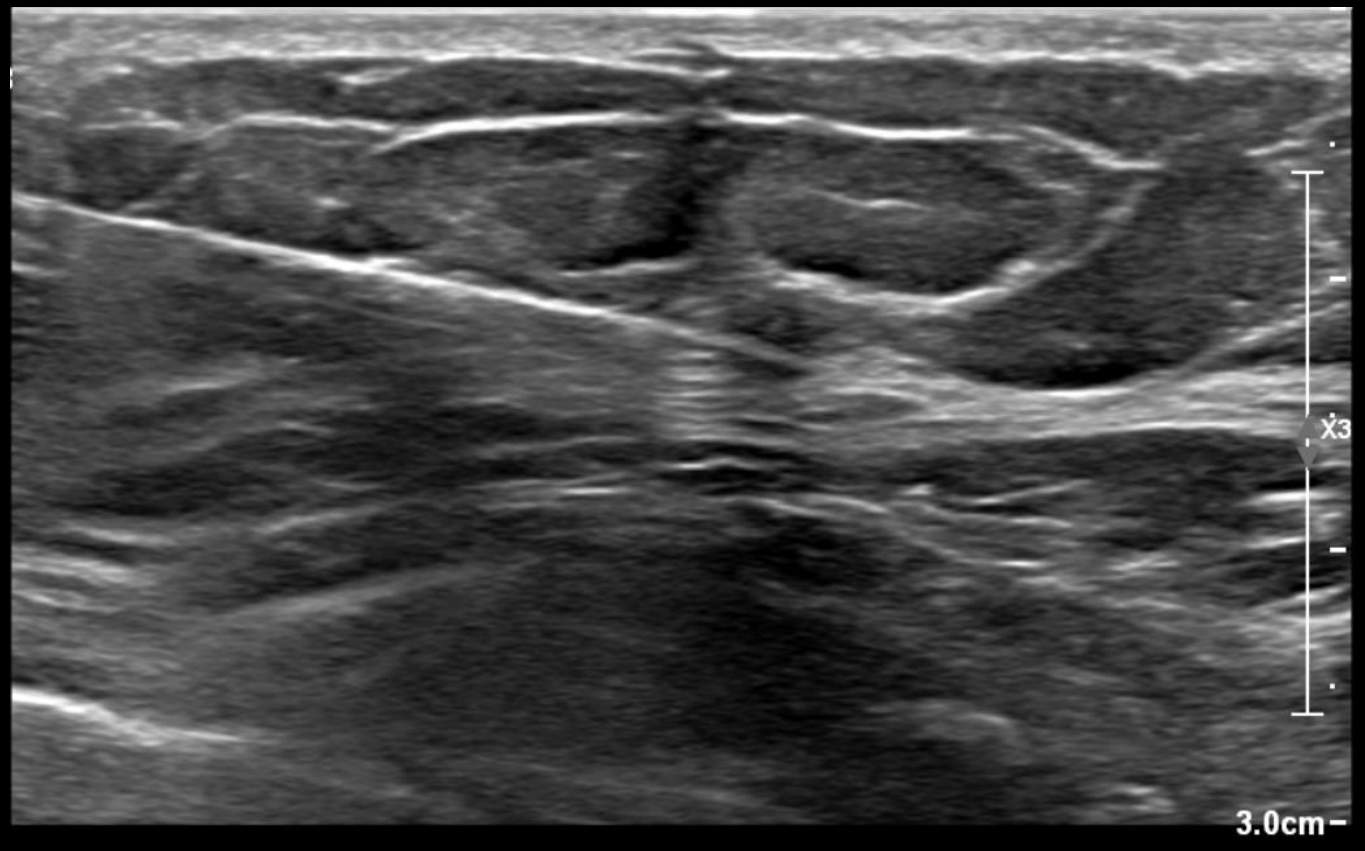
Left axilla – Metastatic ductal carcinoma

60-year-old patient presents for screening mammogram and screening breast US




0.472 cm
4.0cm
RT BREAST 8:00 4 CMFN TRANS


0.489 cm
4.0cm
RT BREAST 8:00 4 CMFN LONG



Invasive lobular carcinoma grade 1

Breast MRI

- Breast MRI can identify cancers not found by mammography or physical exam
- High sensitivity – up to 100% has been reported
  - Specificity lower at 37-97%

Bedrosian I, Mick R, Orel S. Changes in the Surgical Management of Patients with Breast Carcinoma Based on Preoperative Magnetic Resonance Imaging. *Cancer* 2003; 98(3):468-473.

Breast MRI

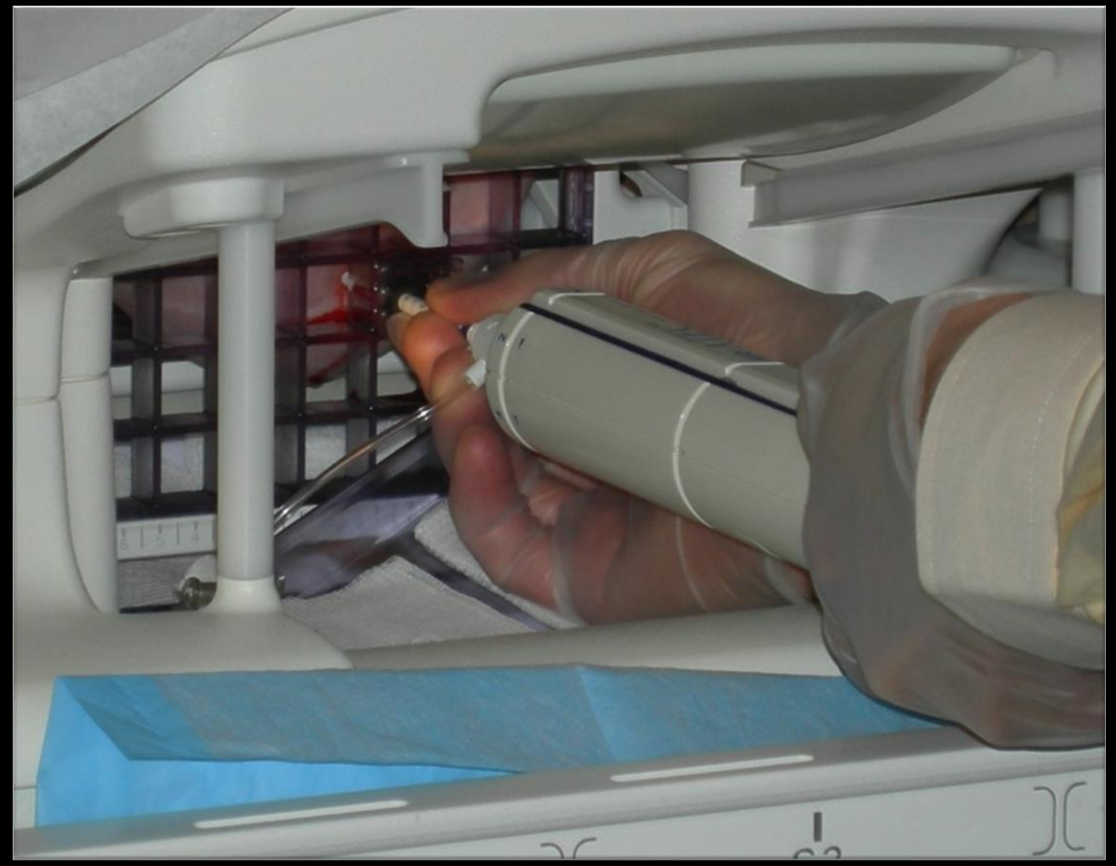
- MRI can identify otherwise unsuspected cancers in up to 4% of women at high risk
- In women with a diagnosed cancer, MRI can identify contralateral disease in 6%
  - 16% in the ipsilateral breast

Liberman L. Breast cancer screening with MRI: what are the data for patients at high risk? N Engl J Med 2004; 351:497-500.
Morris EA, et al. MRI of occult breast carcinoma in a high-risk population. AJR 2003; 181: 619-626.
Lehman CD, et al. MRI Evaluation of the Contralateral Breast In women with Recently Diagnosed Breast Cancer. NEJM 2007;356:1295-1303
Liberman L, et al. MR imaging findings in the contralateral breast in women with recently diagnosed breast cancer. AJR 2003; 180: 333-341.
Liberman L, et al. MR imaging of the ipsilateral breast in women with percutaneously proven breast cancer. AJR 2003; 180: 901-910.

MRI-guided Biopsy

- Increase in detection of MRI lesions due to increase in use of MRI
- MRI biopsy offers ability to sample these lesions that do not have a correlate on mammography or US

- MRI biopsy can be performed with MR-guided needle loc, or with percutaneous biopsy automated core or vacuum-assisted devices

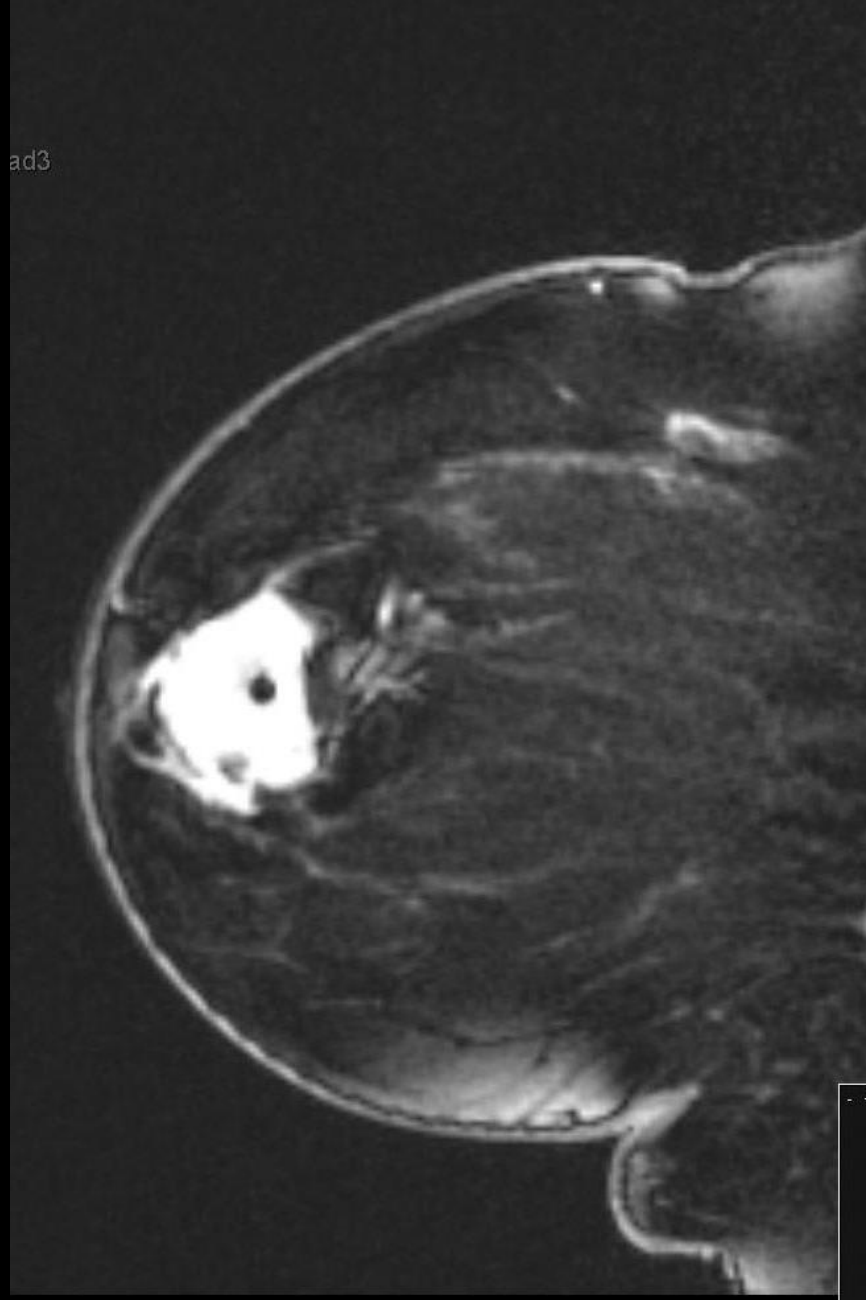


Benefits of MRI Biopsy

- Minimally invasive
- Leaves little or no scarring
- Fast
- No radiation involved
- Safe and accurate
- Less expensive than surgical excision

MRI Guided Biopsy: Obstacles

- Patient must be removed from the magnet to access the breast
- Short window of opportunity (target lesion visibility) after injection of contrast
- Distortion of localization coordinates by the magnetic field
- Excessive bleeding
  - May displace lesion
  - May impair procedure or lead to abortion of procedure
  - Inability to document that the target lesion is removed



Liberman L. Percutaneous Imaging-Guided Core Breast Biopsy State of the Art at the Millennium. *AJR* 2000; 174:1191-1199

MRI-detected Lesions

- Three lesion types that warrant biopsy under MRI guidance:
  - Focus
  - Mass
  - Nonmass enhancement

Success with MRI Biopsy

Author	Lesions	Biopsy Success Rate
Imschweiler et al. (2014)[8]	557	98.4% (548/557)
Ferré et al. (2016)[9]	253	100% (253/253)
Spick et al. (2016)[10]	487	100% (487/487)
Schrading et al. (2017)[11]	1412	99.7% (1408/1412)

MRI Biopsy Procedure

- Approach planning
  - Most performed medial or lateral
  - Shortest route preferred to minimize unnecessary trauma
- Procedure lasts between 30-60 minutes
  - Patient comfort key for optimal imaging/success of procedure

Noroozian M, et al. Factors that impact the duration of MRI-guided core needle biopsy. Am J Roentgenol 2010; 194:W150-157.

MRI Guided Biopsy/Equipment Limitations

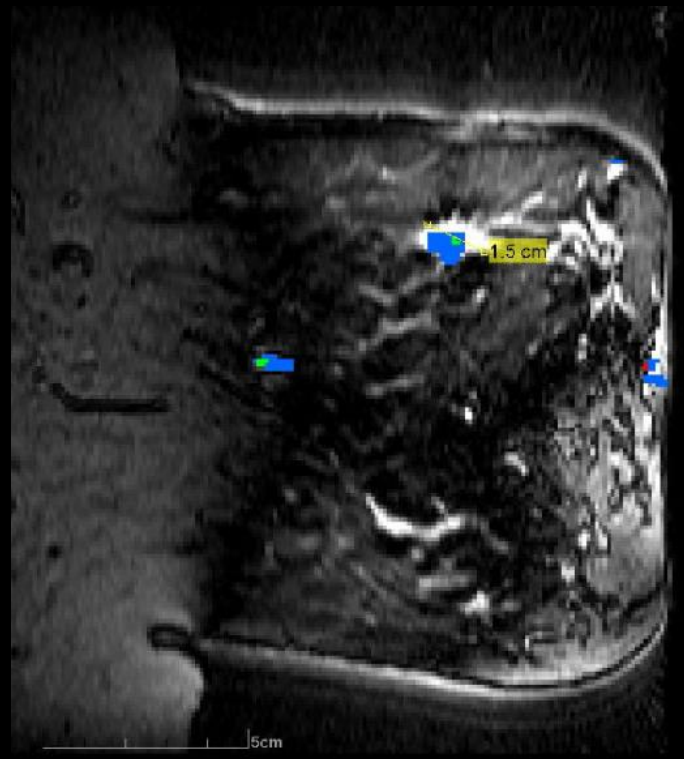
- Posterior lesions
  - Position arms down alongside body
  - Adjust position of grid
  - Oblique patient positioning
  - Remove coil pad
- Breast Size: large breast/coil limitations
- Table weight limitations
- Bore size
- Early on - MRI compatible equipment
  - Needle artifact
  - Tissue shift during probe insertion
  - Contrast washout during procedure
- MRI biopsy coil: medial and lateral access

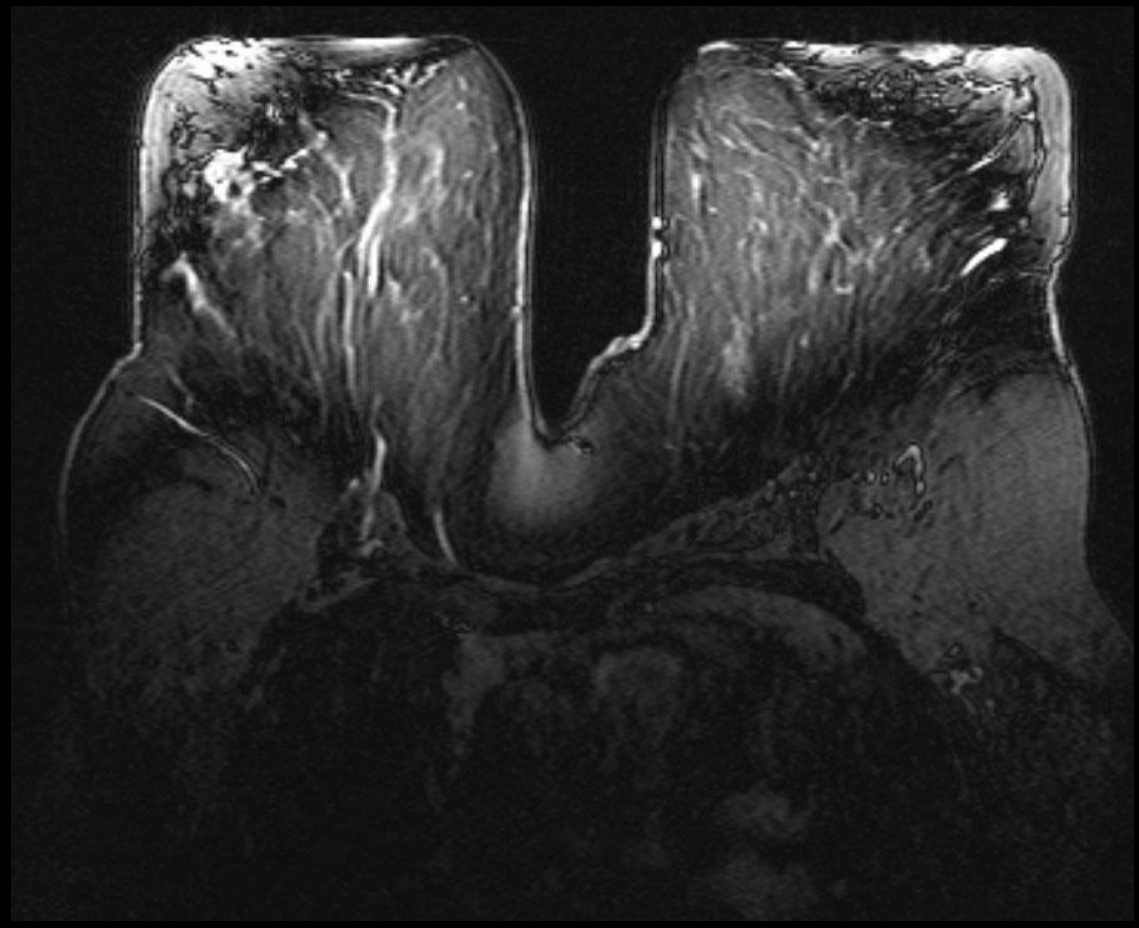
Lehman CD, et al. Posterior lesions: AJR, MRI Guided Vacuum-Assisted Breast Biopsy. AJR 2005; 184:1782-1787.
Price ER. Magnetic resonance imaging-guided biopsy of the breast: fundamentals and finer points. Magn Reson Imaging Clin N Am 2013; 21:571-581.

MRI Guided Biopsy/Patient Limitations

- Lidocaine/hematoma
- Patient comfort/prone positioning
- Patient size/bore opening
- IV access
- Gadolinium sensitivity
- Claustrophobia
- Anxiety
- Artifacts from prior surgeries
  - Augmented breasts
    - Displace implant (similar to mammo positioning)
    - Place vacuum assisted device posterior to lesion and only acquire samples in the anterior direction
  - Posterior Lesions
    - Position vacuum assisted device next to the lesion
  - Patient motion
  - Time limitation/contrast enhancement

Limitation: Breast Size





Distortion of tissue and motion artifact

Limitation:
Patient Size/Bore Size

Tips for Success

- Communicate with patient throughout the procedure
- Optimize patient comfort
  - Minimizing motion
- Persistence pays off
  - Take a break during difficult positioning if necessary
- Know your target
  - Complete imaging evaluation prior to planning biopsy
  - Formulate differential diagnosis
  - Communicate with technologists/assistants
- Choice of biopsy device/needle gauge
  - Target features - including location
  - Differential diagnosis
- Shortest distance from skin to target whenever possible

Scan Procedure

- Positioning
- Contrast administration
  - 10mL Dotarem
  - Recommended 0.1mmol/kg followed by 10cc saline flush
- Imaging sequence
  - Delay between contrast injection and acquisition varies, range from 30 to 60 seconds [McGrath]
  - After contrast, 20-30 min working time frame for targeting and performing biopsy [Price]

Imaging Sequences

Start with 3-plane loc

All sagittal images, 1-minute scans

- Speed more important than resolution

Noncontrast T1 fat sat

Inject

Post gad T1 fat sat – targeting image

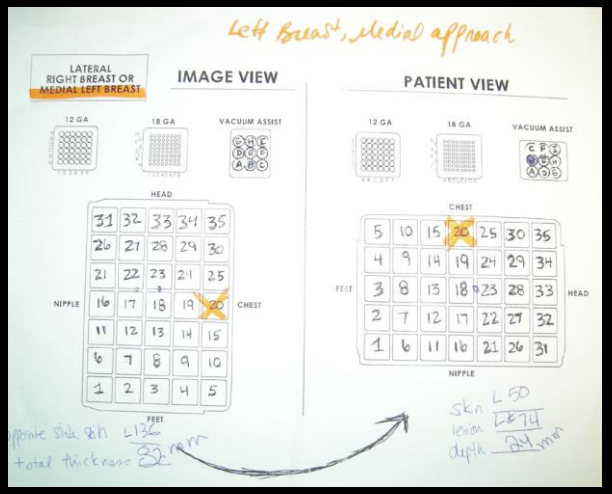
- May need to do several for delay, or fast for washout

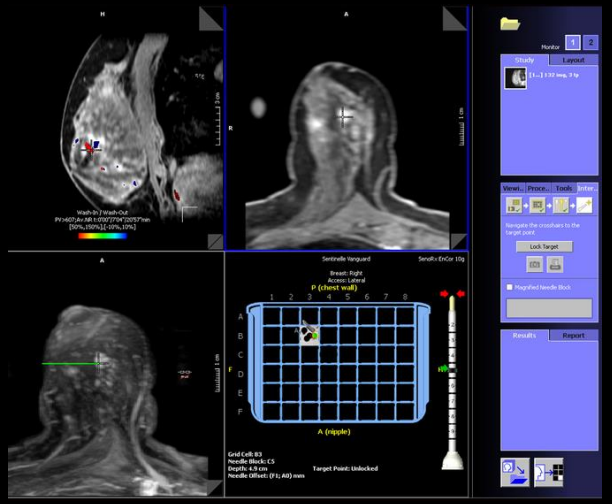
Axial to confirm placement (sometimes)

- Or post clip mammogram

How We Target the Lesion

- Post injection - Bring up slice that contains lesion
- Note the slice location
- Skin minus slice = depth
- Lesion slice minus opposite skin = probe clearance (stroke margin, except no firing)
- Use software to mark lesion and page back to waffle pattern to mark insertion point





Sampling

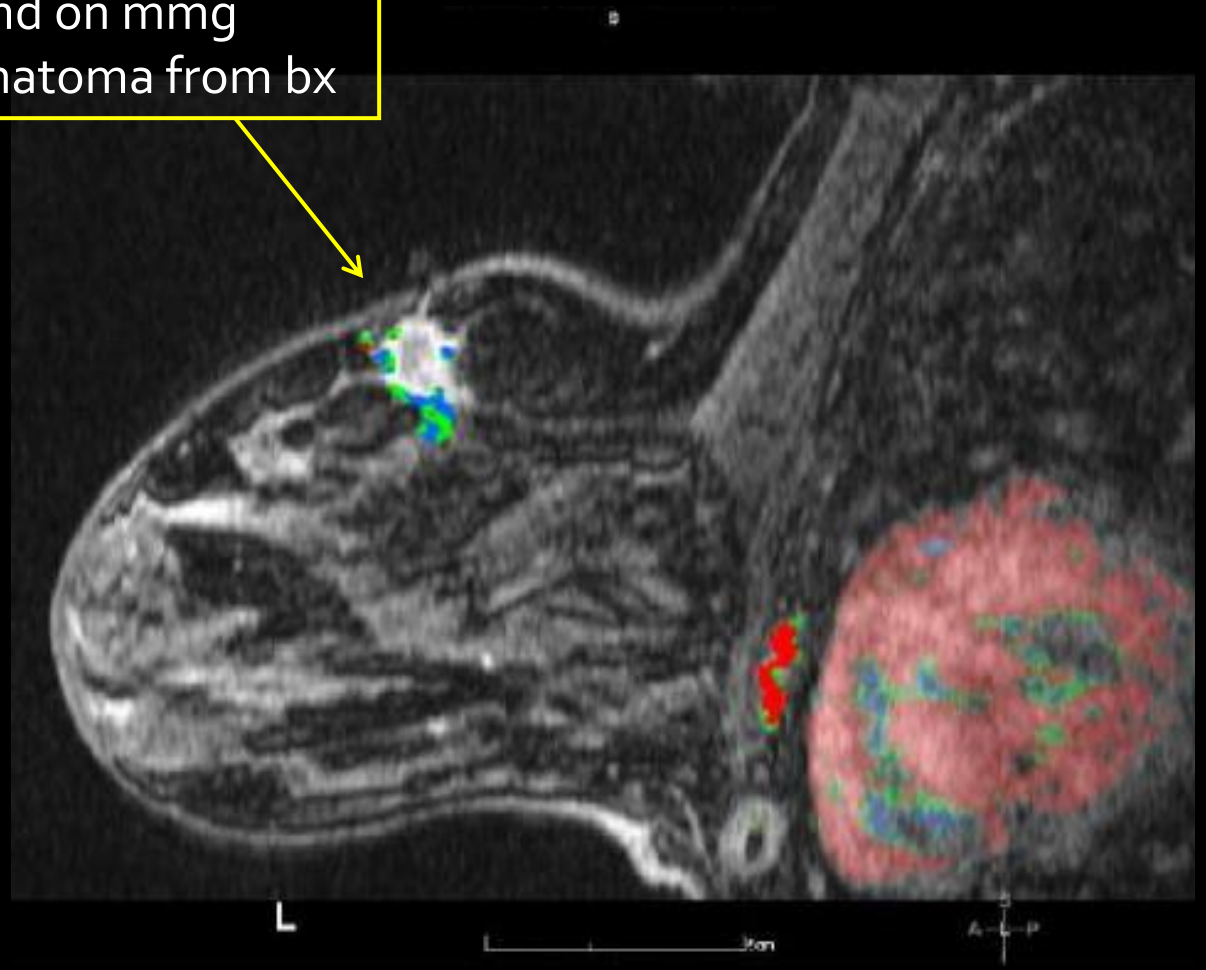
- Note the location of lesion relative to obturator
- Orient trough toward lesion for best sampling

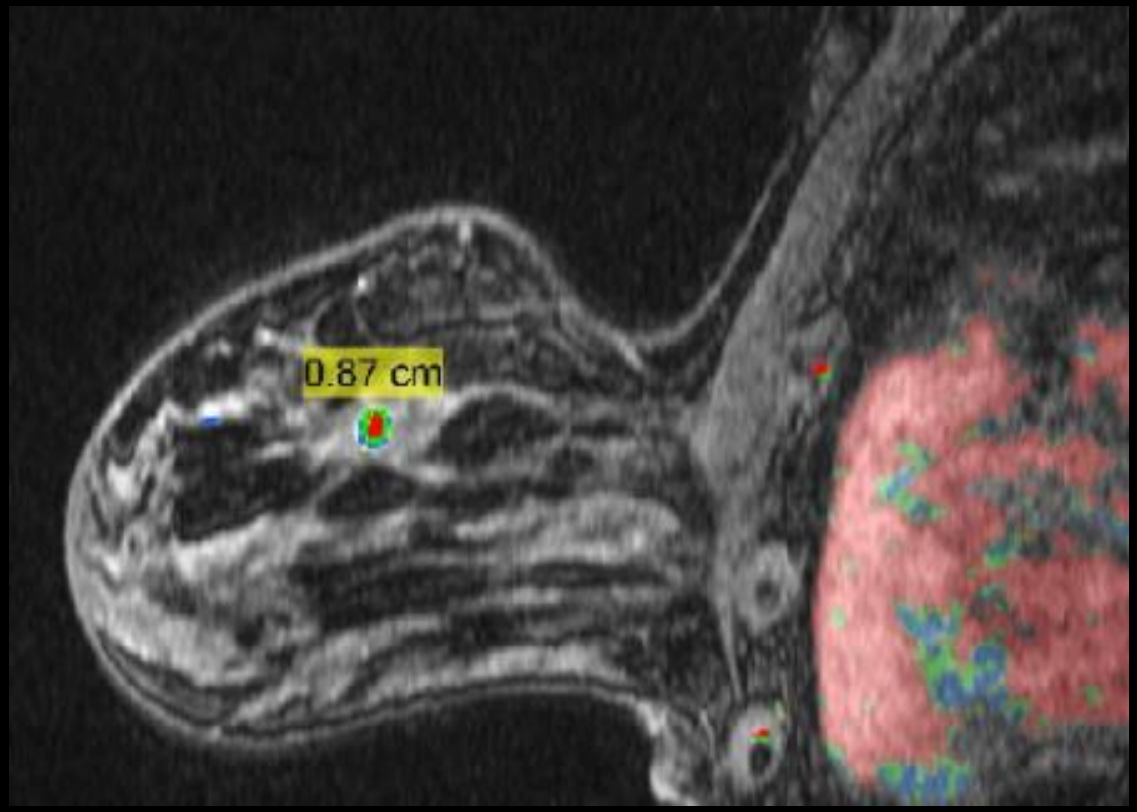
Sampling

- Lavage following sampling completion
- Image to confirm sample area
- Clip placement
- Clip image (MR and mammogram)


Original lesion found on mmg
New lesion found on MR

Original lesion found on mmg
Rim enhanced hematoma from bx

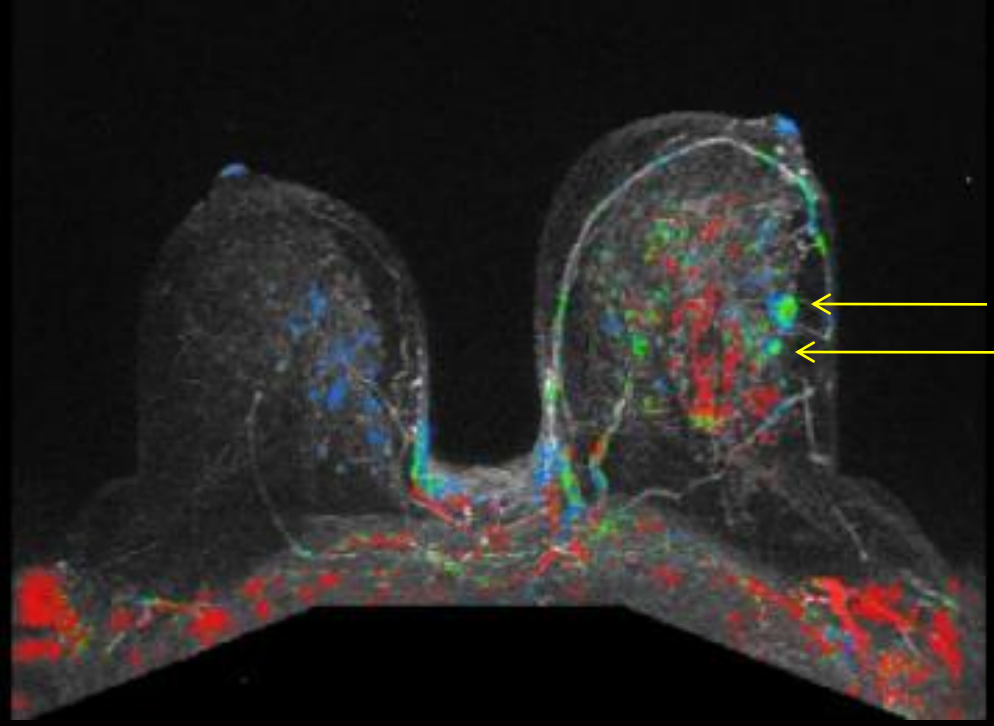


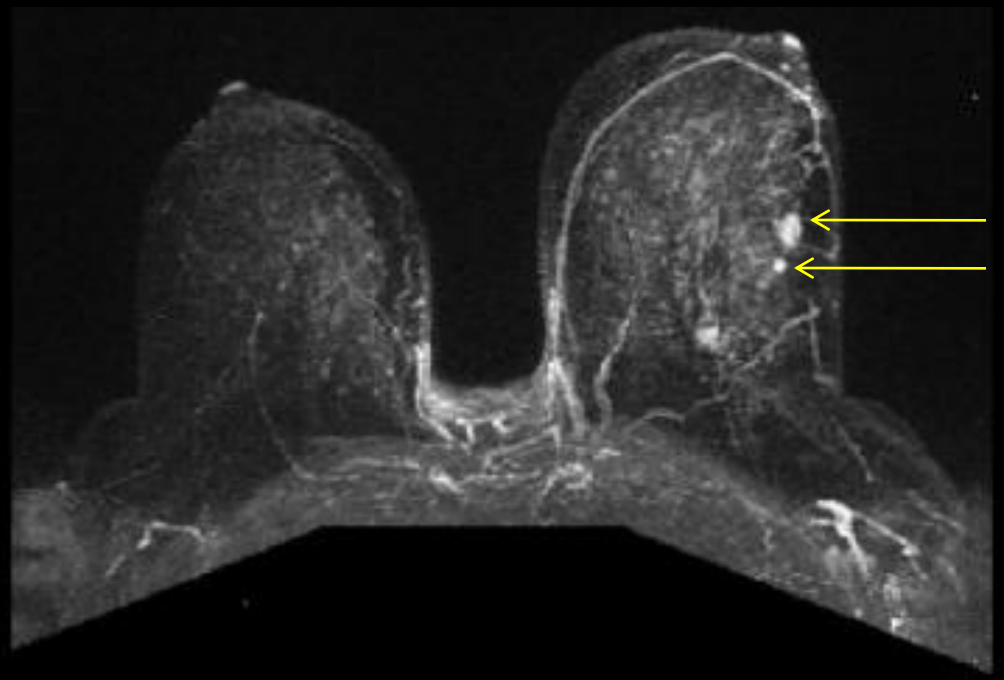


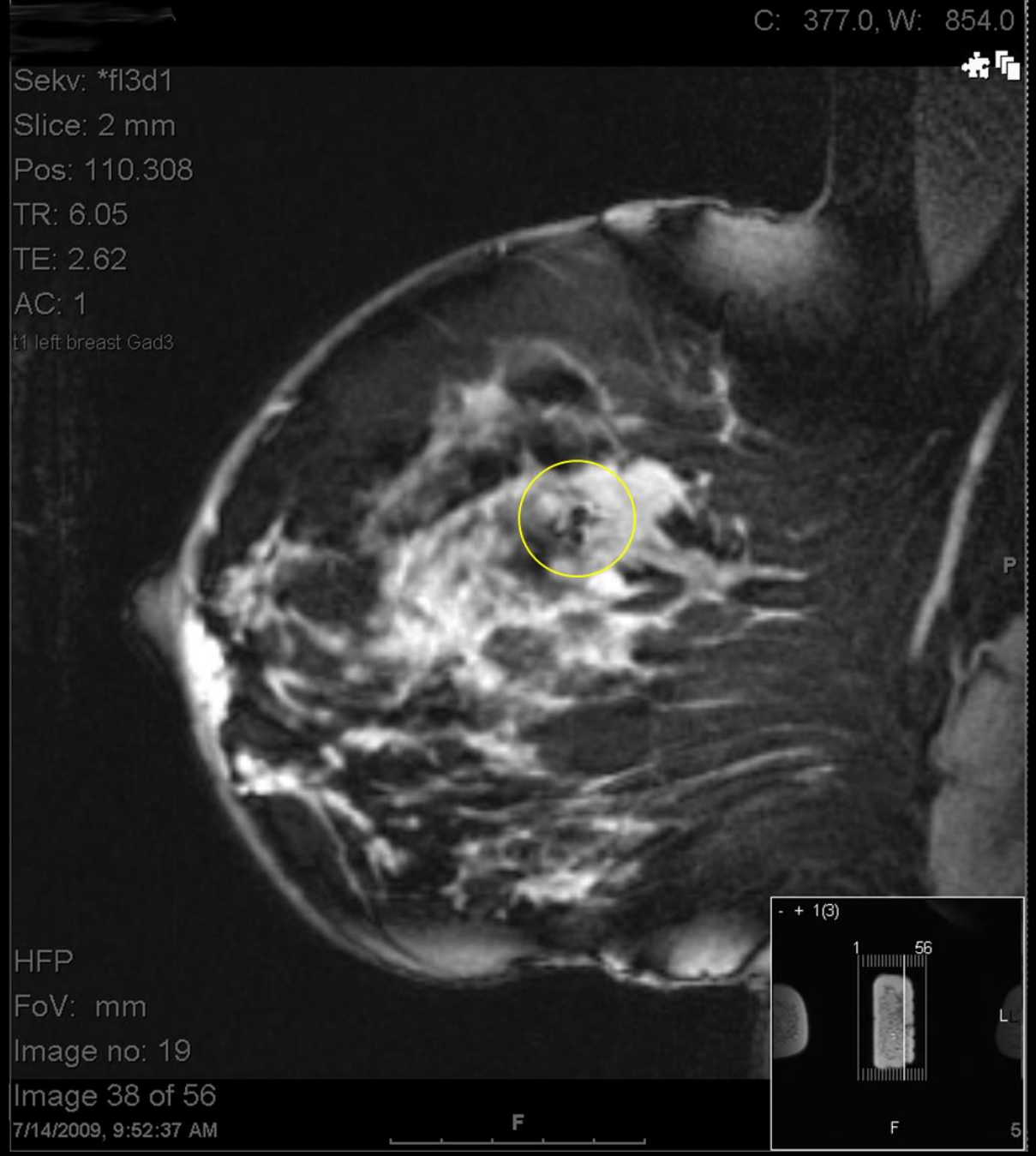
New lesion found on MR

MRI biopsy reveals IDC, nuclear grade 2

Patient proceeded to left mastectomy
0/20 nodes


Original CA
Satellite lesion


Original CA
Satellite lesion



MRI biopsy reveals
IDC NG2
DCIS NG2

Morphology similar to original CA

Concordance with Imaging

- Post-op/ post-biopsy MRI in patients where there is a question as to whether or not the lesion was removed
  - Careful review of post biopsy MRI images
    - Reposition and re-inject and take more tissue samples
- Imaging/pathologic discordance occurs in approx. 7-9% of MRI biopsies
- Lesions with discordant imaging have a 30% higher rate of malignancy
  - Repeat biopsy should be considered

Morris and Liberman. Breast MRI Diagnosis and Intervention, Chapter 20; Percutaneous Magnetic Resonance Imaging Guided Breast Biopsy
Noroozian M, et al. Factors that impact the duration of MRI-guided core needle biopsy. Am J Roentgenol 2010; 194: W150-157.
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Lee JM, et al. Imaging histologic discordance at MRI-guided 9-gauge vacuum-assisted breast biopsy. Am J Roentgenol 2007; 189: 852-859.

Follow-up of Benign MRI Biopsy

- Confirmation that target lesion was sampled
- Confirmation that the target lesion is not growing
- 6–12-month follow-up imaging for benign-concordant imaging
  - Sooner if concerns about sampling accuracy
  - Can have issues with compliance due to varying insurance coverage/policies

Needle Core Biopsy Follow-up of Benign Lesions

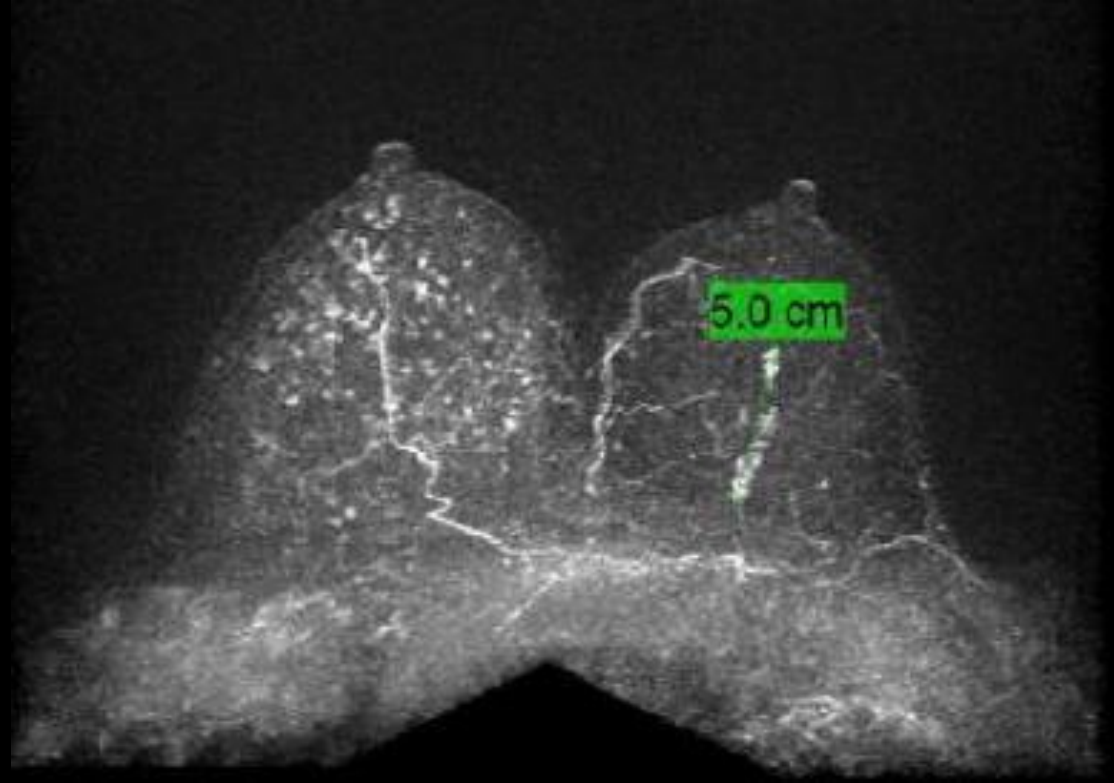
- Li and colleagues reported that benign lesion follow up MRI at less than 4 months may have limited value, however at 6 months could show otherwise undetected interval enlargement without sacrificing early detection that a longer interval time frame may have

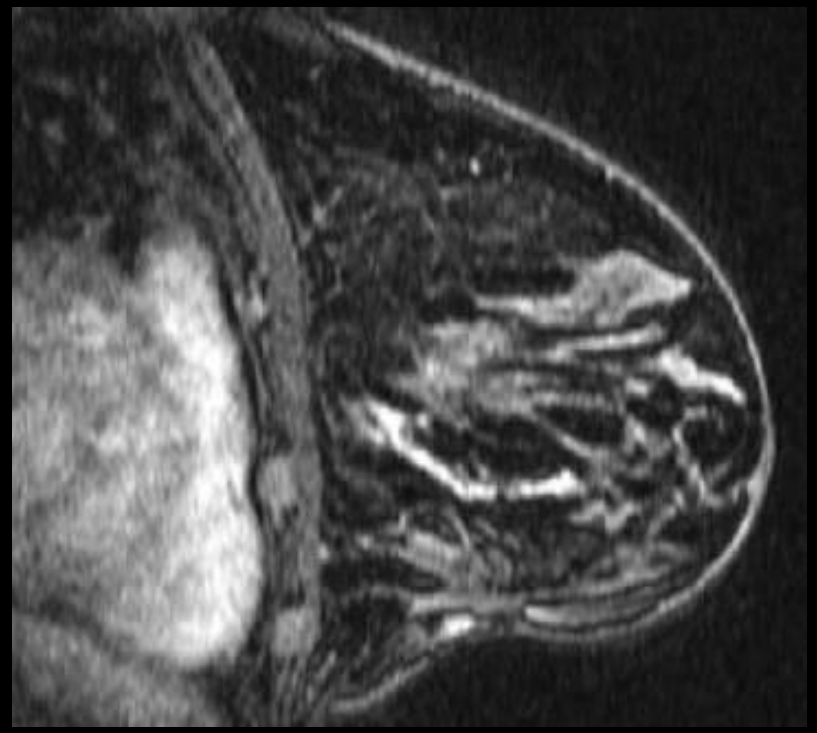
Li L, Dershaw DD, Lee CH et al. MRI Follow-Up After Concordant, Histologically Benign Diagnosis of Breast Lesions Sampled by MRI-Guided Biopsy. *AJR* 2009; 193:850-855.

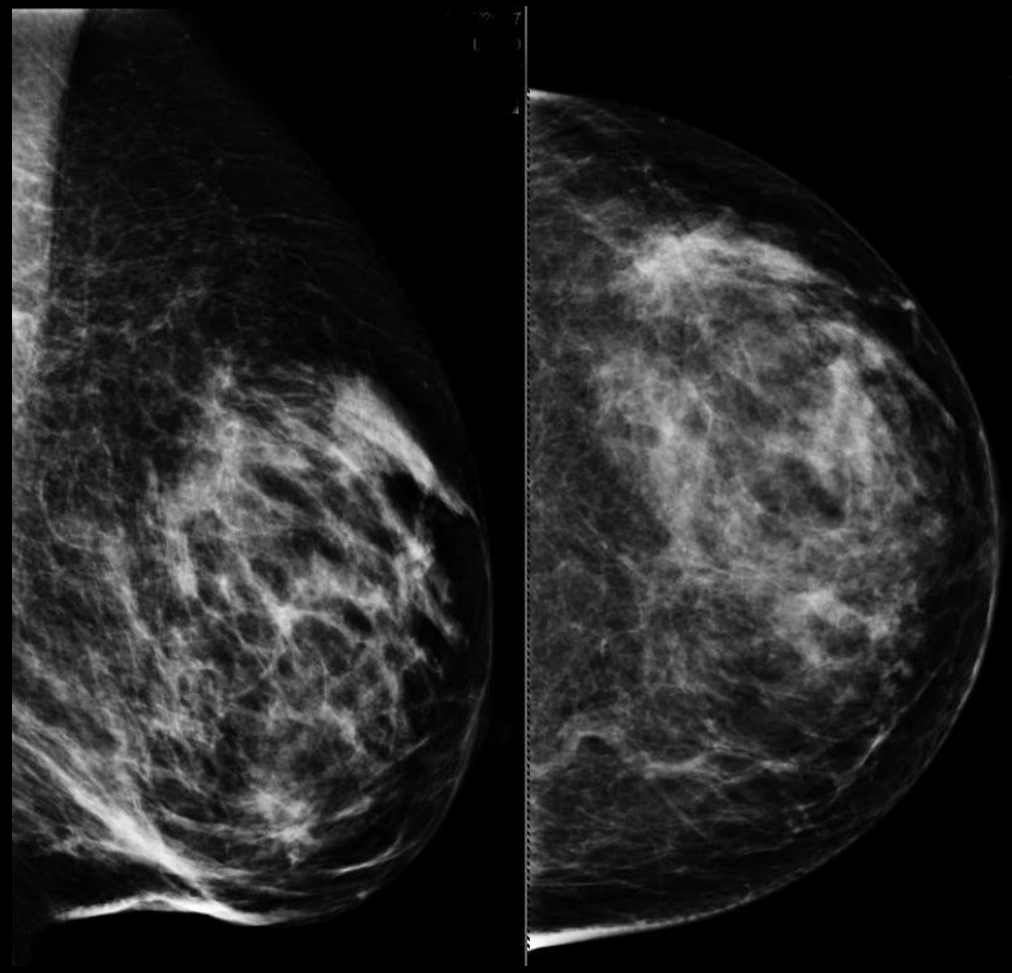
Follow-up after Non-visualization at NCB

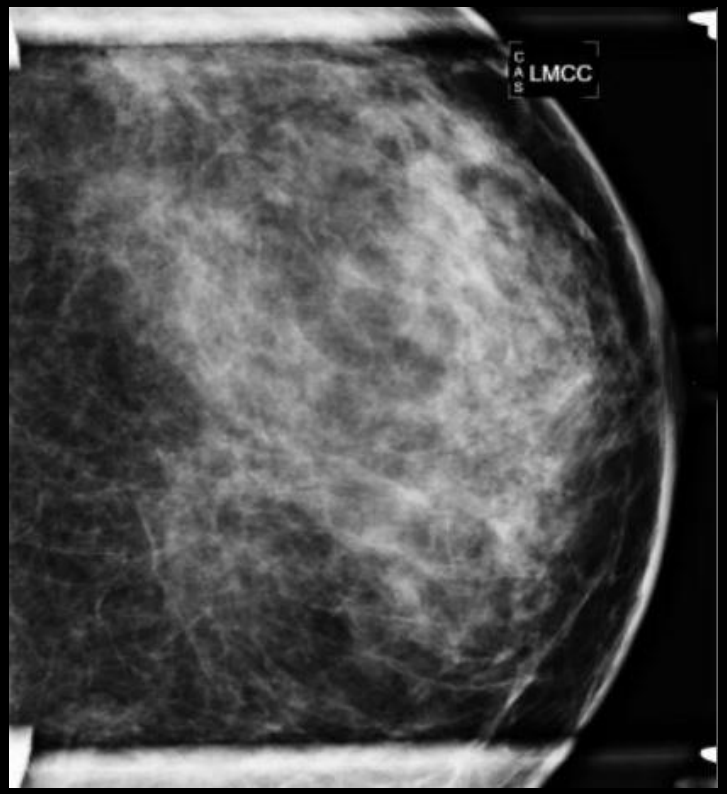
- Study to determine the rate of cancelled MR guided breast biopsies due to non-visualization of the lesion
  - Also assessed associated features and outcome data for these cases
- Found MR guided biopsy was cancelled due to lesion non-visualization in 8%
- Cancer detection rate in this population was low
  - Conclusion: Short-term follow-up MR imaging is prudent

Brennan SB, Sung JS, Dershaw DD, et al. Cancellation of MR Imaging–guided Breast Biopsy Due to Lesion Nonvisualization: Frequency and Follow-Up. Radiology 2011; 261: 92-99.


5.0 cm



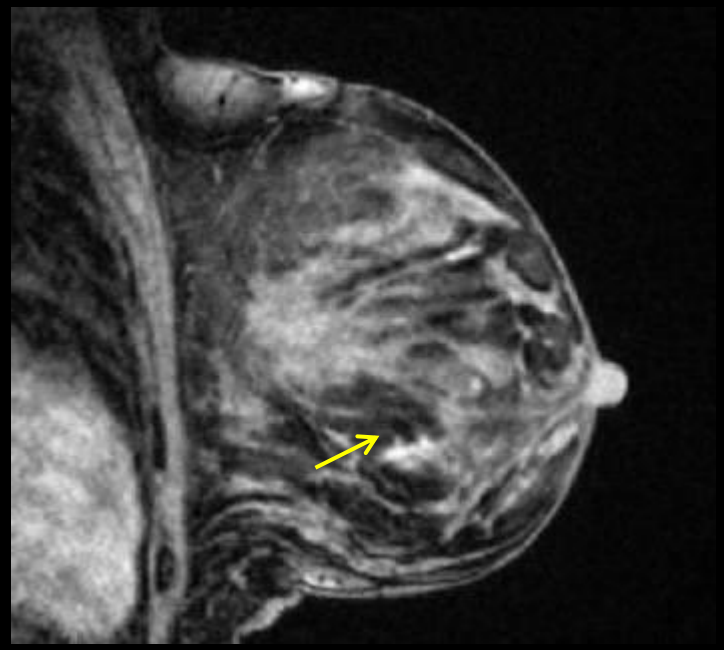



LMCC

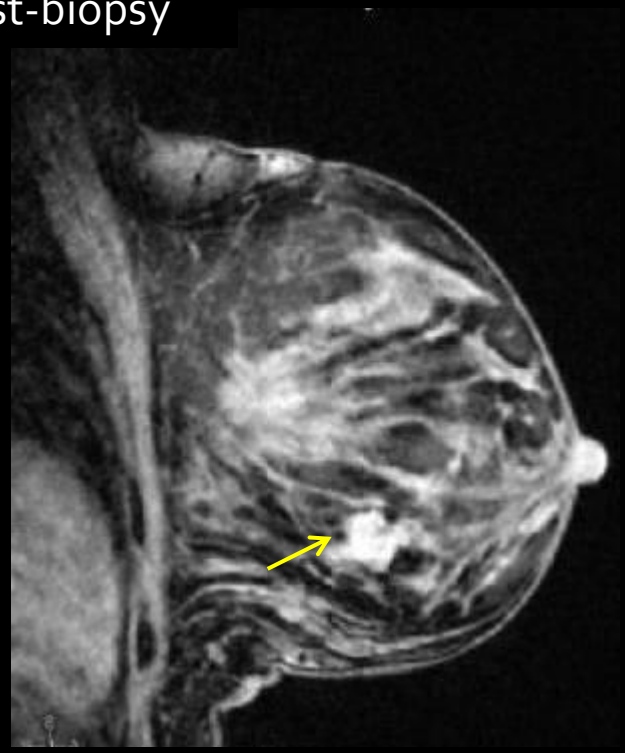
Targeted Ultrasound

Benign appearing US-nothing to correlate to linear enhancement on MRI

Pre-biopsy



Post-biopsy



MRI biopsy= Intraductal Carcinoma, NG 3

Patient proceeded to surgical excision where pathology revealed DCIS

Summary

- Multimodality imaging requires multimodality biopsy capabilities
- Core needle biopsy is proven to be efficient and cost-effective

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Thank You!

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