

Ultrasound-Guided Biopsy

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Disclosures

- Subtle Medical – advisory panel
- Seno Medical – advisory panel
- Bracco – advisory panel
- Guerbet – advisory panel

Overview

- Benefits
- Technique
- US-guided biopsy of calcifications
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance

Overview

- **Benefits**
- Technique
- US-guided biopsy of calcifications
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance

Cost-effectiveness is essential in any breast imaging program.

Percutaneous breast biopsy is cost-effective.

Cost-effectiveness of two breast biopsy procedures: surgical biopsy versus vacuum-assisted biopsy

Confronto costi ed efficacia di due sistemi di biopsia mammaria: biopsia chirurgica vs. biopsia vuoto-assistita

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ray and anaesthesiological assessment. With regard to the choice of imaging guidance, although based on the modality that best allowed lesion detection, ultrasound (US) was preferred where possible due to its lower cost and ease and speed of use. Stereotactic guidance was used in patients

Benefits

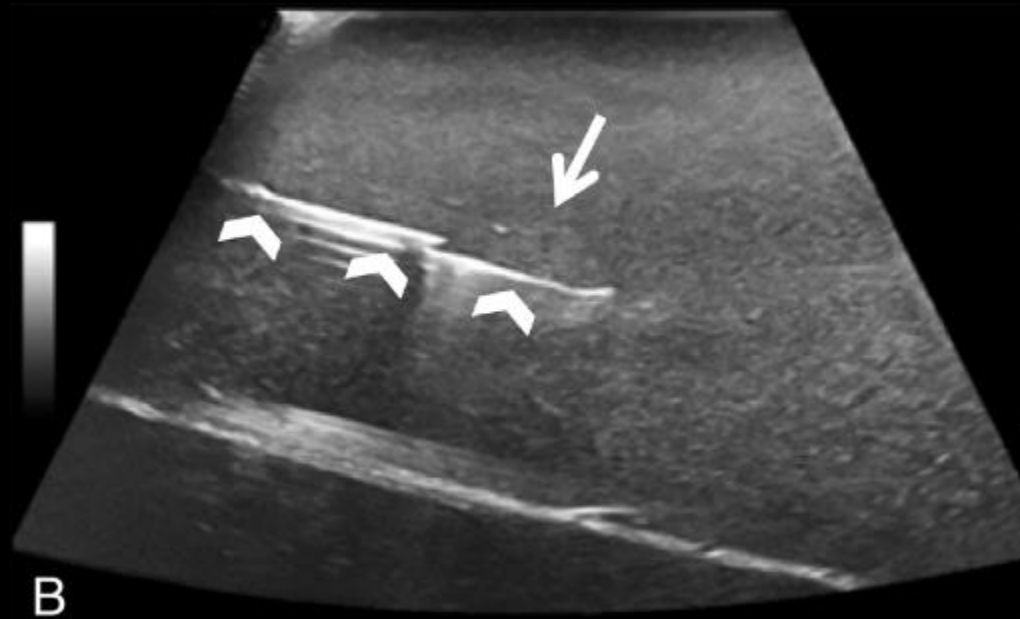
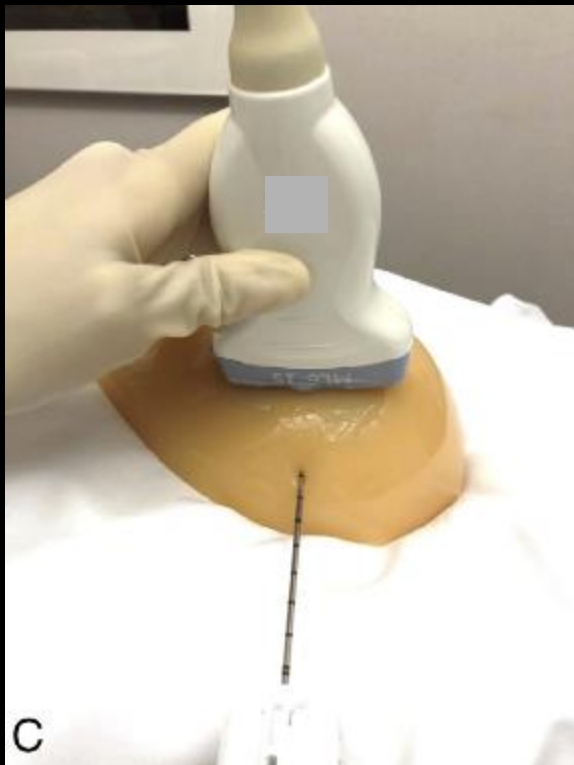
- Real-time visualization of needle and lesion during biopsy
- Patient comfort
- No ionizing radiation
- No contrast injection
- Accessibility
- Relatively low cost

Overview

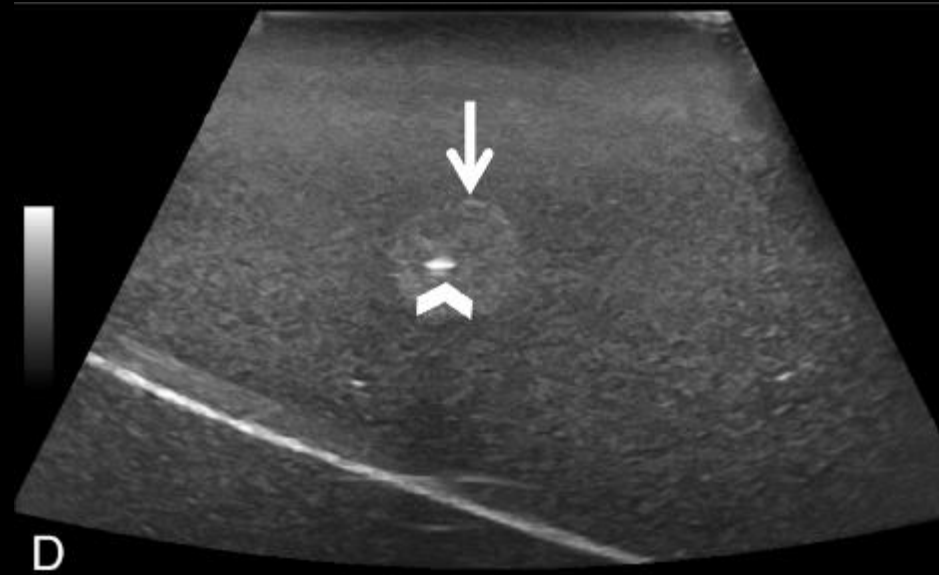
- Benefits
- **Technique**
- US-guided biopsy of calcifications
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance

Technique

- Parallel to US transducer beam

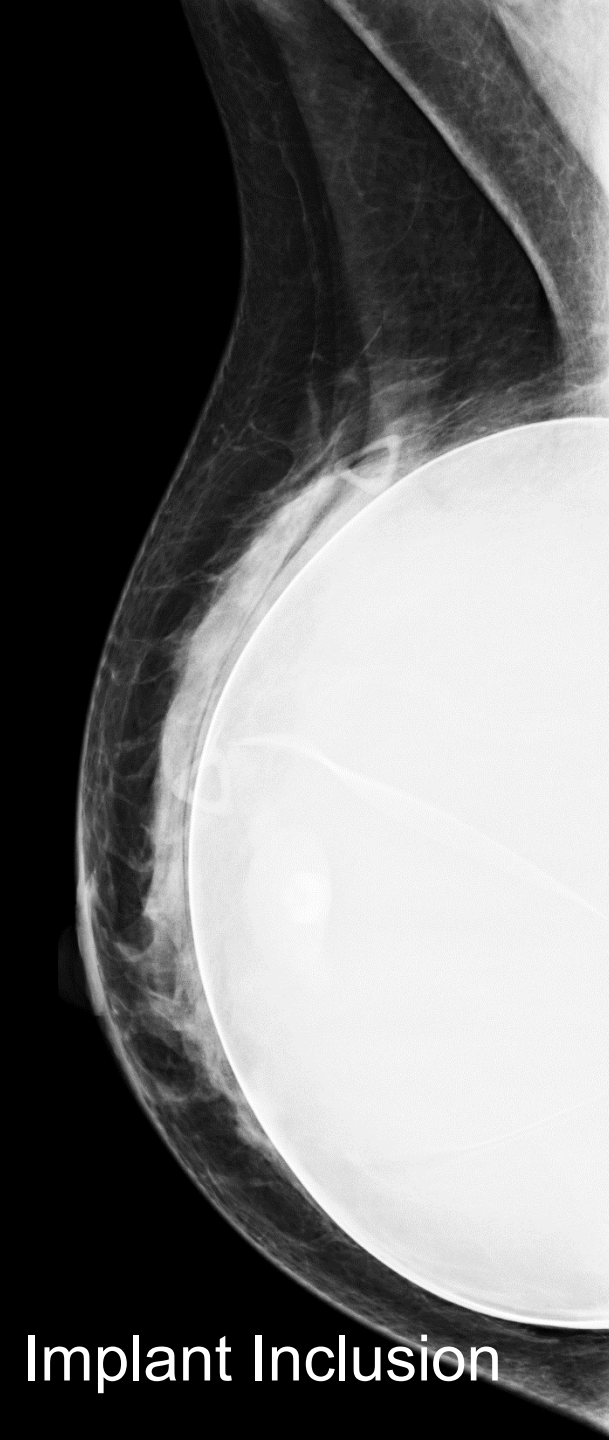


Parallel

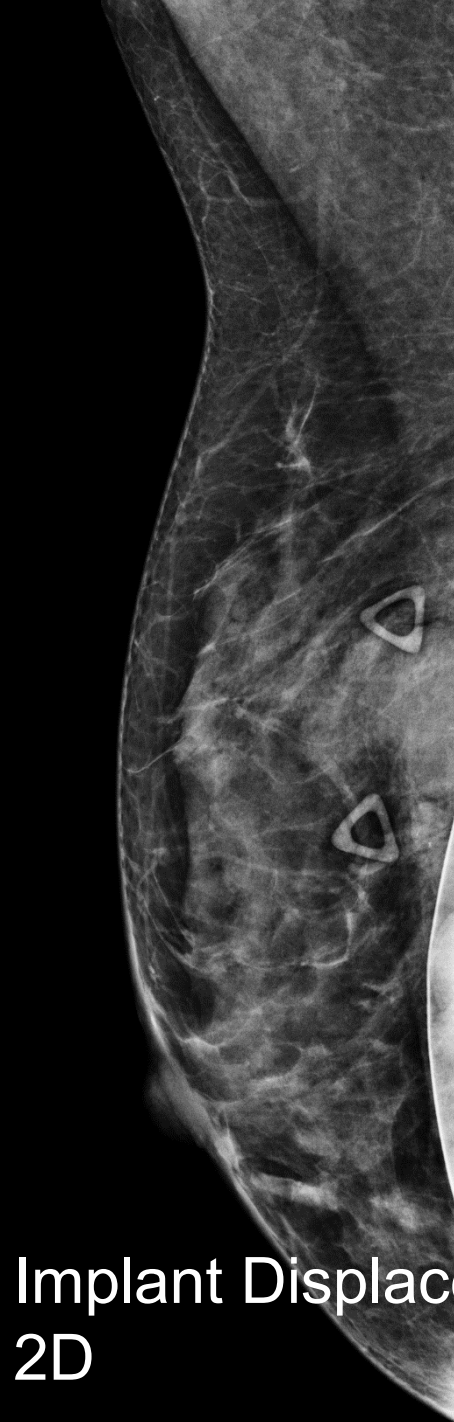


Orthogonal

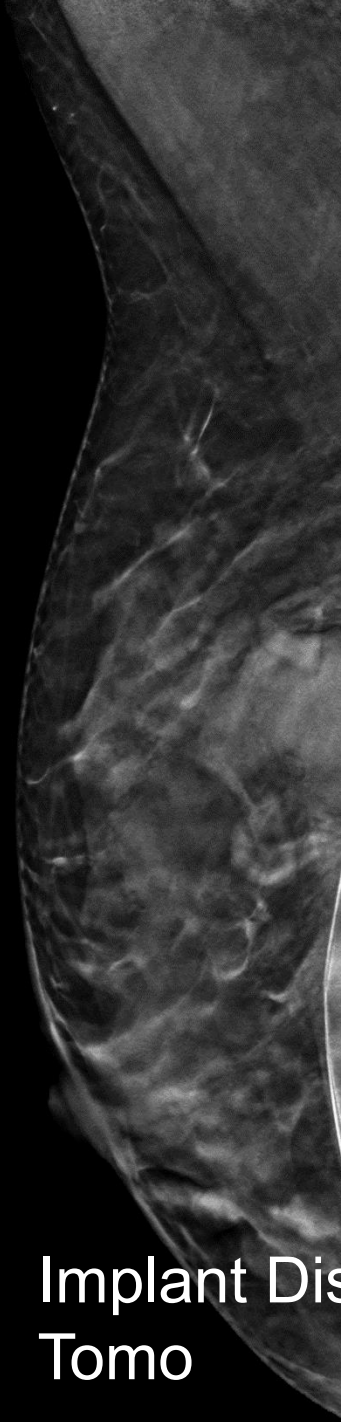
Source: Bhatt AA et al. J Ultrasound Med 2021; 40:1427-1443



Implant Inclusion

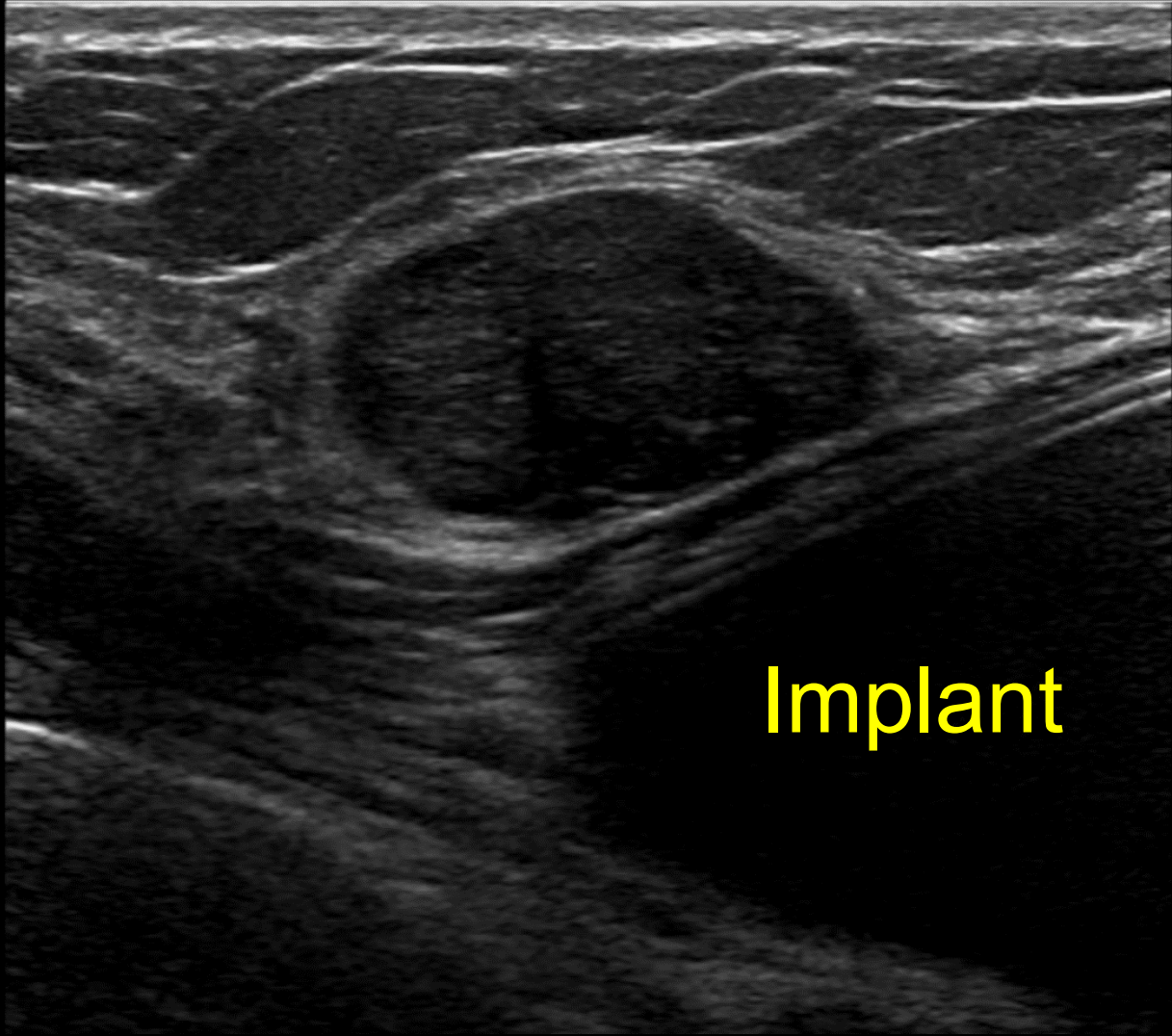


Implant Displaced
2D

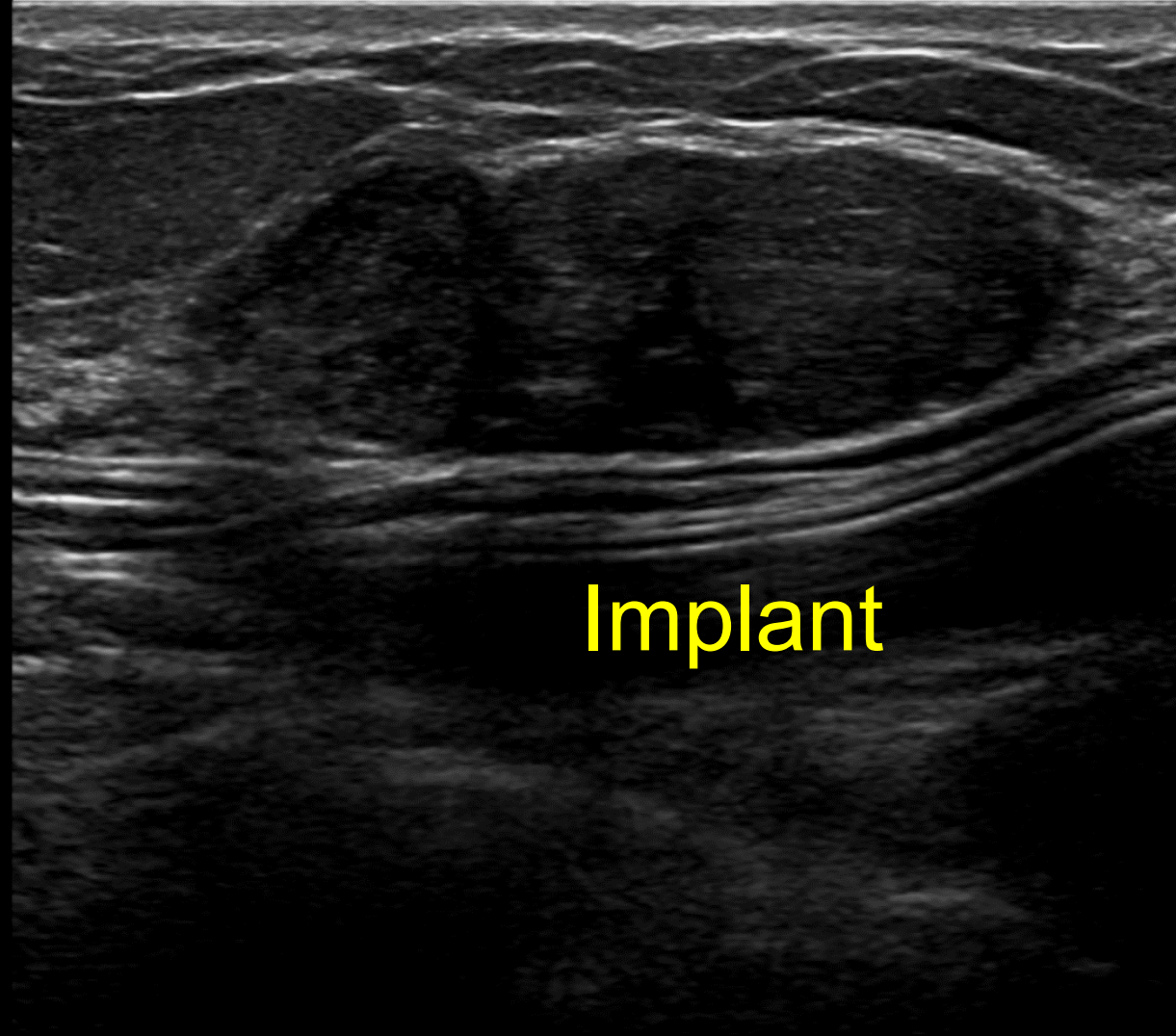


Implant Displaced
Tomo

Palpable Lump(s)
Retropectoral
Saline Implant



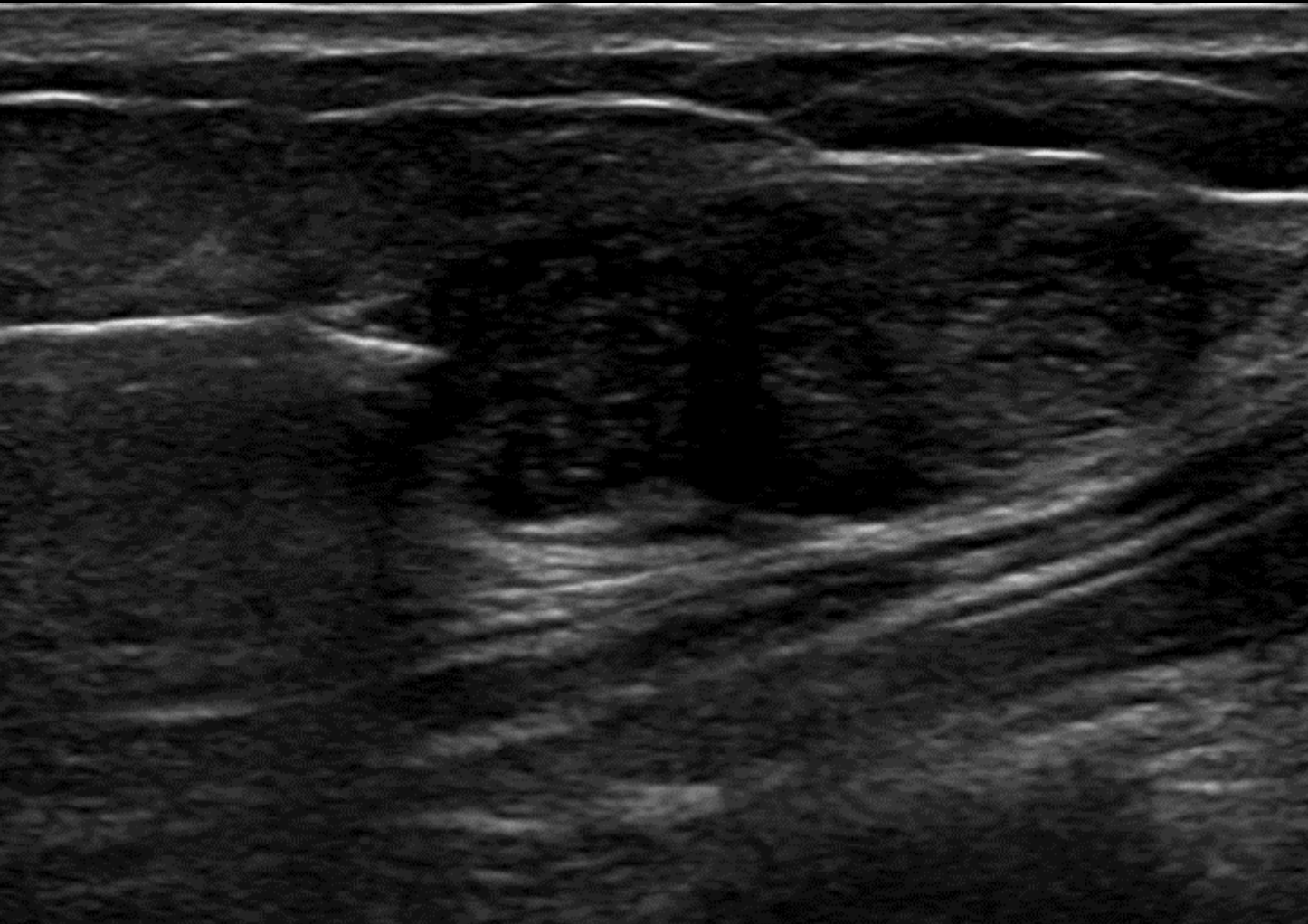
Longitudinal



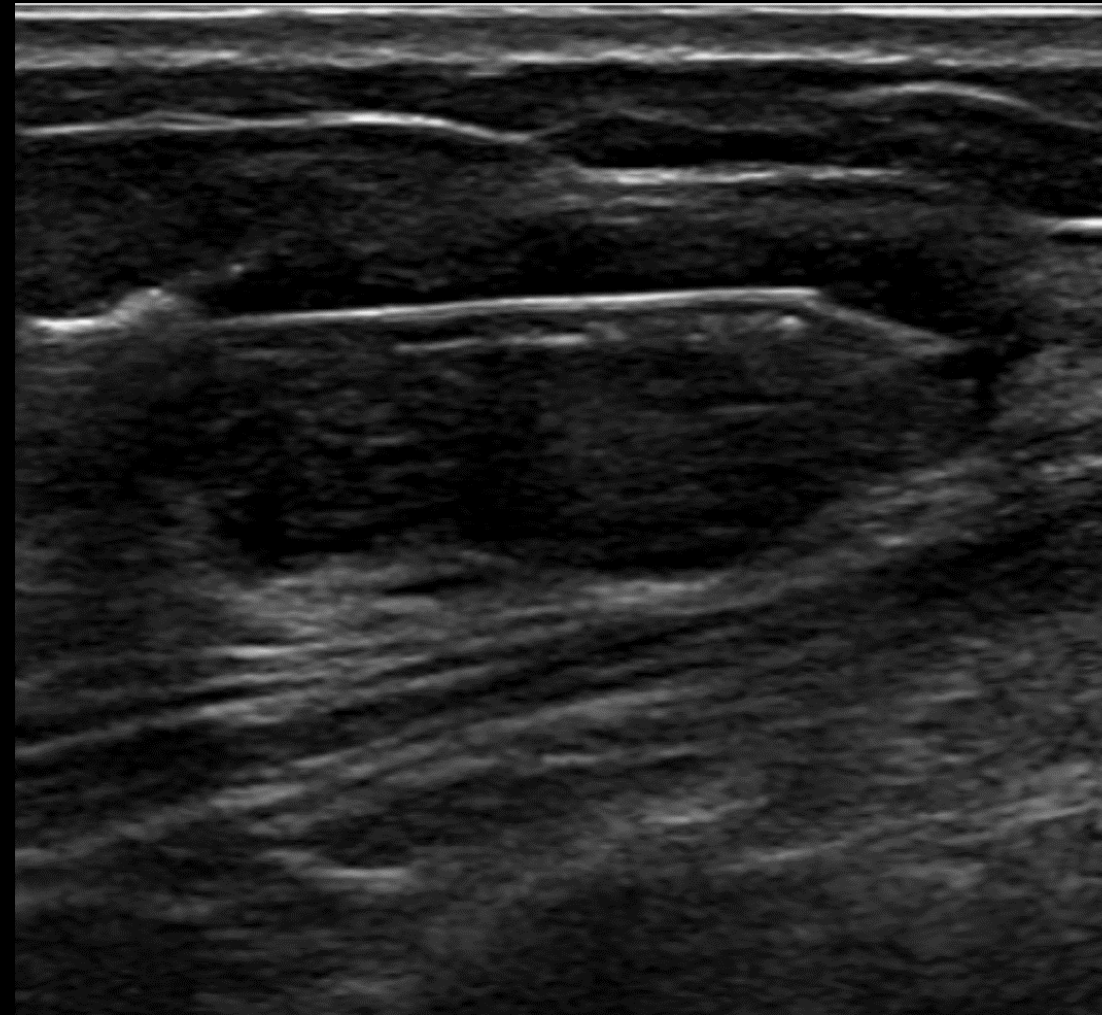
Transverse

US Core Biopsy (Automated Spring Loaded Needle)

→ Fibroepithelial Lesion



Pre



Post

Etta D. Pisano, MD
Laurie L. Fajardo, MD
Daryl J. Caudry, MS
Nour Snelge, MD
William J. Frable, MD
Wendie A. Berg, MD, PhD
Irena Tocolno, MD
Stuart J. Schnltt, MD
James L. Connolly, MD
Constantine A. Gatsonis, PhD
Barbara J. McNell, MD, PhD
For the Radiologist
Investigators of the
Radiologic Diagnostic
Oncology Group V

Index terms:

Breast, biopsy, 00.126
Breast neoplasms, 00.31, 00.32
Breast neoplasms, US, 00.12985
Stereotaxis, 00.1267

Radiology 2001; 219:785-792

Abbreviations:

FNAB = fine-needle aspiration biopsy
NPV = negative predictive value
PPV = positive predictive value
RDOGV = Radiologic Diagnostic
Oncology Group V

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Fine-Needle Aspiration Biopsy of Nonpalpable Breast Lesions in a Multicenter Clinical Trial: Results from the Radiologic Diagnostic Oncology Group V¹

PURPOSE: To determine the diagnostic accuracy of ultrasonographically (US) and stereotactically guided fine-needle aspiration biopsy (FNAB) in the diagnosis of nonpalpable breast lesions.

MATERIALS AND METHODS: At 18 institutions, 442 women who underwent 22–25-gauge imaging-guided FNAB were enrolled. Definitive surgical, core-needle biopsy, and/or follow-up information was available for 423 (95.7%) of these women. The reference standard was established from additional clinical and imaging information for an additional six (1.4%) women who did not undergo further histopathologic evaluation. The FNAB protocol was standardized at all institutions, and all specimens were reread by one of two expert cytopathologists.

RESULTS: When insufficient samples were included in the analysis and classified as positive, the sensitivity and specificity of FNAB were 85%–88% and 55.6%–90.5%, respectively; accuracy ranged from 62.2% to 89.2%. The diagnostic accuracy of FNAB was significantly better for detection of masses than for detection of calcifications (67.3% vs 53.8%, $P = .006$) and with US guidance than with stereotactic guidance (77.2% vs 58.9%; $P = .002$).

CONCLUSION: FNAB of nonpalpable breast lesions has limited value given the high insufficient sample rate and greater diagnostic accuracy of other interventions, including core-needle biopsy and needle-localized open surgical biopsy.

Core Needle Biopsy Versus Fine Needle Aspiration Biopsy in Breast—A Historical Perspective and Opportunities in the Modern Era

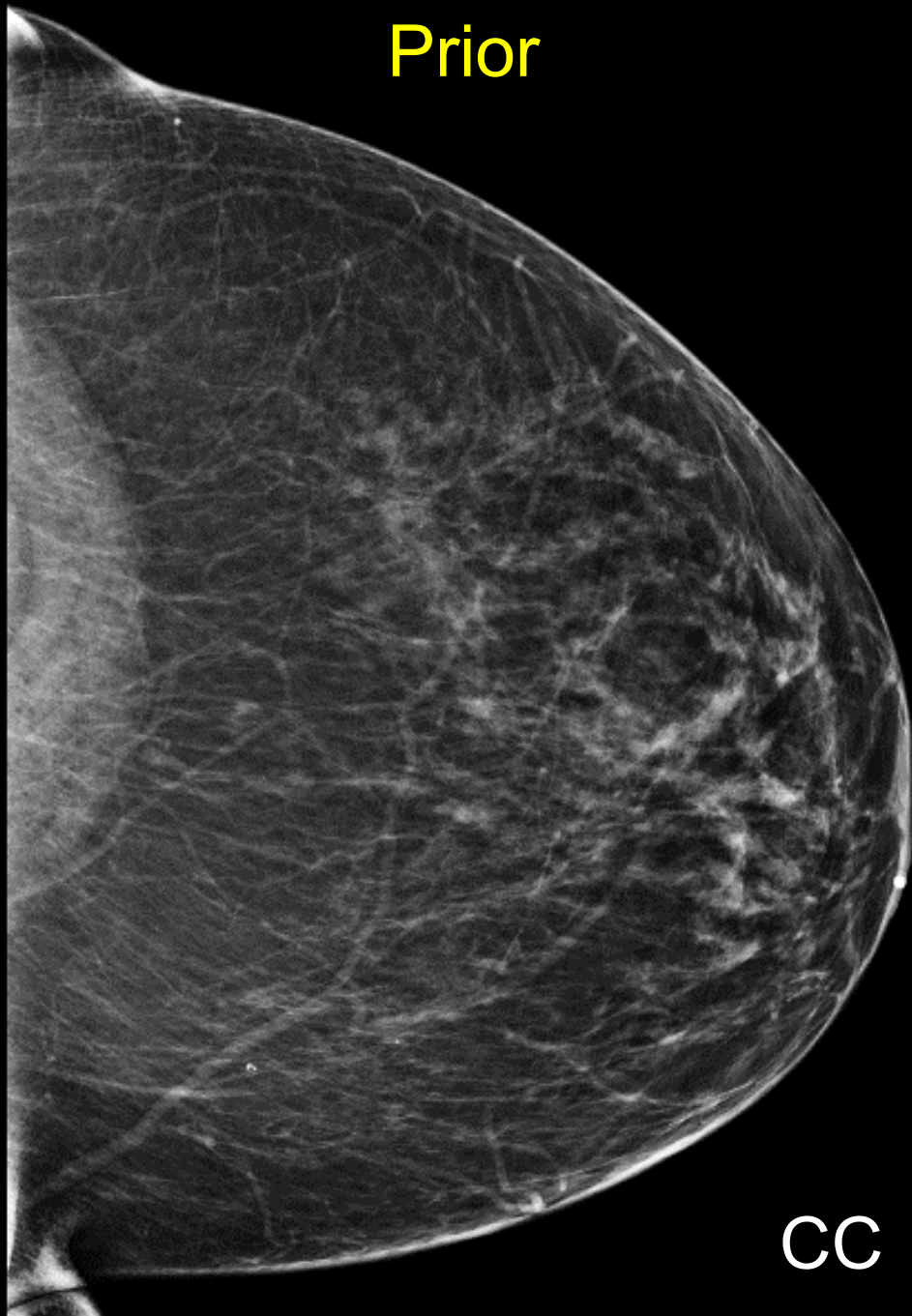
Aziza Nassar, M.D., F.I.A.C.*

Breast fine-needle aspiration biopsy (FNAB) by palpation is on the decline, due to its limitations in diagnostic accuracy, decreased sensitivity, and its replacement with core needle biopsy (CNB). Despite its decreasing utility, superficial fine-needle aspiration (FNA) in breast is still the main modality for evaluating metastatic lesions, recurrence, and axillary lymph node metastasis. New modalities including proteomic pattern expression and methylation profiling of breast lesions are other promising techniques that can be used as ancillary tests for refining the diagnosis of breast lesions using FNAB. Image-guided breast FNA proves to be a successful alternative with high sensitivity and specificity. In this review, the advantages, disadvantages, and inherent limitations of breast FNA and CNB, and new advanced techniques are discussed. Diagn. Cytopathol. 2011;39:380–388. © 2010 Wiley-Liss, Inc.

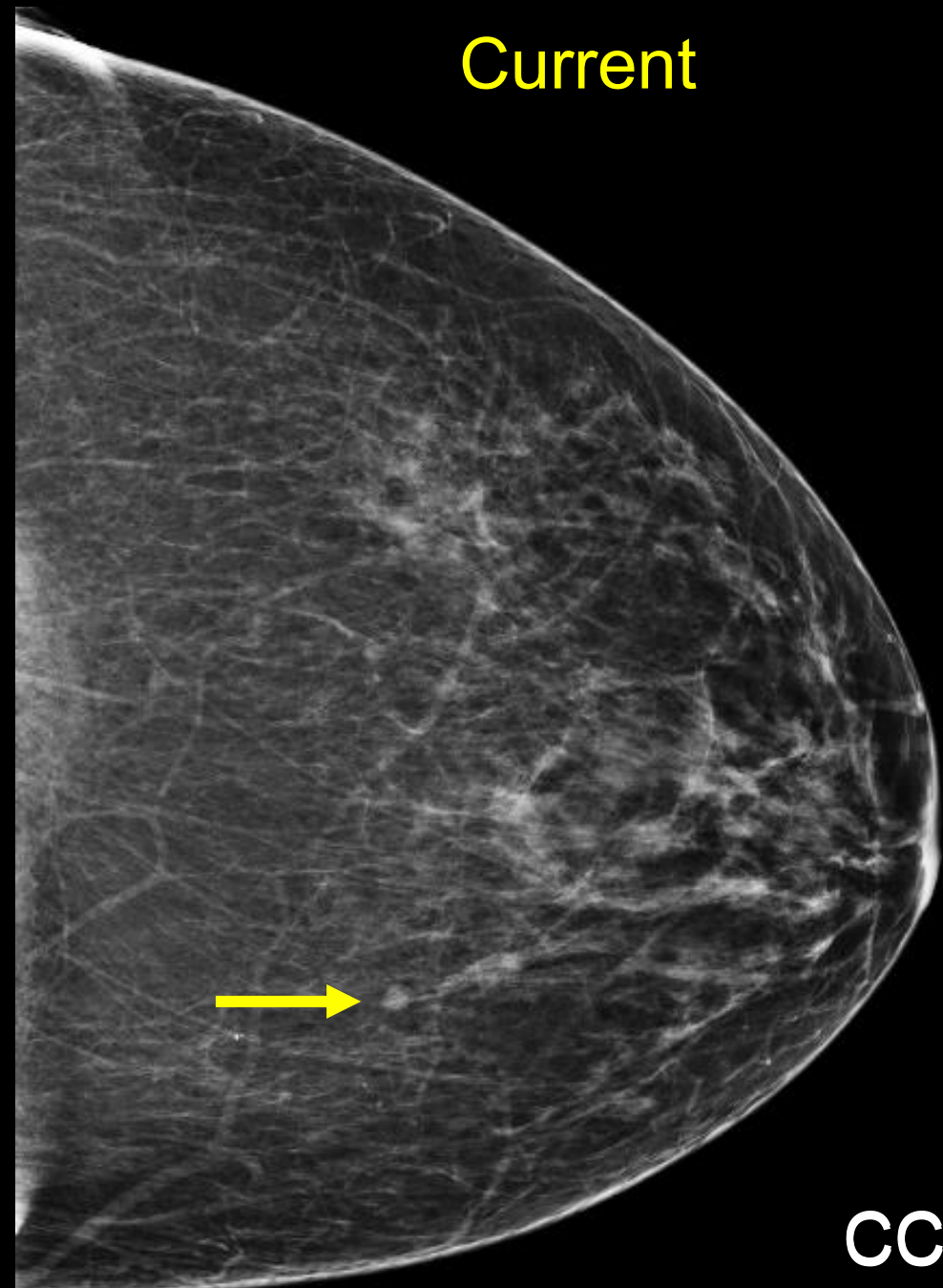
masses became increasingly useful.² Although it was popular in Europe, it only became a widely accepted practice in the United States during the era of managed care and the heightened awareness on cost containment.^{2–4}

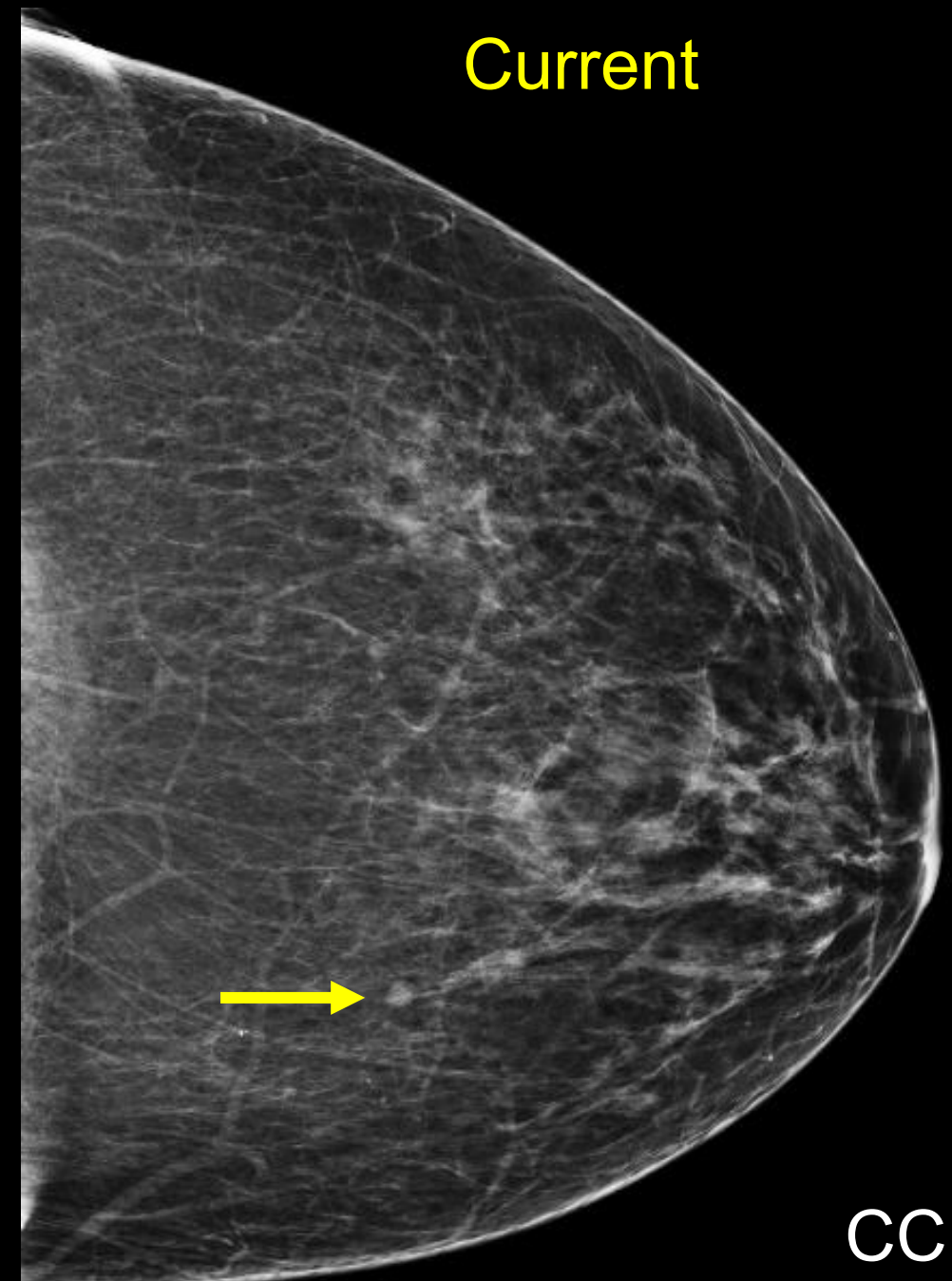
Several diagnostic trends have occurred during the last several years, including breast screening mammography, development of innovative localizing devices, and advances in breast imaging, that have changed the practice pattern for FNAB.⁴ Furthermore, because of the limitations posed by FNAB, such as the inability to discriminate in situ from invasive carcinoma, difficulty in rendering a definitive diagnosis

Prior

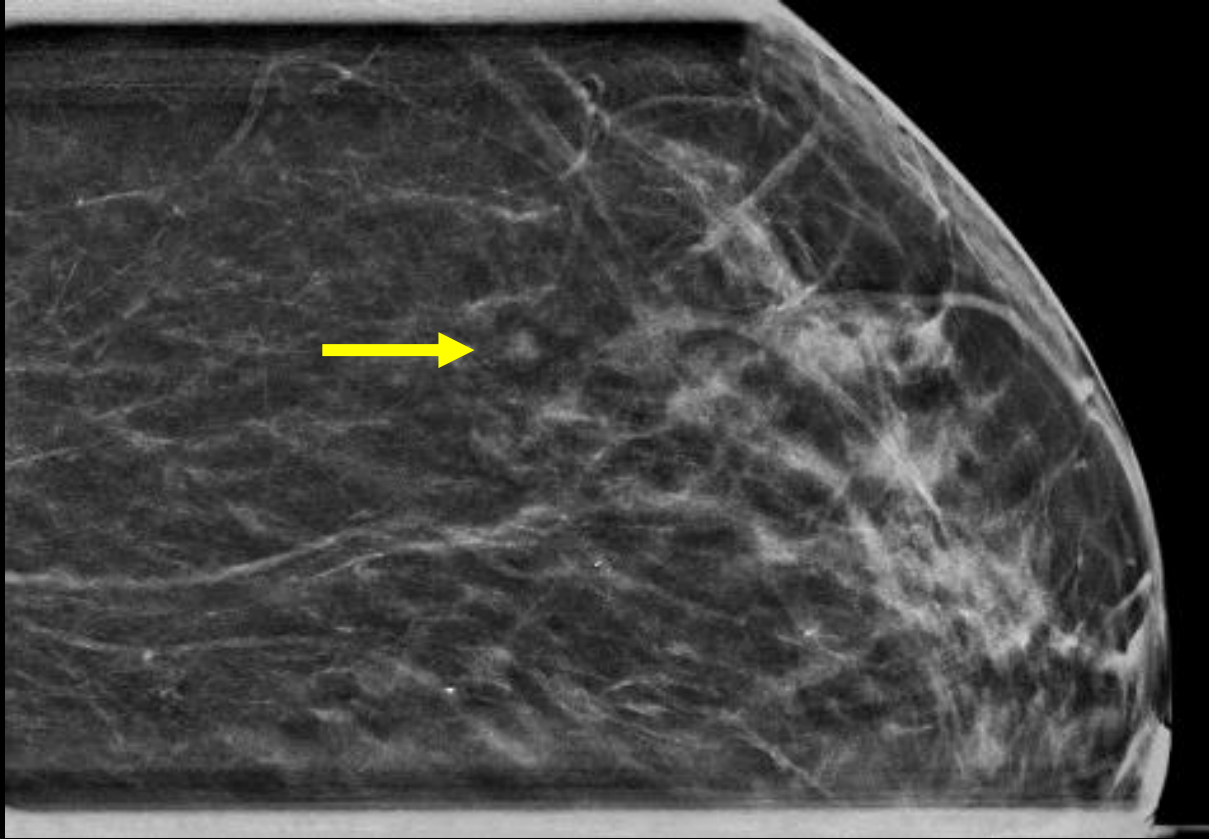


Current

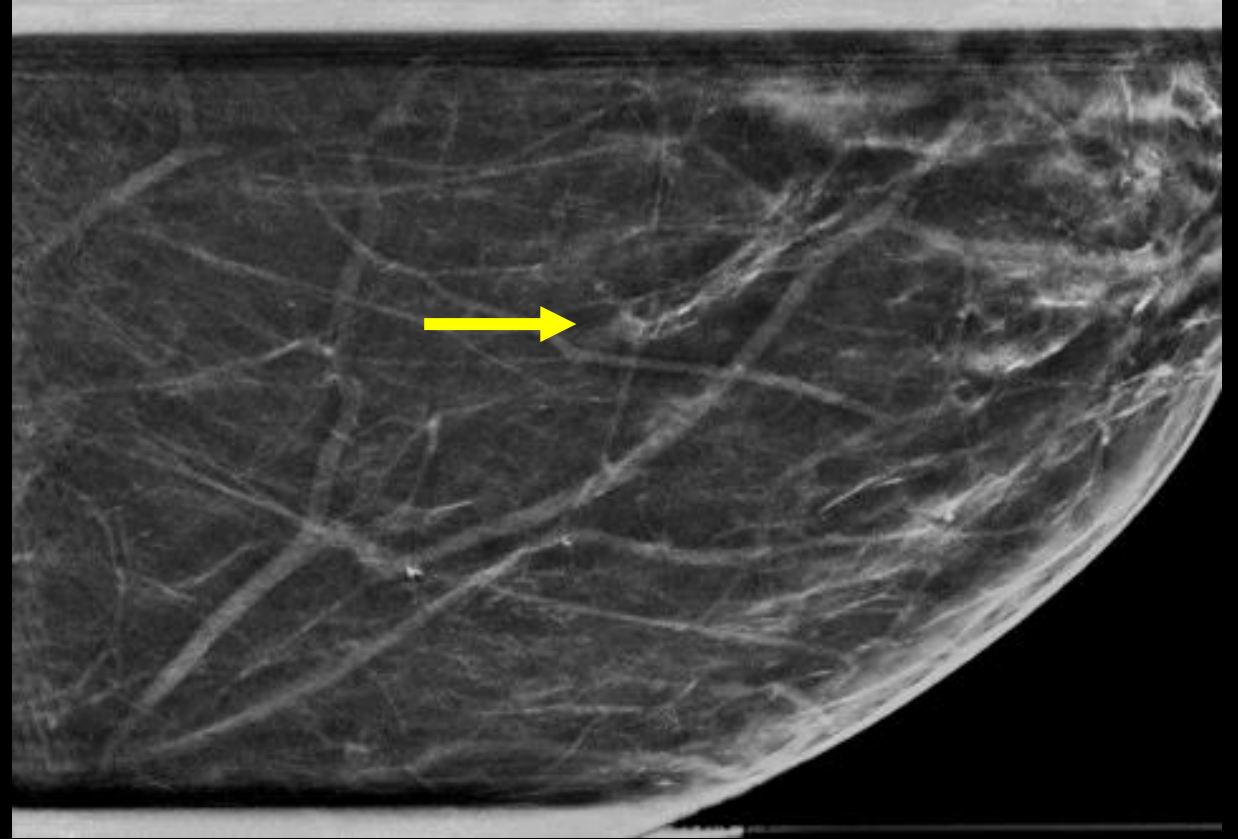




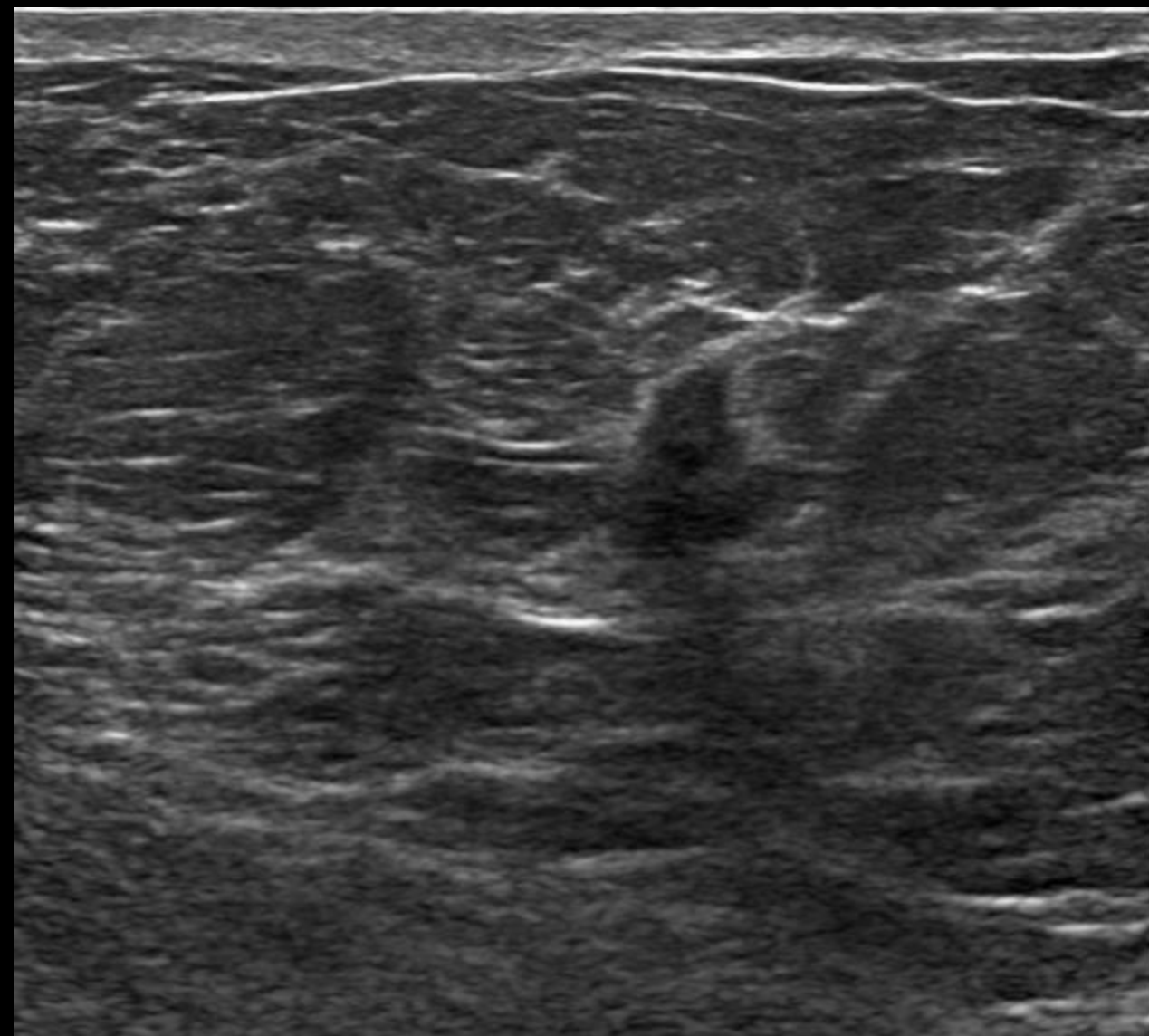
Spot Tomo



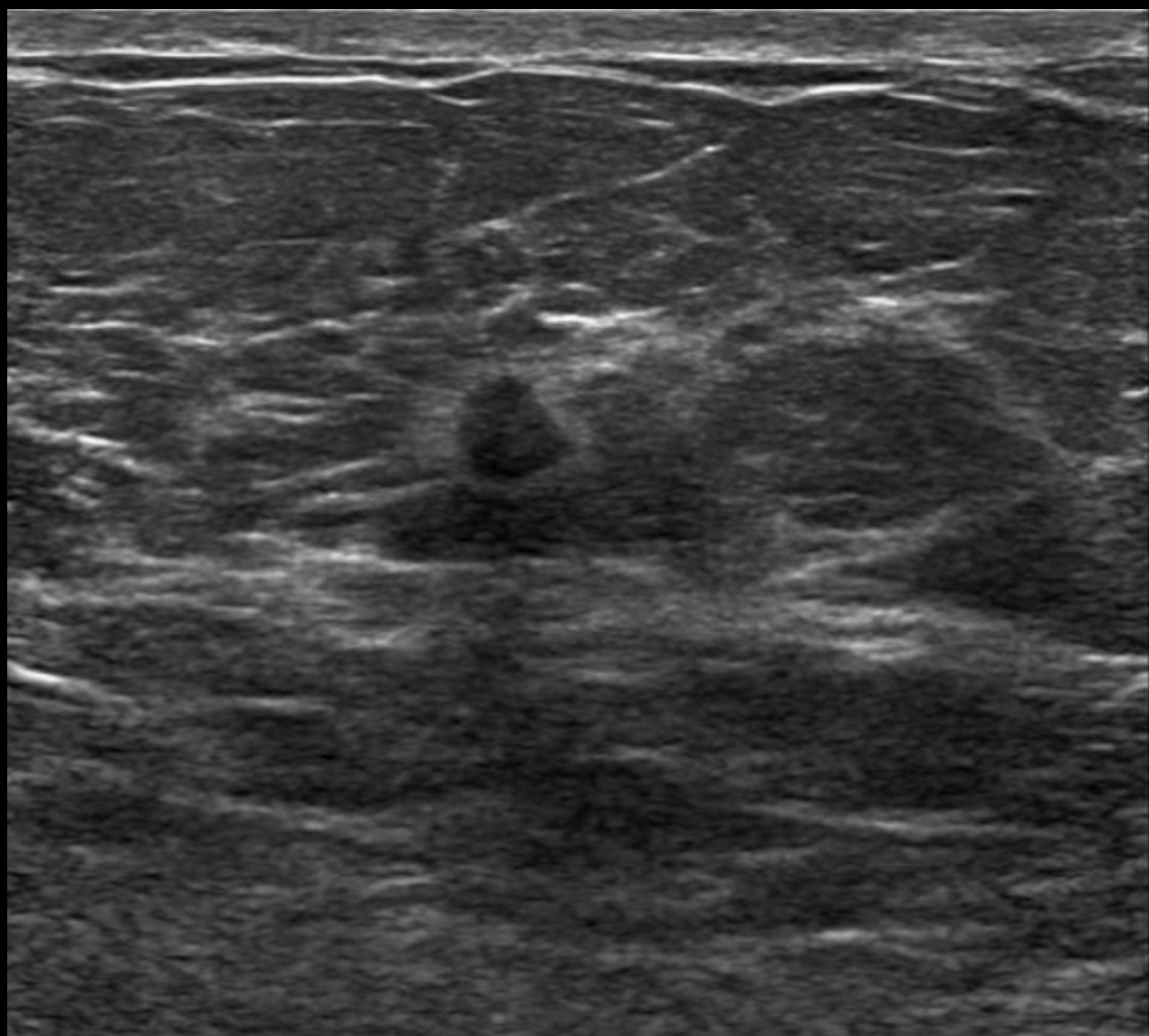
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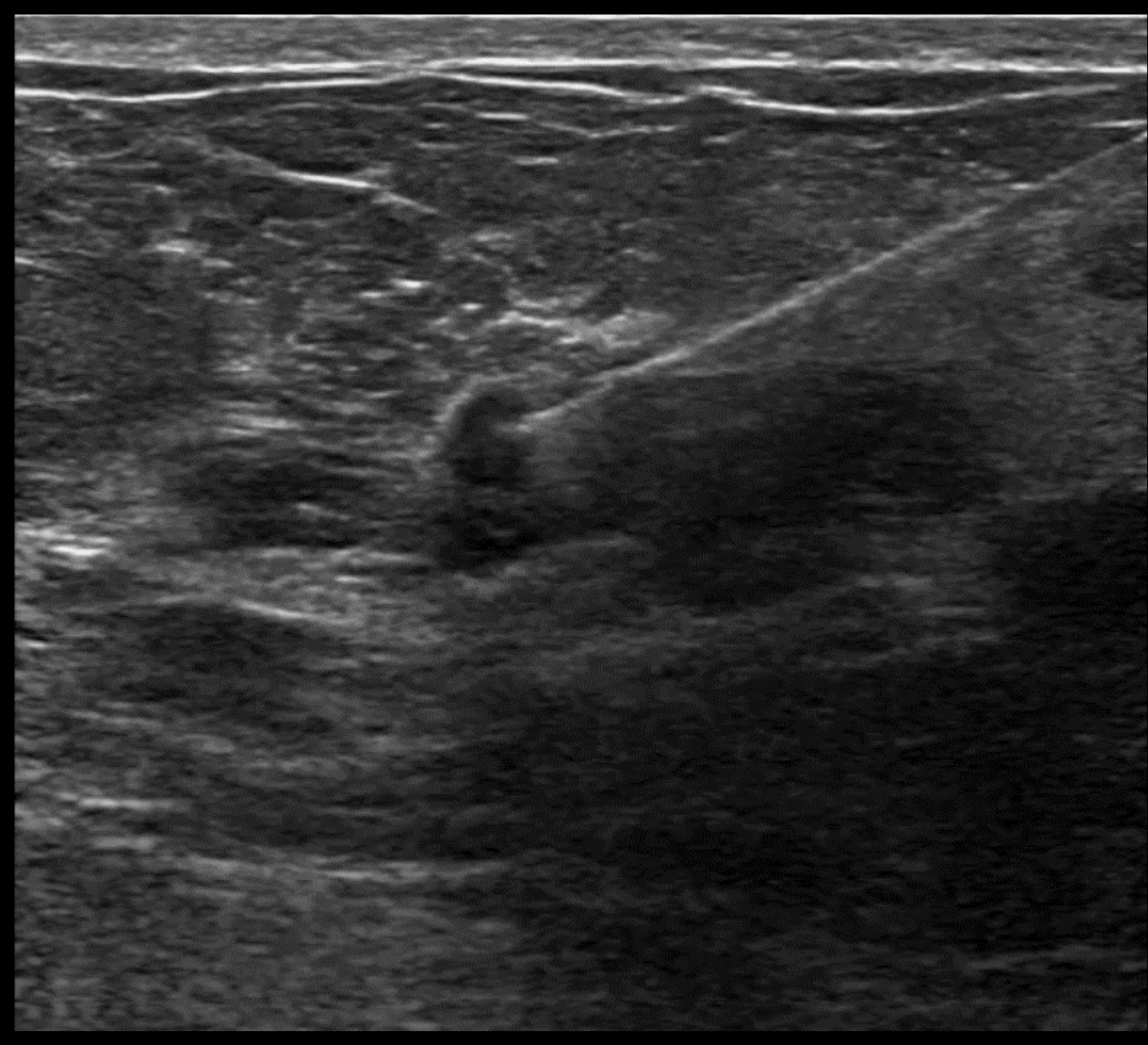
CC



Longitudinal



Transverse

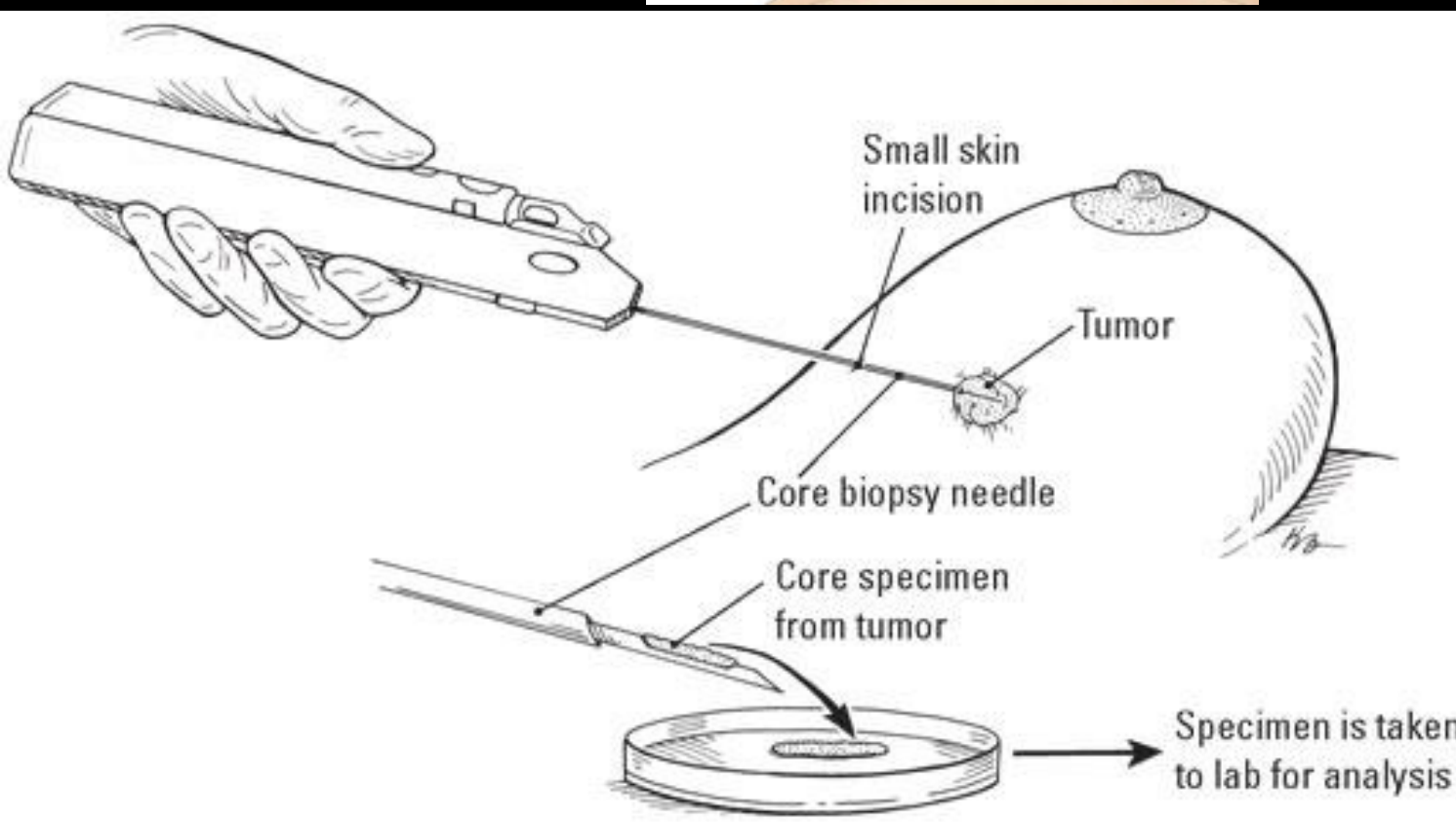
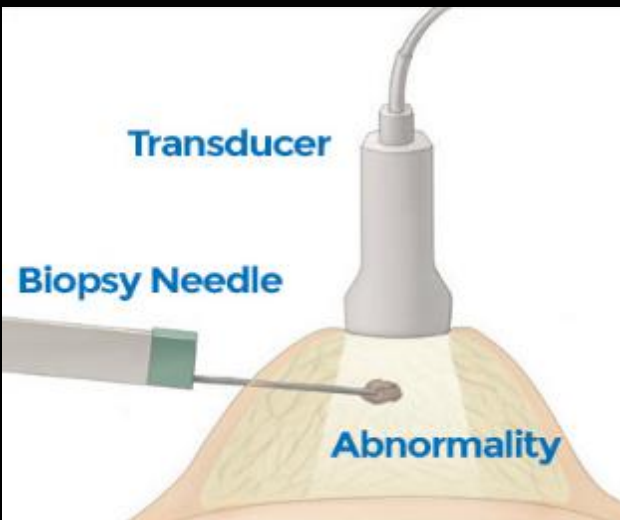
A grayscale B-mode ultrasound image of a breast. A dark, hypoechoic, oval-shaped lesion is visible in the center-left. A thin, bright, curved line, representing the needle tip, is positioned just to the right of the lesion, indicating the site of a fine needle aspiration (FNA) biopsy. The surrounding breast tissue shows a typical echotexture with various linear and curved echogenic lines.

US-guided FNA Biopsy
Adenocarcinoma,
ductal type,
intermediate nuclear
grade

Fine Needle Aspiration FNA Biopsy Versus Core Biopsy in Lymph Node Assessment

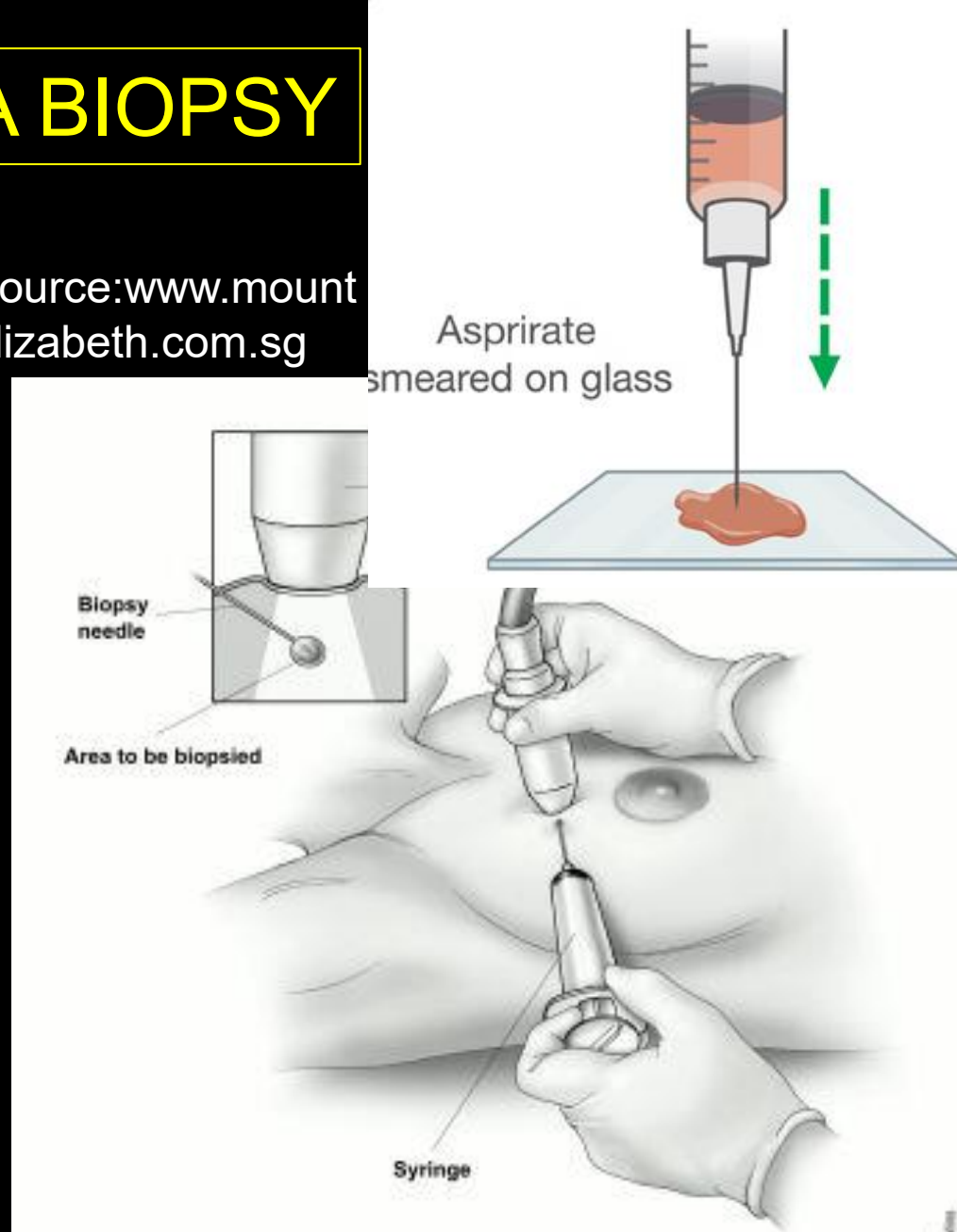
CORE BIOPSY

Source:
www.adrad.com



FNA BIOPSY

Source: www.mountelizabeth.com.sg



Source: www.cancer.org
Fine needle aspiration using ultrasound

Source: www.dummies.com/health/diseases/cancer

2013
Finland

Suvi Rautiainen, MD
Amro Masarwah MD
Mazen Sudah, MD
Anna Sutela, MD, PhD
Outi Pelkonen, MD, PhD
Sarianna Joukainen, MD
Reijo Sironen, MD, PhD
Vesa Kärjä, MD, PhD
Ritva Vanninen, MD, PhD

Axillary Lymph Node Biopsy in Newly Diagnosed Invasive Breast Cancer: Comparative Accuracy of Fine-Needle Aspiration Biopsy versus Core-Needle Biopsy¹

Radiology

Purpose:

To compare the diagnostic accuracy of ultrasonographically (US)-guided fine-needle aspiration biopsy (FNAB) and core-needle biopsy (CNB) of the axillary lymph nodes (LNs) of patients with newly diagnosed invasive breast cancer.

Materials and Methods:

This prospective single-center study had institutional review board approval, and written informed consent was obtained. Between April 2011 and March 2012, 178 consecutive patients (182 axillae) were evaluated by using axillary US. Sixty-six axillae fulfilled the inclusion criteria (cortical thickness greater than 2 mm or abnormal morphologic characteristics), and patients with these axillae underwent US-guided axillary LN biopsy. Both FNAB and CNB were obtained from the same suspicious LN. Patients with biopsy-proved metastasis underwent axillary clearance, and those with a negative biopsy underwent sentinel LN biopsy with completion axillary clearance if needed.

- N = 178 patients (182 axillae)
- Underwent both FNA and core bx
 - Morphology
 - > 2 mm cortical thickness
- SLNB if negative
- ALND if positive

Table 2**Diagnostic Performance of US, FNAB, and CNB for Evaluation of Axillary LN Status**

Measure	US (%)	FNAB (%)	CNB (%)
Sensitivity	61.4 (51/83) [50.7, 71.2]	72.5 (37/51) [59.1, 82.9]	88.2 (45/51) [76.6, 94.5]
Specificity	84.8 (84/99) [76.5, 90.6]	100 (15/15) [79.6, 100]	100 (15/15) [79.6, 100]
Negative predictive value	72.9 [64.2, 80.2]	81.7 [64.2, 91.7]	91.2 [72.0, 97.7]
Positive predictive value	76.8 [65.4, 85.4]	100 [90.6, 100]	100 [92.1, 100]
Overall accuracy	74.2 (135/182) [67.4, 80.0]	78.8 (52/66) [67.5, 86.9]	90.9 (60/66) [81.6, 95.8]

Note.—Data in parentheses are numbers used to calculate percentages, and data in brackets are 95% confidence intervals.

- CNB performed better than FNAB (more sensitive)
- Biopsy (either FNAB or CNB) augmented the clinical application of US

2018
China

Original Article

Impact of sentinel lymph node biopsy in newly diagnosed invasive breast cancer patients with suspicious node: a comparative accuracy survey of fine-needle aspiration biopsy versus core-needle biopsy

Adheesh Bhandari^{1*}, Erjie Xia^{1*}, Yinghao Wang¹, Namita Sindan², Ranjan Kc³, Yaoyao Guan¹, Yueh-Lung Lin⁴, Xiaoshang Wang⁵, Xiaohua Zhang¹, Ouchen Wang¹

¹Department of Thyroid and Breast Surgery, The First Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang, PR China; ²Department of Reproductive Health Center, Second Affiliated Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang, PR China; ³Department of Cellular and Molecular Medicine, Lerner Research Institute, Cleveland Clinic, OH 44120, USA; ⁴Mathematical Sciences, University of Nottingham, Ningbo 325000, Zhejiang, PR China; ⁵School of International Studies, Wenzhou Medical University, Wenzhou 325000, Zhejiang, PR China. *Equal contributors.

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- N = 289 patients initial → 131 patients final
- Underwent both FNA and core bx
 - Morphology
 - > 2 mm cortical thickness
- SLNB if negative
- ALND if positive

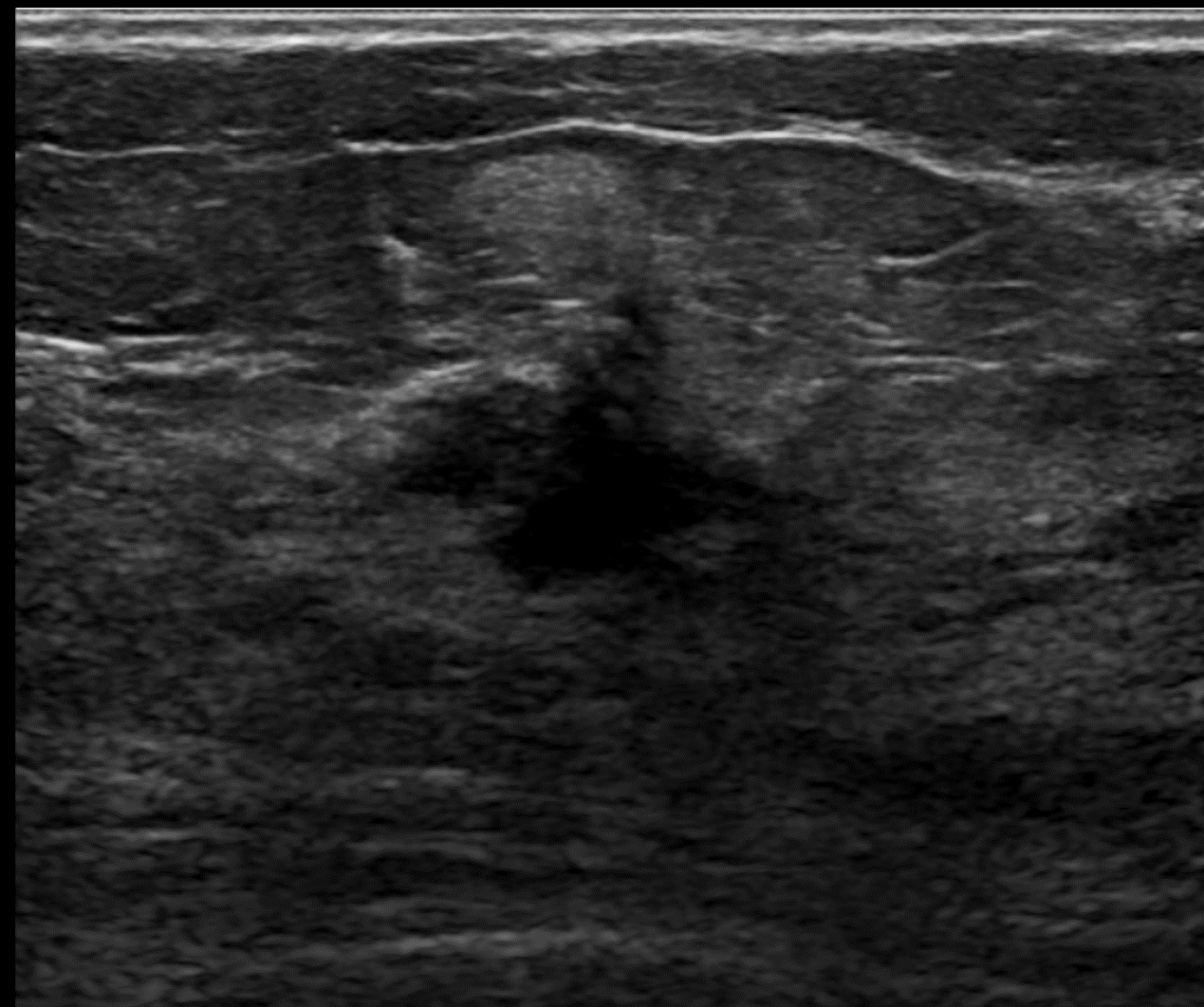
Table 2. Diagnostic performance of FNAB, and CNB for evaluation of axillary LN status

Measure	FNAB (%) (95% CI)	CNB (%) (95% CI)
Sensitivity	76.0 (38/50) [62.6, 85.7]	90.0 (45/50) [78.6, 95.7]
Specificity	100.0 (81/81) [95.5, 100]	100.0 (81/81) [95.5, 100]
Negative predictive value	100.0 [90.8, 100]	100.0 [87.1, 100]
Positive predictive value	87.1 [78.8, 92.5]	94.2 [87.1, 97.5]
Overall accuracy	90.8 (119/131) [84.7, 94.7]	96.2 (126/131) [91.4, 98.4]

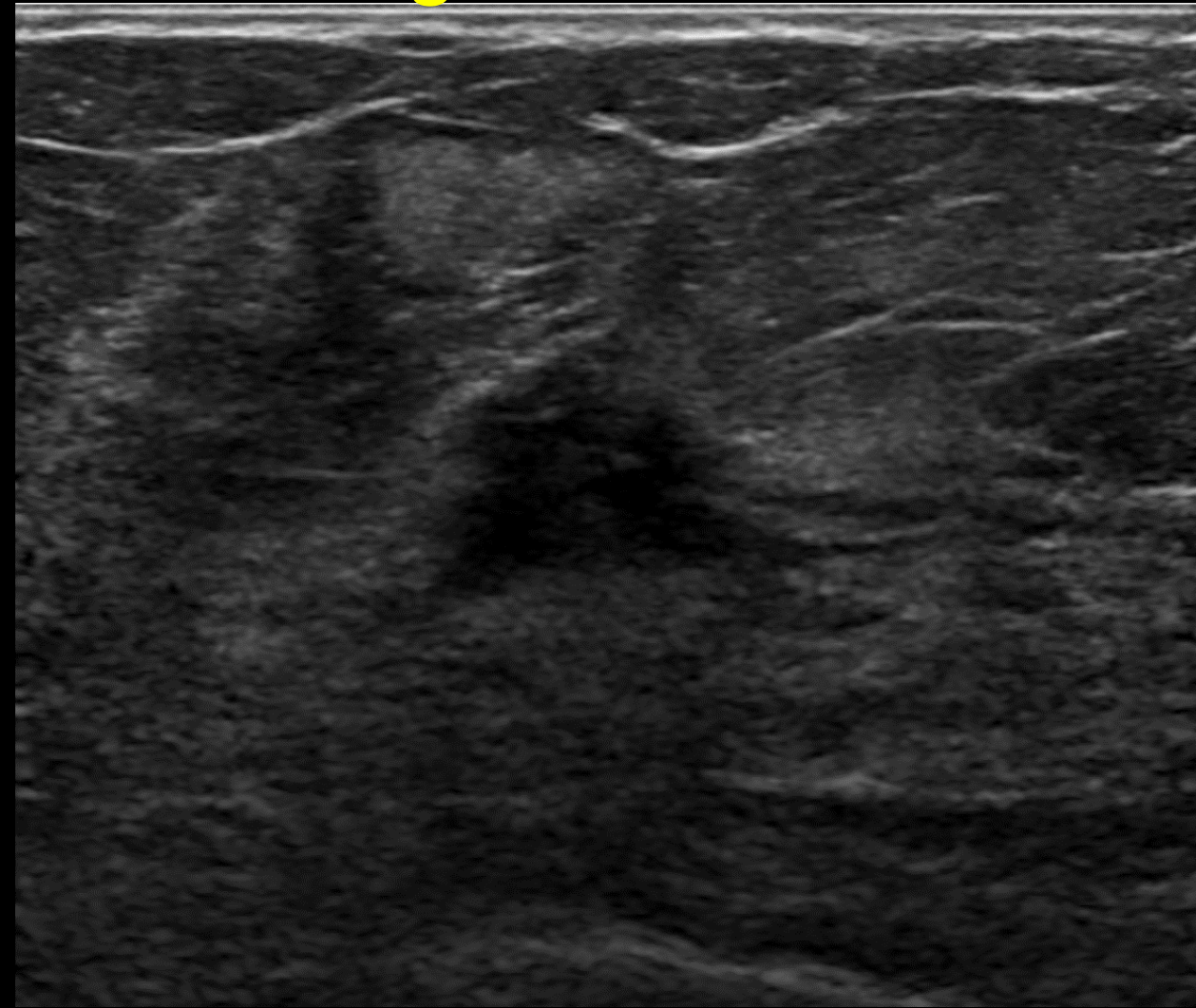
Appropriate Case Selection is Key



Invasive Ductal Carcinoma, grade 2

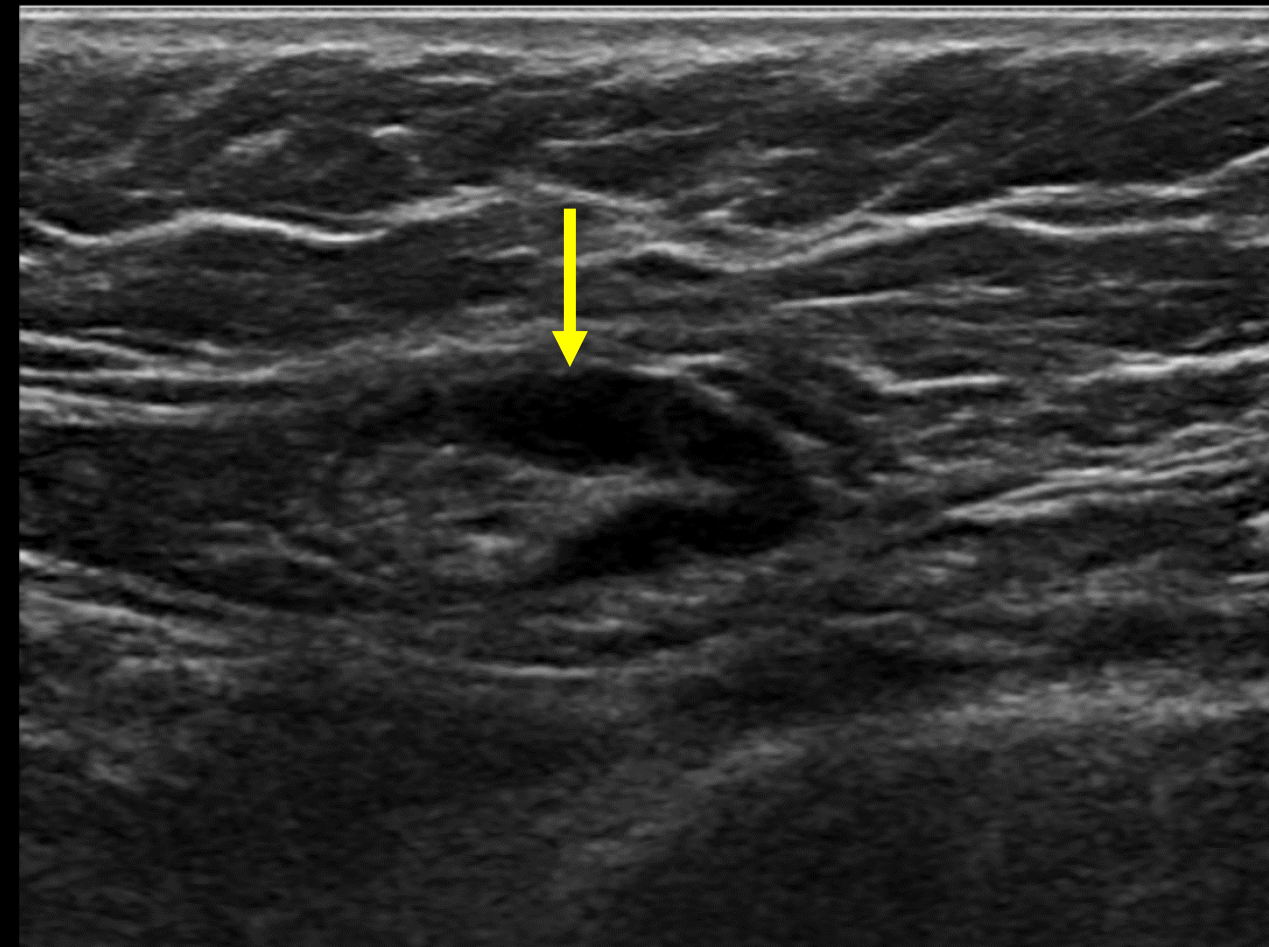


Longitudinal

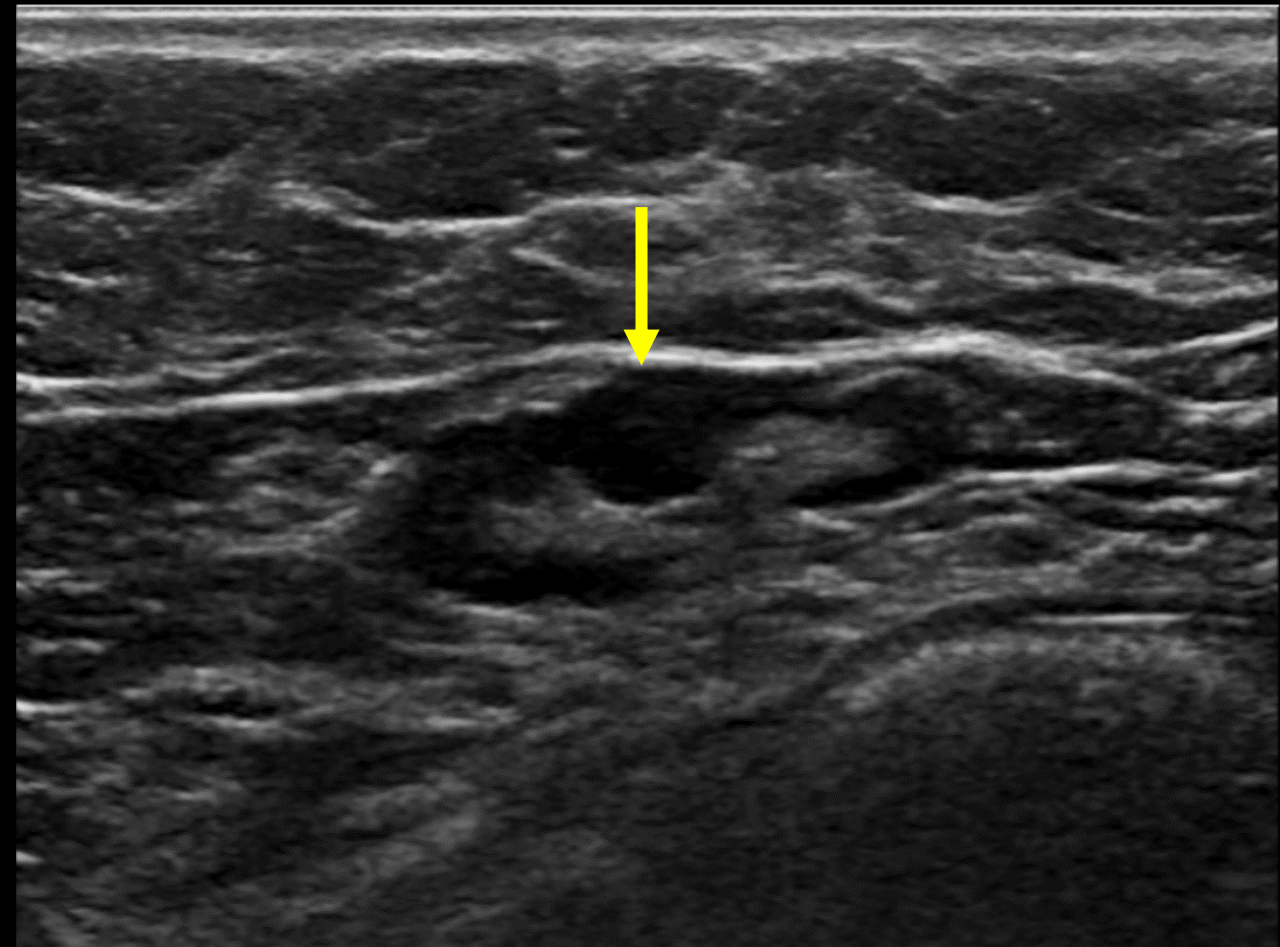


Transverse

Axilla Level I Node

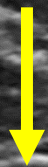


Longitudinal



Transverse

Pre-FNA



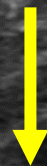
FNA 2nd Pass



FNA 1st Pass (Image 1)



FNA 1st Pass (Image 2)



FNA Biopsy

- Less invasive
- Real-time work-up possibility

- CPT 10005 (US-guided FNA)
- \$139.22 (non-facility)
- \$73.52 (facility)

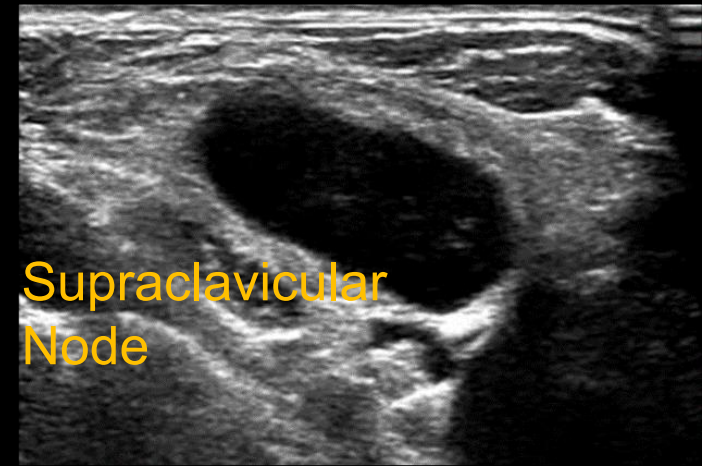
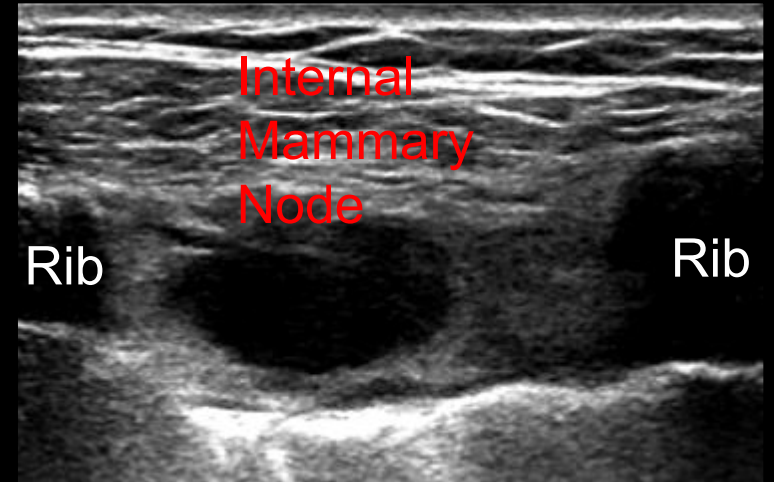
Core Biopsy

- Higher sensitivity
- More materials for biomarkers

- CPT 38505 (core biopsy) + CPT 76942 (US-guidance)
- \$125.96 + \$58.97 (non-facility)
- \$70.48 + \$58.97 (facility)

Proposed BI-RADS 6th Edition

- Expansion of discussion on lymph nodes
- Location
 - Intramammary node
 - Axillary node (levels I, II, III)
 - Internal mammary node
 - Supraclavicular node
- Morphology
 - Cortical-hilar relationship



cN Category	cN Criteria
cNX	Regional nodes cannot be assessed (previously removed)
cN0	No regional nodal metastases
cN1	Metastases to movable ipsilateral level I and/or level II axillary nodes
cN1mi	Micrometastases
cN2	Metastases to fixed or matted ipsilateral level I and/or level II axillary nodes; or metastases to ipsilateral internal mammary nodes without axillary metastases
cN2a	Metastases to fixed or matted ipsilateral level I and/or level II axillary nodes
cN2b	Metastases to ipsilateral internal mammary nodes without axillary metastases
cN3	Metastases to ipsilateral level III axillary nodes with or without level I and/or level II axillary metastases; or metastases to ipsilateral internal mammary nodes with level I and/or level II axillary metastases; or metastases to ipsilateral supraclavicular nodes
cN3a	Metastases to ipsilateral level III axillary nodes with or without level I and/or level II axillary metastases
cN3b	Metastases to ipsilateral internal mammary nodes with level I and/or level II axillary metastases
cN3c	Metastases to ipsilateral supraclavicular nodes

TNM Staging

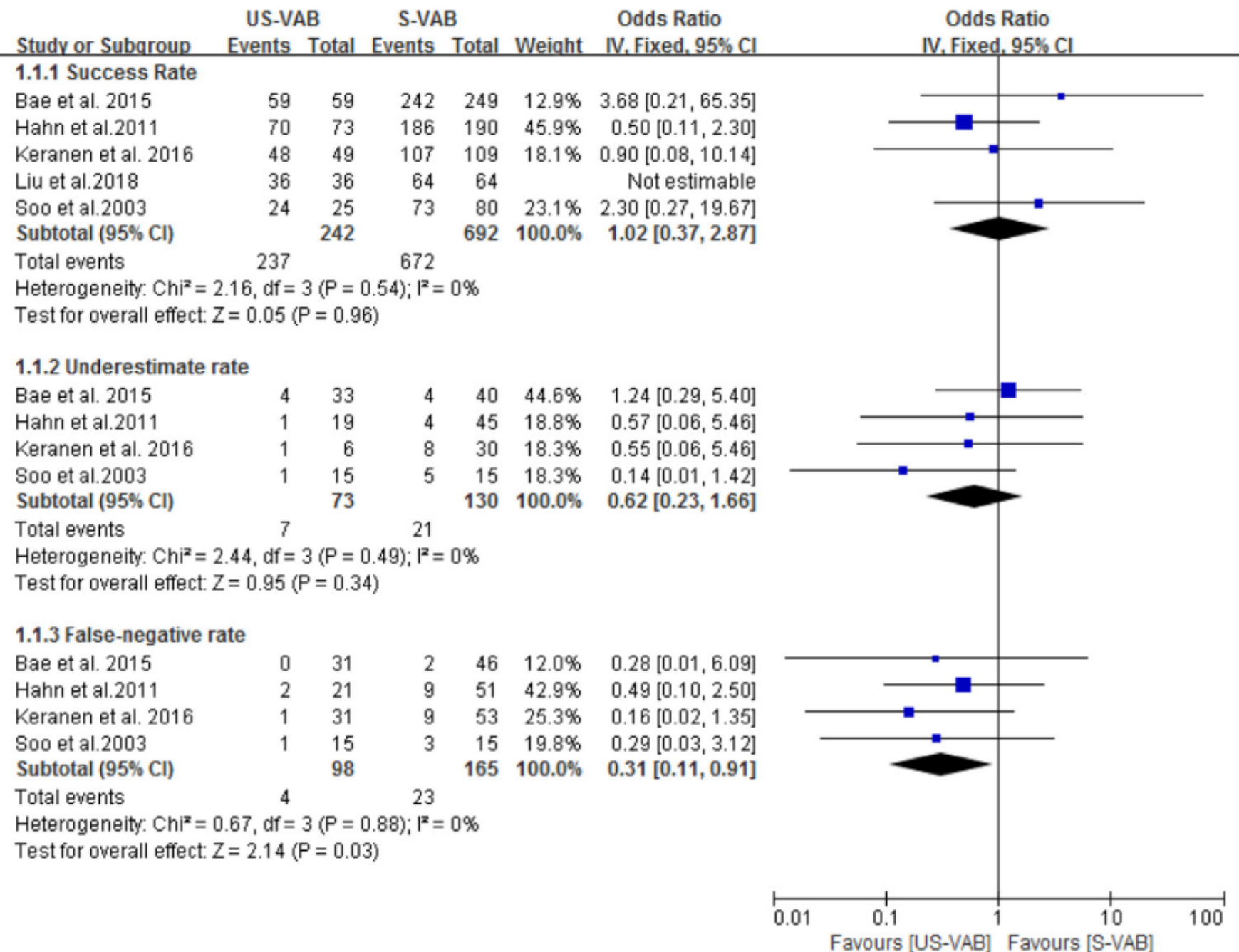
US-FNA is ideally suited for biopsy of lymph nodes that are not amenable to core biopsy in breast cancer evaluation.

Overview

- Benefits
- Technique
- **US-guided biopsy of calcifications**
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance

US Biopsy of Calcifications

- Increasing detection of calcifications at US (23% to 95%)
- Greater detection when calcifications seen in association with breast masses or dilated ducts
- Higher PPV when calcifications seen at US in addition to mammography
- If seen at US, may attempt biopsy using US guidance
 - Especially when stereotactic biopsy not accessible



Three Parameters

- Technical success
- Underestimation rate
- False-negative rate

US-VAB not inferior to Stereo-VAB

Source:
Wu J et al. Ultrasound Med
Biol 2021; 47:1172-1181

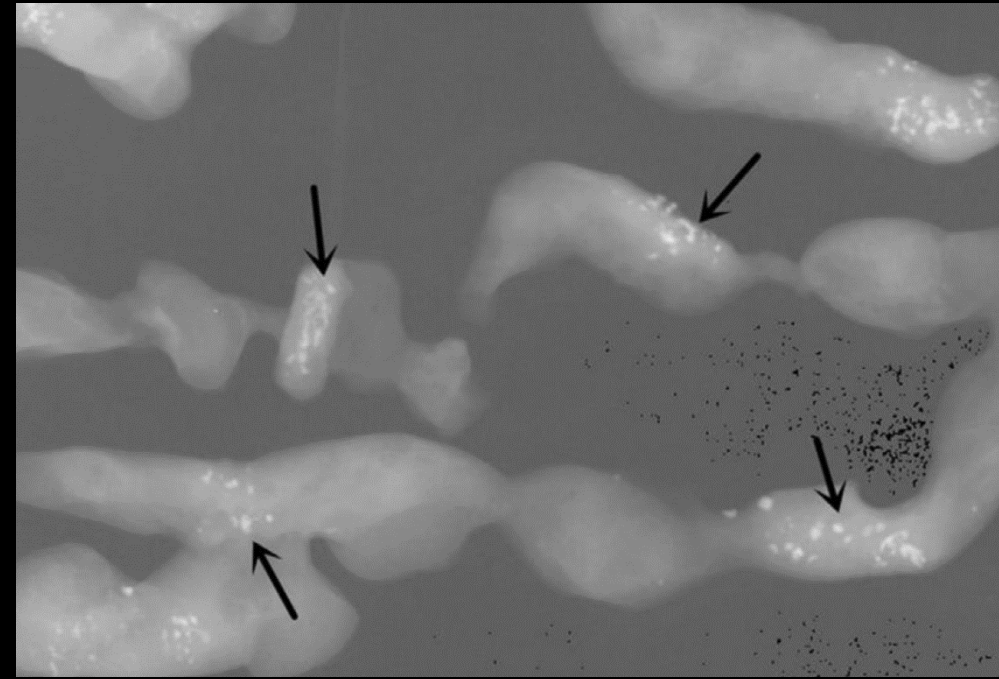
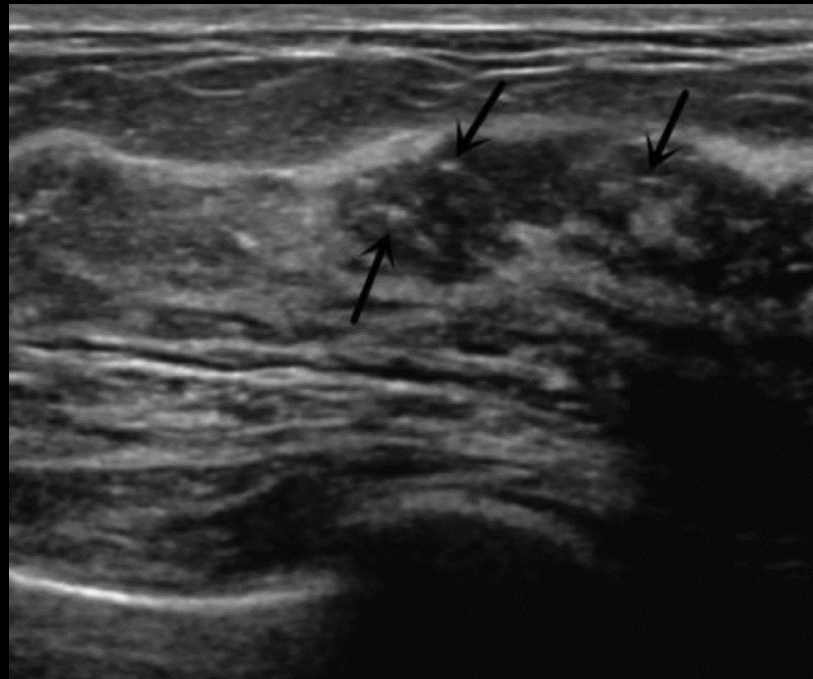
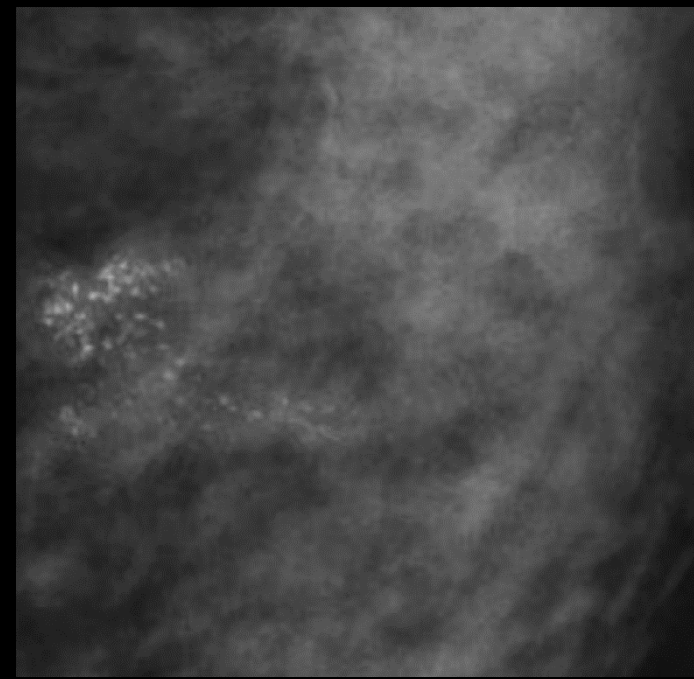


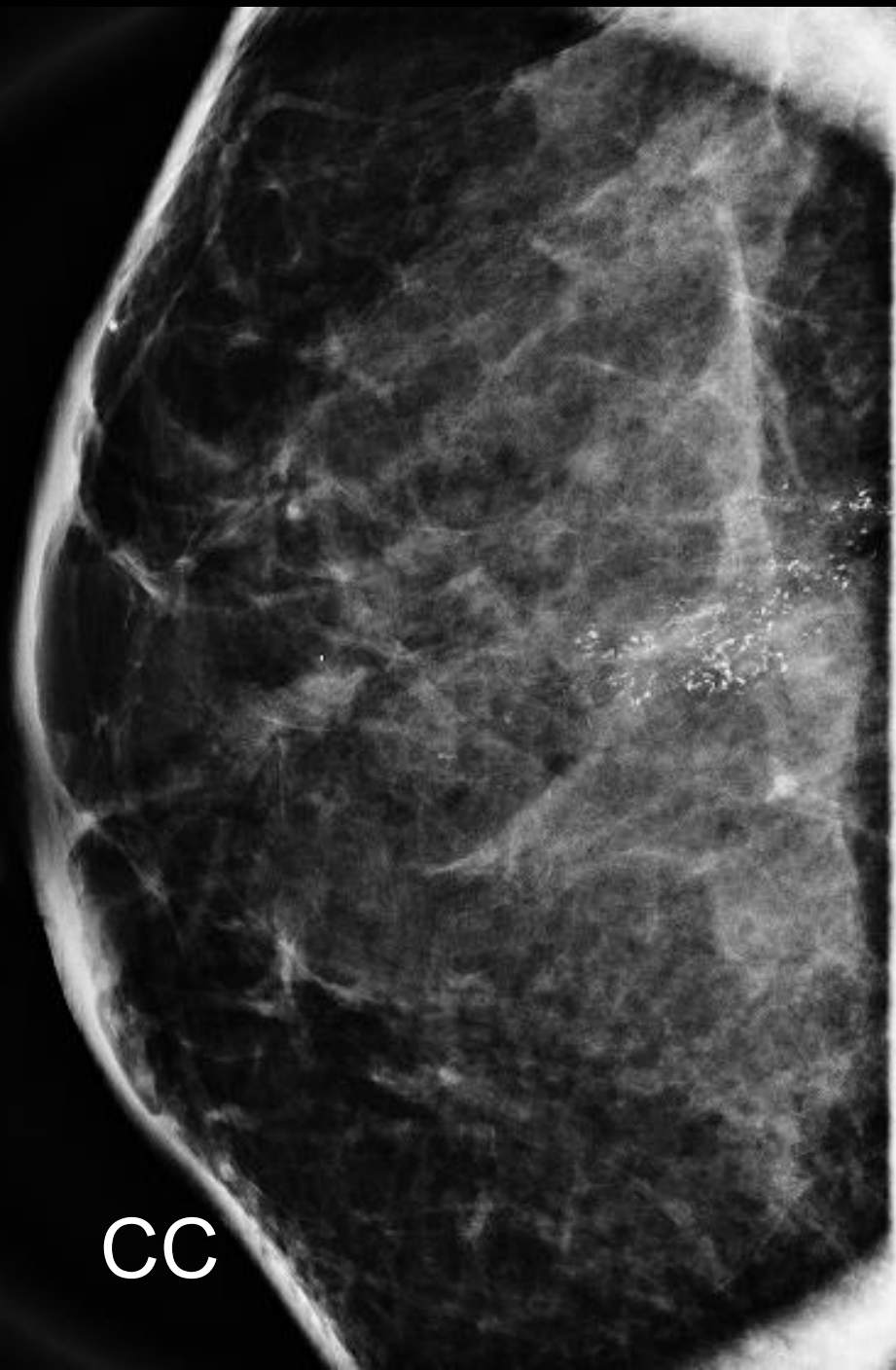
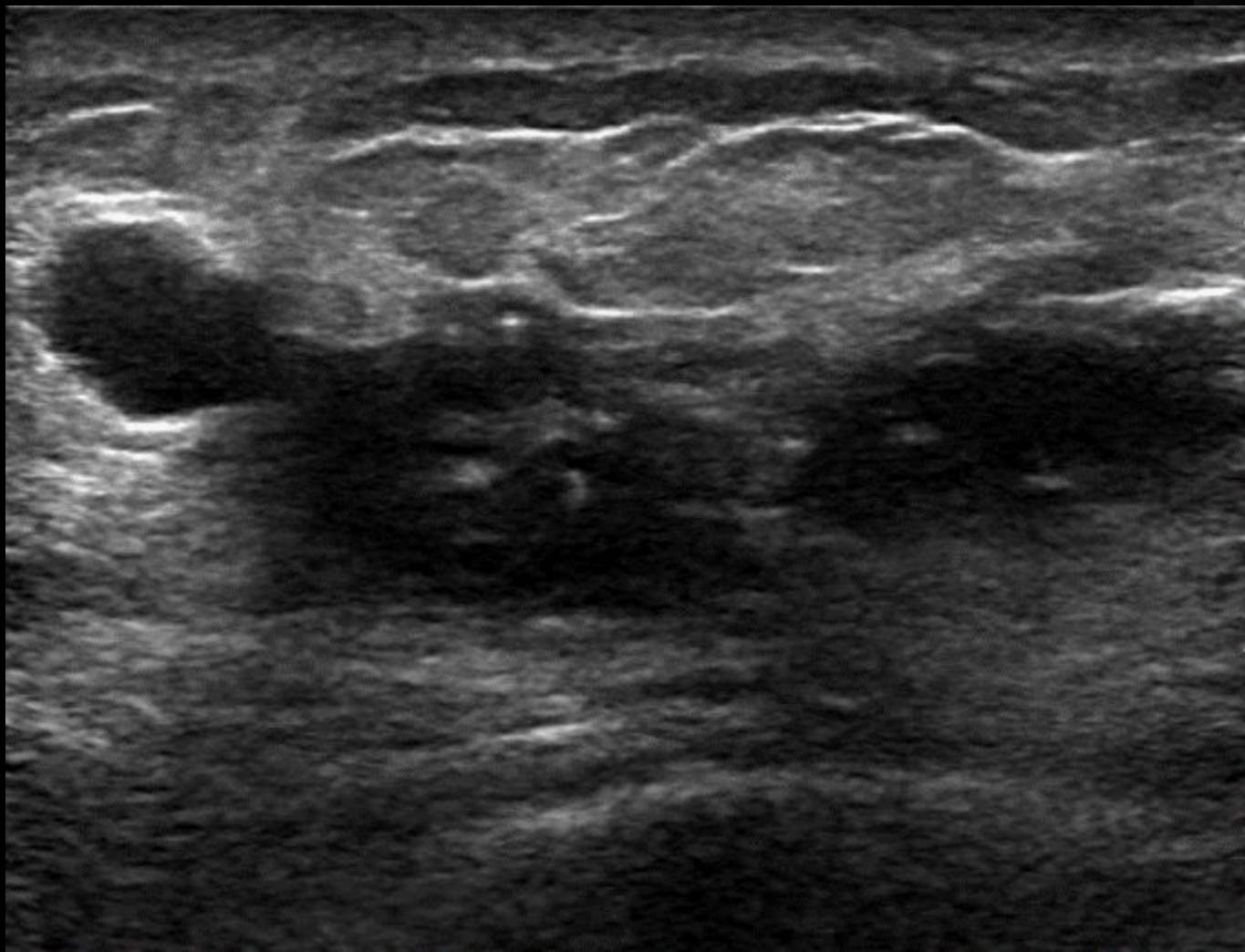
Image Source:
Wu J et al. Ultrasound Med Biol 2021; 47:1172-1181

**Specimen radiograph is indicated for biopsy
of calcifications.**

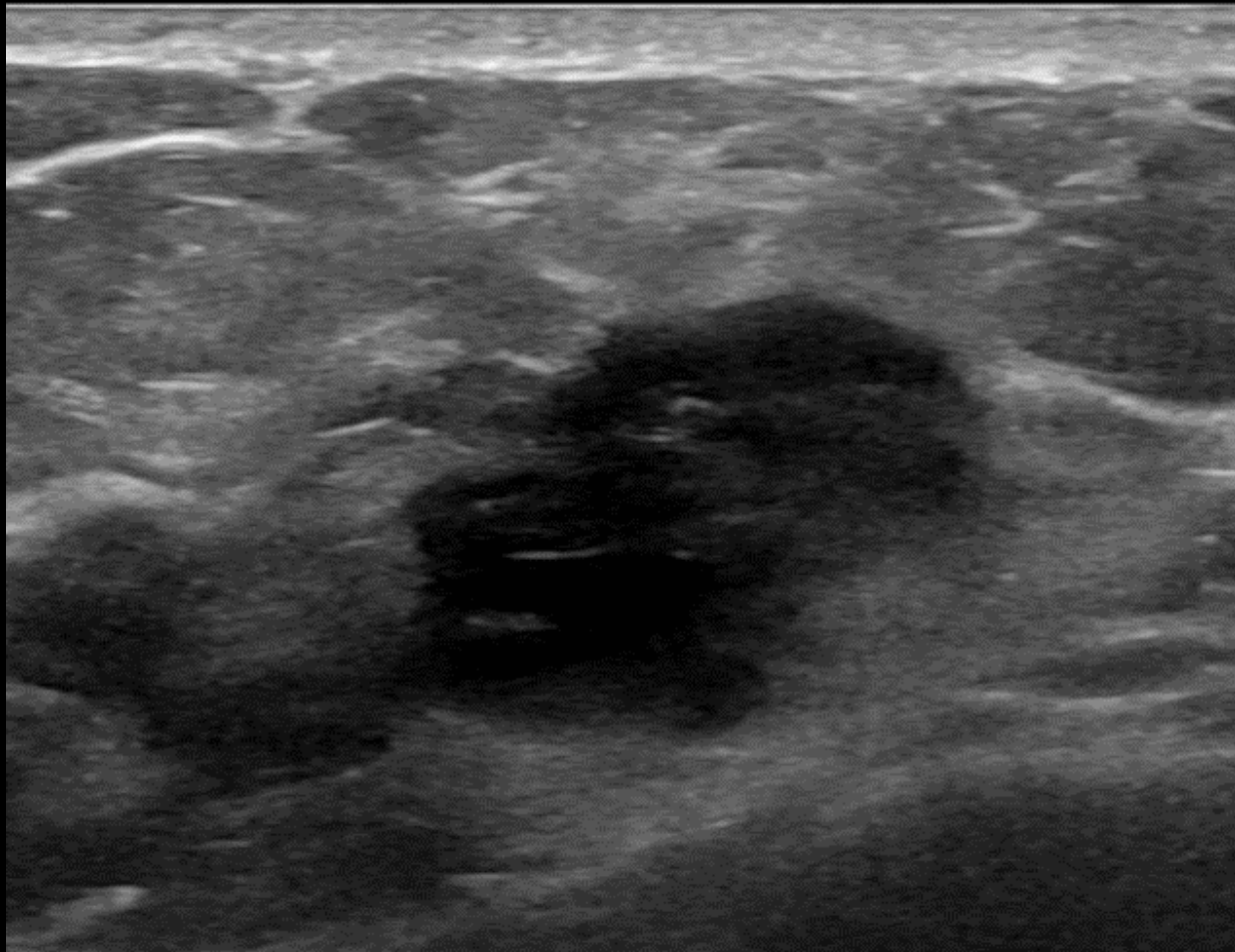
Segmental
Pleomorphic
Calcifications

LM

CC

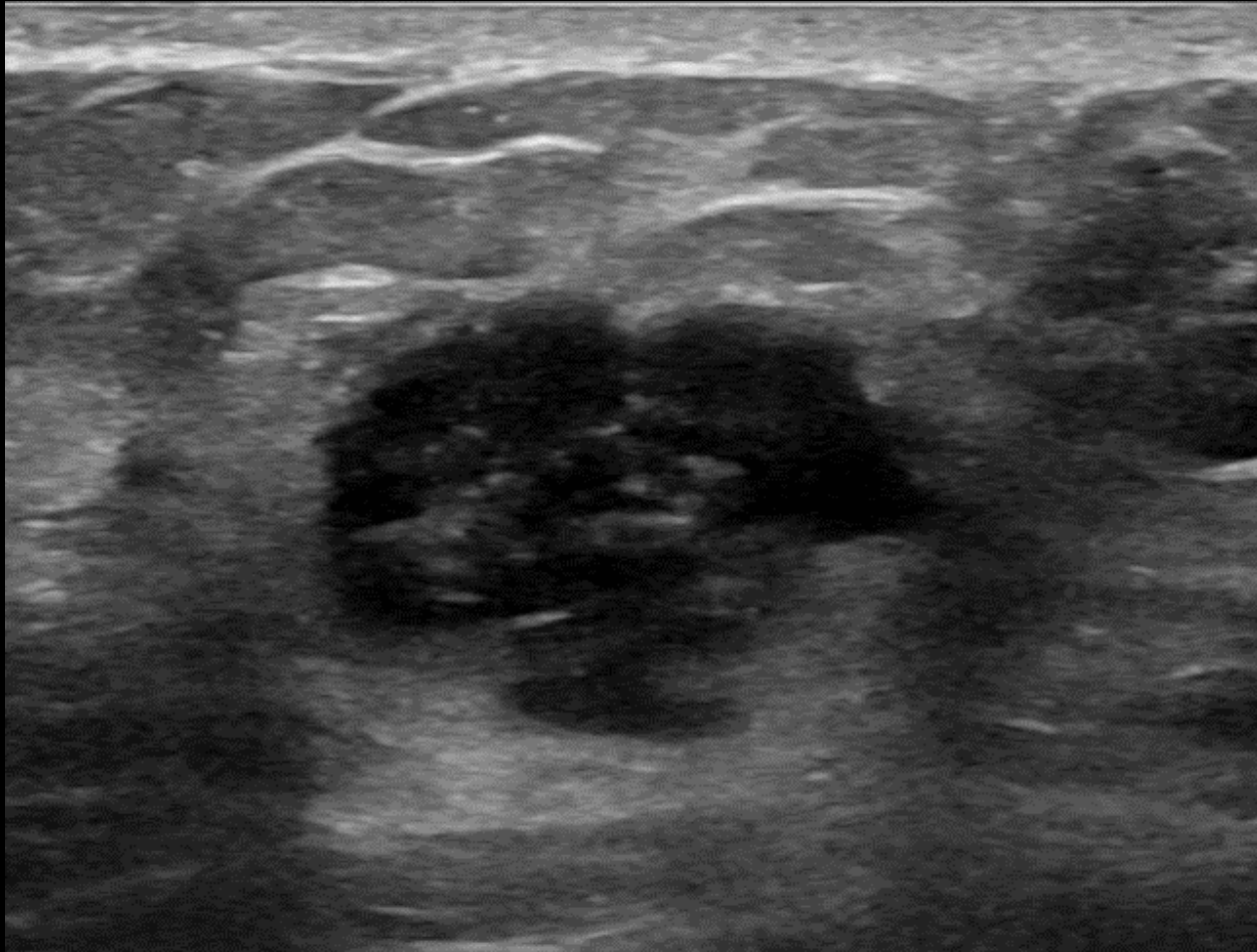


CC



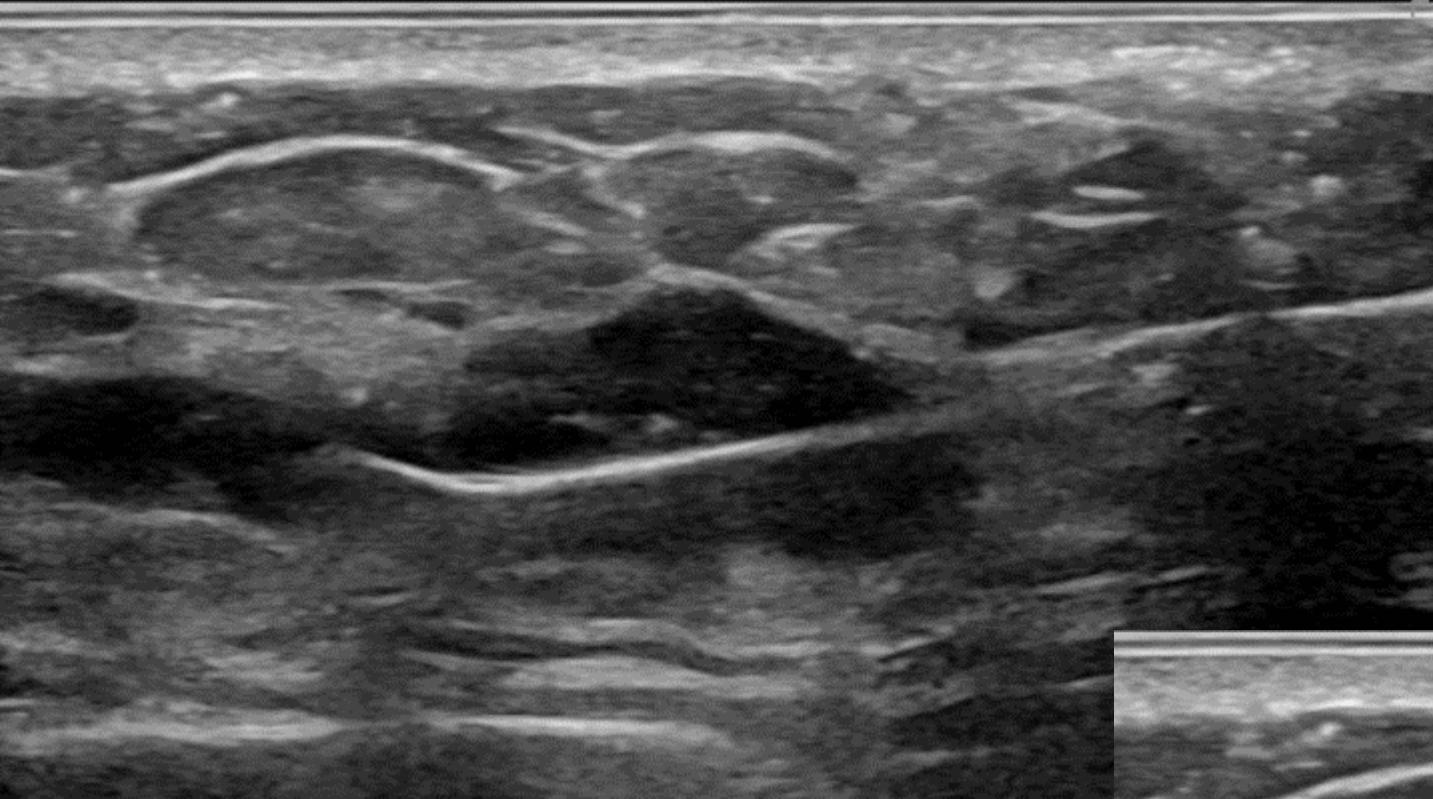
RT BREAST 7 O'CLOCK

longitudinal

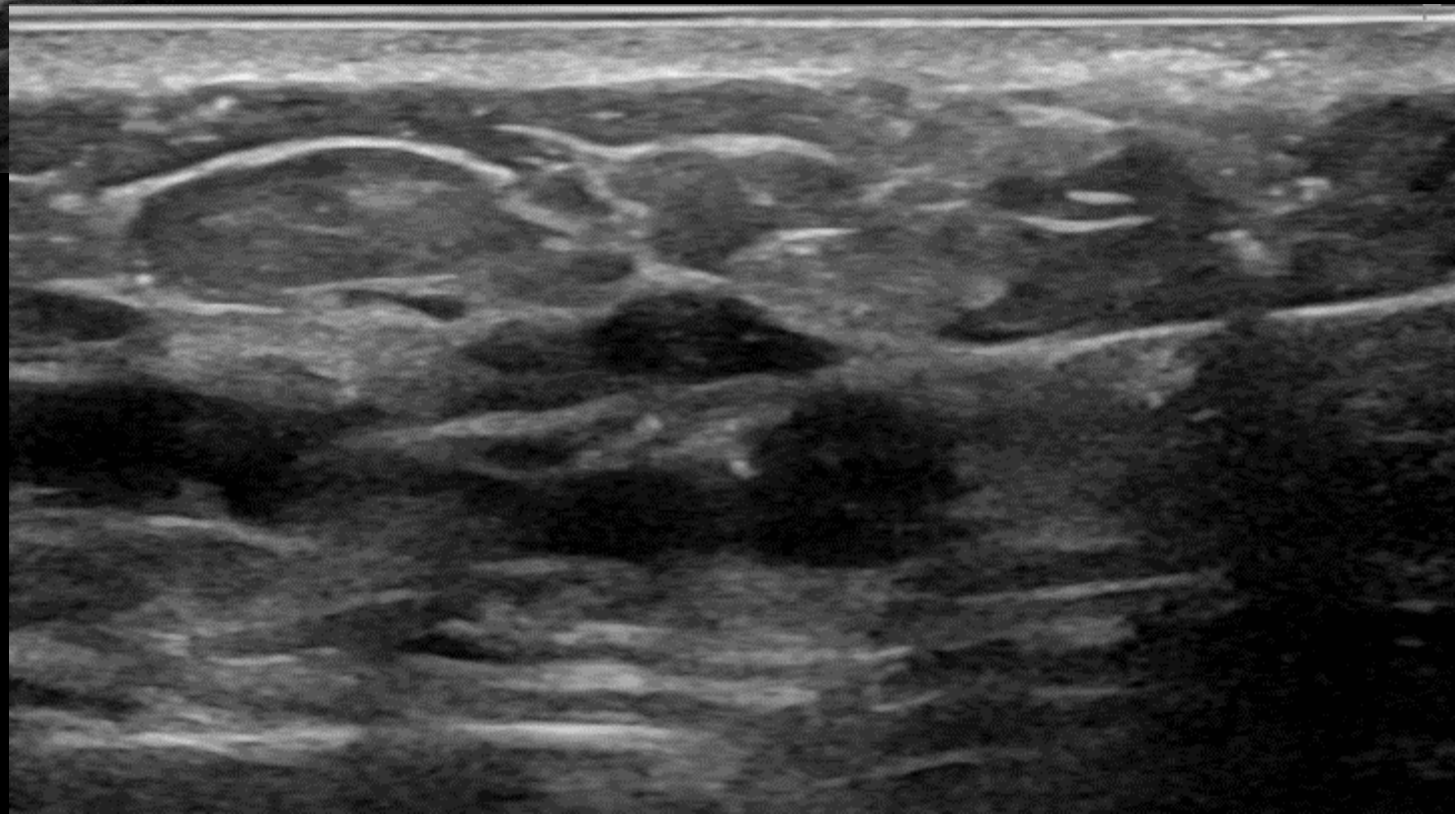


RT BREAST 7 O'CLOCK

transverse



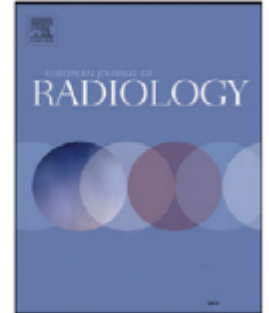
US Core Biopsy
(Vacuum-Assisted Device)



Invasive Ductal Carcinoma
+ DCIS

Overview

- Benefits
- Technique
- US-guided biopsy of calcifications
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance



Second-look ultrasound: Only for biopsy or more?

Jessica W.T. Leung*

Breast Health Center, California Pacific Medical Center, San Francisco, CA, USA

MRI-directed ultrasound

Mammography/Tomosynthesis

Molecular Breast Imaging

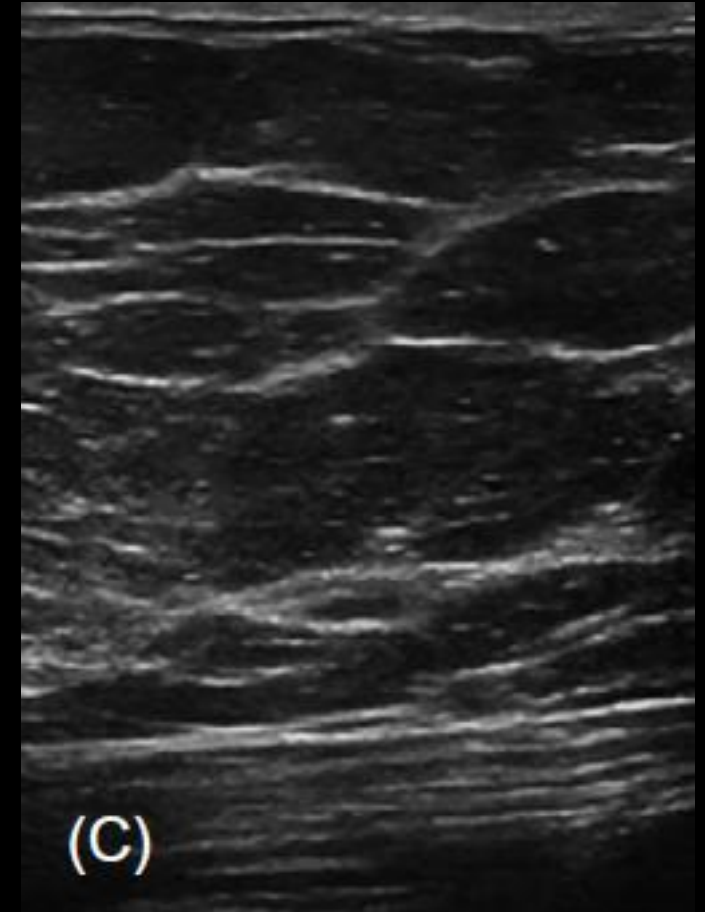
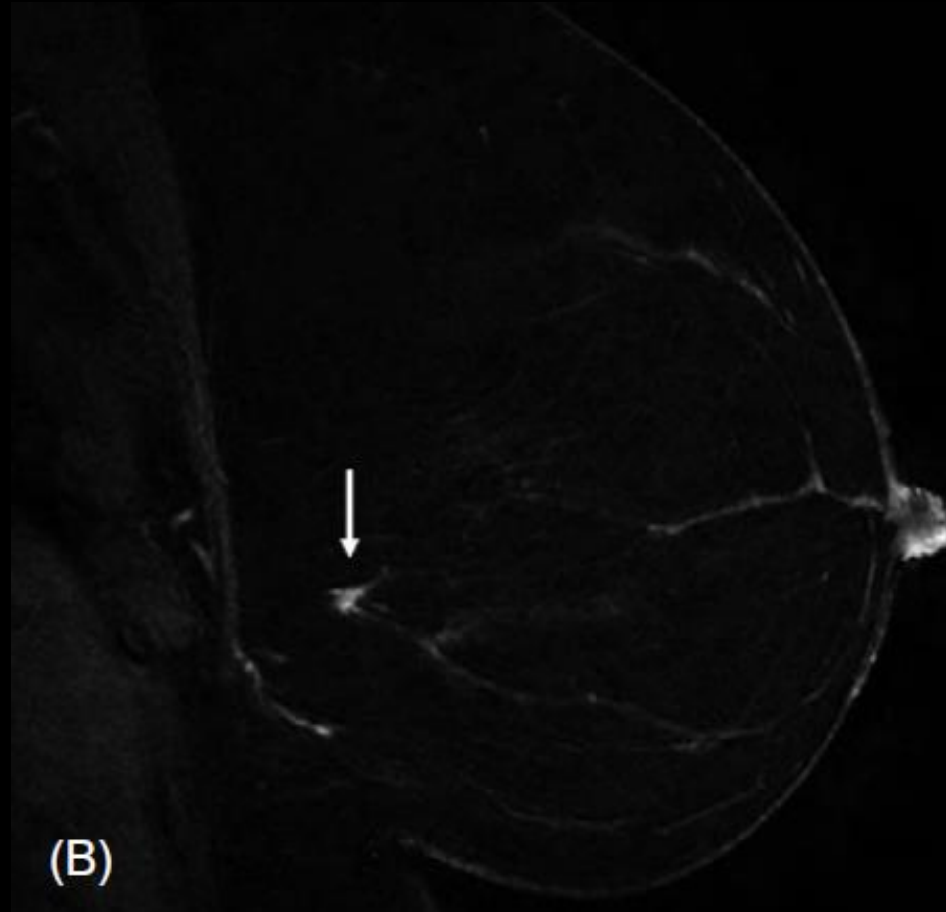
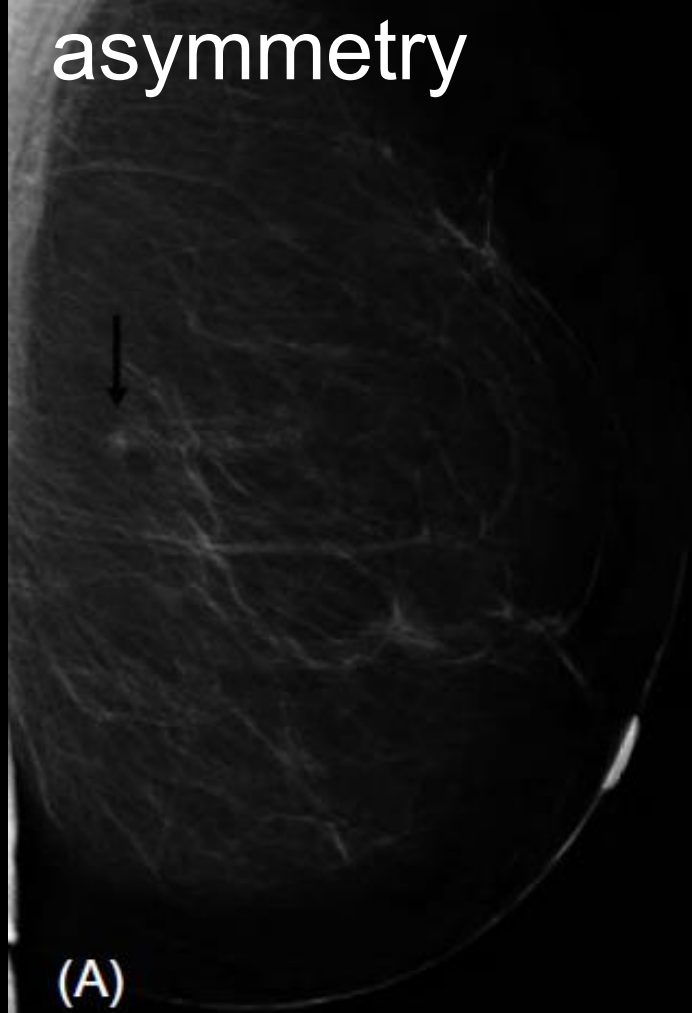
PET

MRI

Contrast-enhanced Mammography

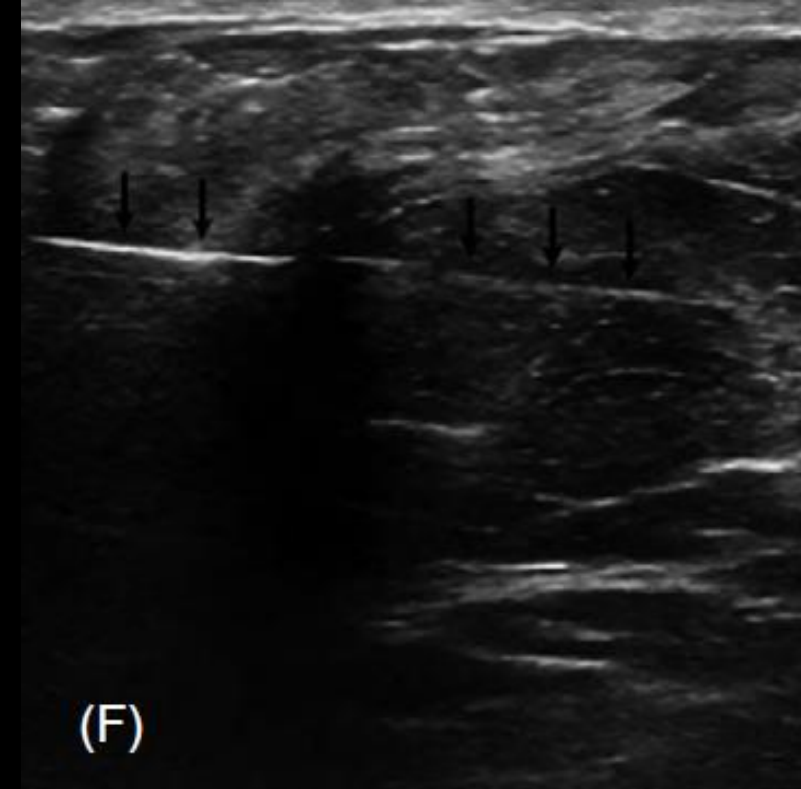
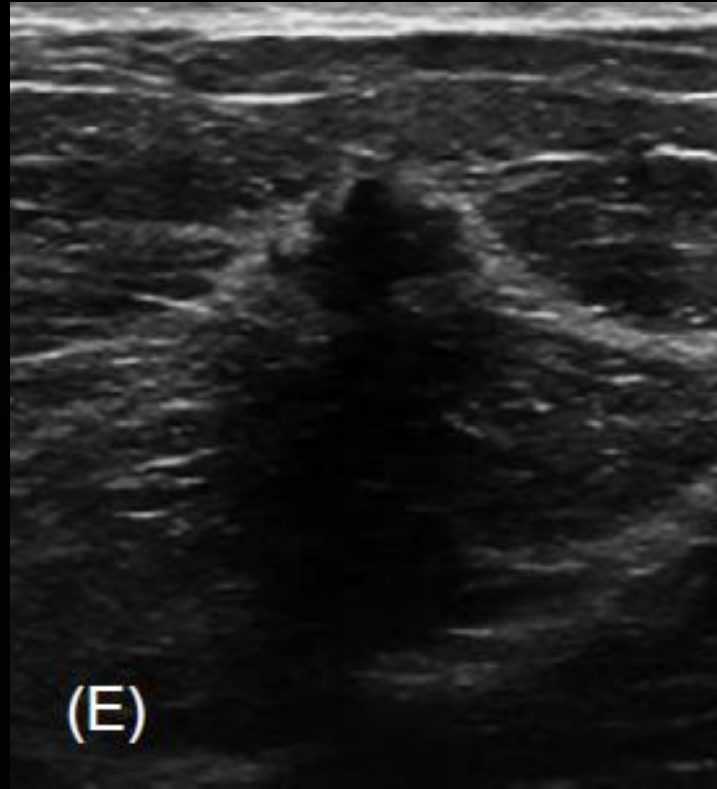
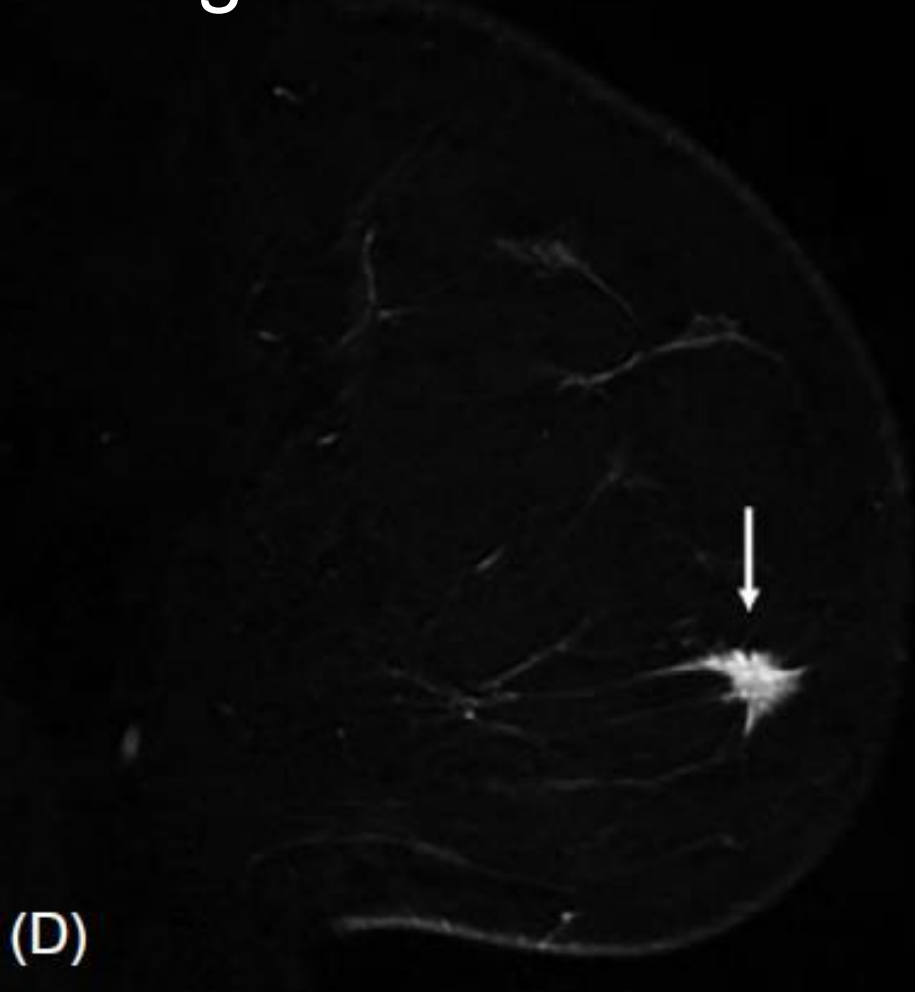
Site 1 Invasive Ductal Carcinoma

Diagnosed via stereotactic core biopsy of mammographic asymmetry



Site 2 Invasive Ductal Carcinoma

Diagnosed via US core biopsy of sonographic mass



Source: Leung JW. Eur J Radiol 2012; 81 Suppl 1:S87-89

Semin Roentgenol 2011; 46:260-274

Seminars in
ROENTGENOLOGY

Utility of Second-Look Ultrasound in the Evaluation of MRI-Detected Breast Lesions

Jessica W.T. Leung, MD

Likelihood of detecting lesion at US correlates with

- Size
- Degree of suspicion at MRI
- **Mass >>> Non-mass Enhancement**

2014

Predictors

- Mass (vs. non-mass enhancement)
- Malignant (vs. benign)

Claudio Spick, MD
Pascal A. T. Baltzer, MD

Diagnostic Utility of Second-Look US for Breast Lesions Identified at MR Imaging: Systematic Review and Meta-Analysis¹

Purpose:

To evaluate the diagnostic utility of second-look ultrasonography (US) in the assessment of lesions identified at breast magnetic resonance (MR) imaging.

Materials and Methods:

A systematic review of the PubMed database for articles published up to January 6, 2013, was performed by us-

N = 17 studies (2201 lesions)

US Detection Rate 22.6% to 82.1%
Pooled Rate 57.5% (1266/2201)

Utility of Targeted Ultrasound to Predict Malignancy Among Lesions Detected on Contrast-Enhanced Digital Mammography

Kristen Coffey, MD¹, Janice Sung, MD¹, Christopher Comstock, MD¹, Gulce Askin, MPH², Maxine S. Jochelson, MD¹, Elizabeth A. Morris, MD¹, Donna D'Alessio, MD¹

Breast Imaging • Original Research

PPV of CEM-directed US-guided biopsy = 32%

Keywords

breast neoplasms, contrast media, mammography, ultrasound

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J. Sung has received research grants from Hologic and GE Healthcare. C. Comstock has received honoraria for speaking at symposia from Bayer Pharmaceutical, Inc. M. S. Jochelson has received an honorarium for speaking from GE Healthcare and the Lynn Sage Breast Cancer Symposium and at MD Anderson. E. A. Morris has received a

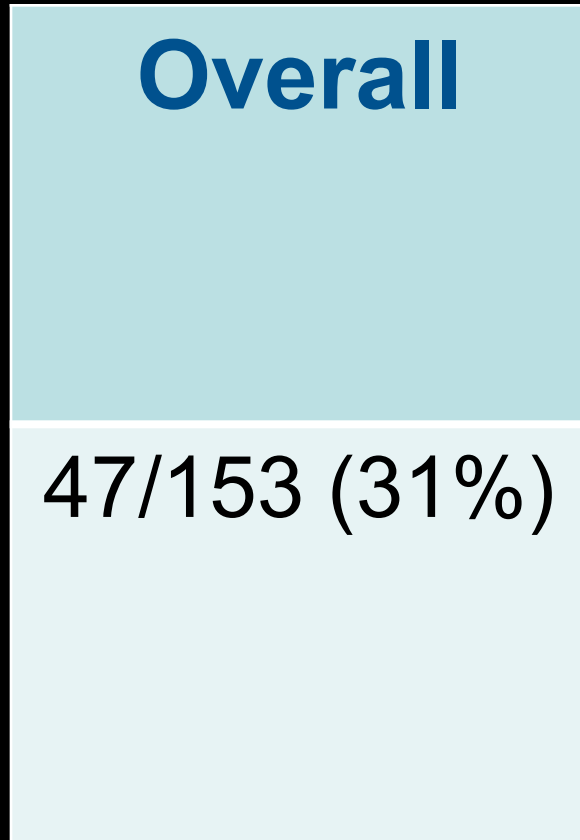
BACKGROUND. Targeted ultrasound (US) can be performed to characterize and potentially biopsy areas of enhancement detected on contrast-enhanced mammography (CEM).

OBJECTIVE. The purpose of this study was to assess the utility of targeted US in predicting malignancy of lesions with indeterminate or suspicious enhancement on CEM.

METHODS. One thousand consecutive CEM examinations with same-day targeted breast US at one institution between October 2013 and May 2018 were retrospectively reviewed. All patients with indeterminate or suspicious enhancement detected on CEM that underwent US evaluation were included. Patients with palpable or symptomatic lesions, those with suspicious findings on low-energy mammograms or images obtained with another modality, and those with less than 1 year of follow-up were excluded. Medical records, imaging, and pathology data were reviewed. Histopathologic analysis was used as the reference standard for biopsied lesions, and follow-up imaging was used for unbiopsied lesions. Associations between pathologic diagnosis, presence of a US correlate, and lesion characteristics were assessed by Fisher exact, chi-square, and Wilcoxon rank sum tests.

Source: Coffey K et al. AJR Am J Roentgenol 2021; 217:595-604

Likelihood of Detection at US



Source: Coffey K et al. AJR Am J Roentgenol 2021; 217:595-604

Likelihood of Detection at US

Overall	Mass	Non-Mass Lesion
47/153 (31%)	28/43 (65%)	19/110 (17%)

Source: Coffey K et al. AJR Am J Roentgenol 2021; 217:595-604

Likelihood of Detection at US

Overall	Mass	Non-Mass Lesion	P-value
47/153 (31%)	28/43 (65%)	19/110 (17%)	< 0.001

Source: Coffey K et al. AJR Am J Roentgenol 2021; 217:595-604

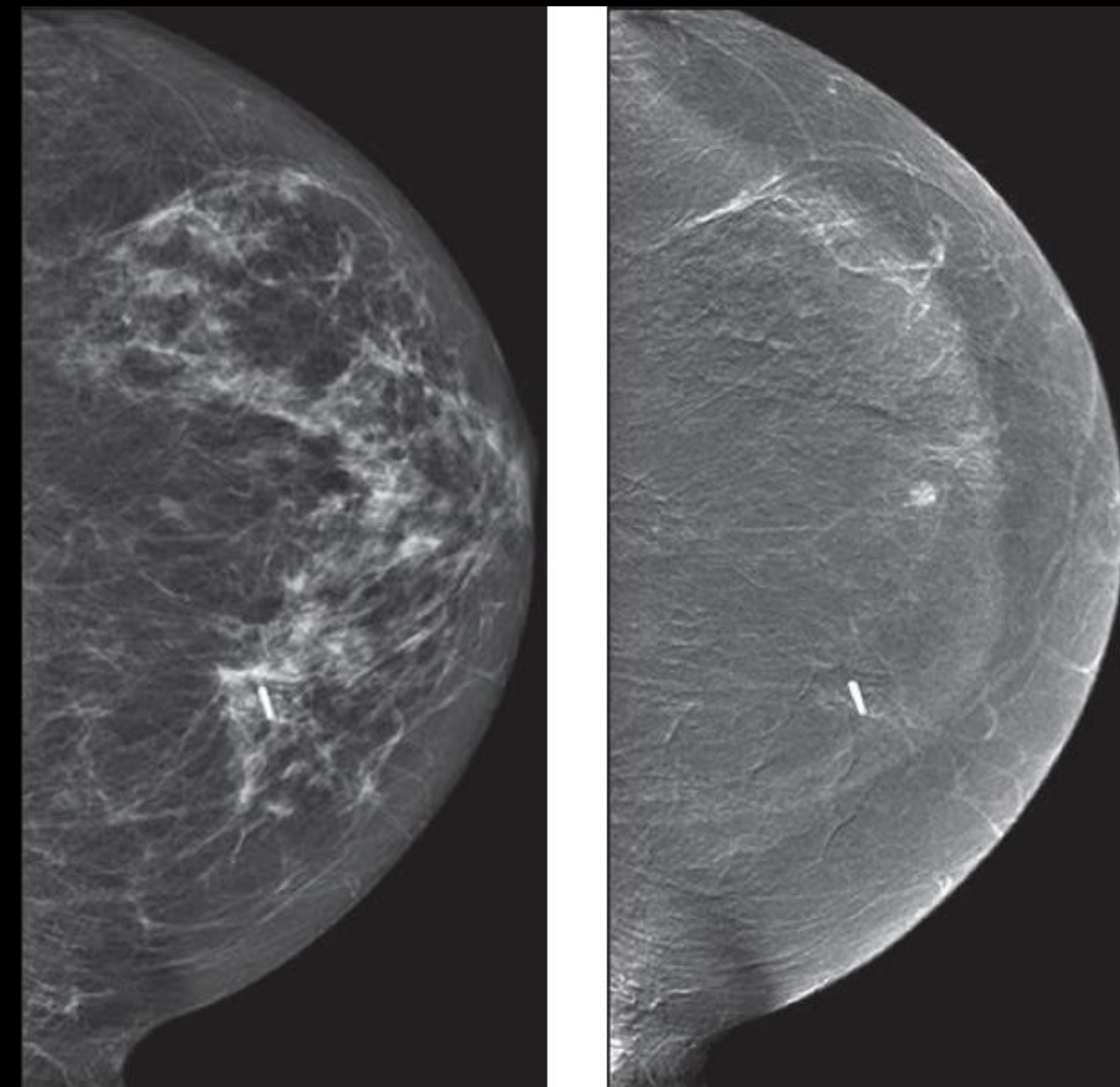
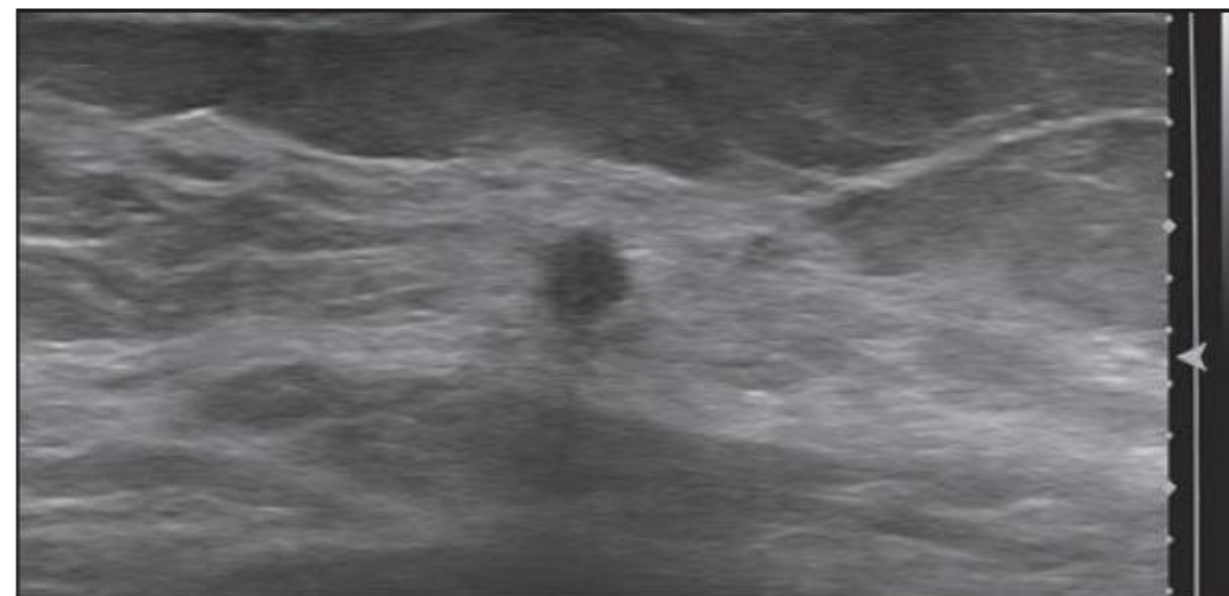


Fig. 3—57-year-old woman with history of left breast excision for lobular carcinoma in situ who underwent contrast-enhanced mammography.
A, Low-energy mammogram shows no abnormality.
B, Recombined mammogram shows enhancing 0.4-cm mass in 6-o'clock axis of left breast. Mass was evident only on recombined images.
C, Image obtained during targeted ultrasound-guided core biopsy shows ultrasound correlate. Pathology result was invasive lobular carcinoma.



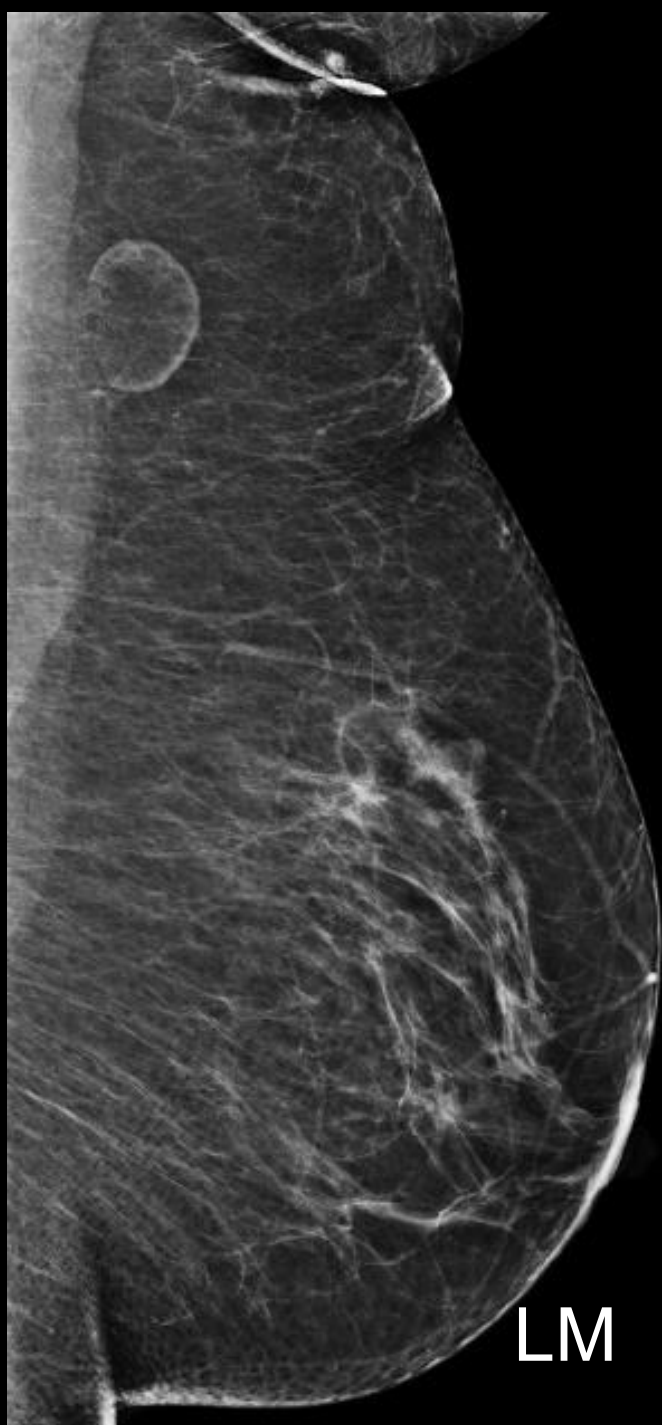
Source: Coffey K et al. AJR Am J Roentgenol 2021; 217:595-604

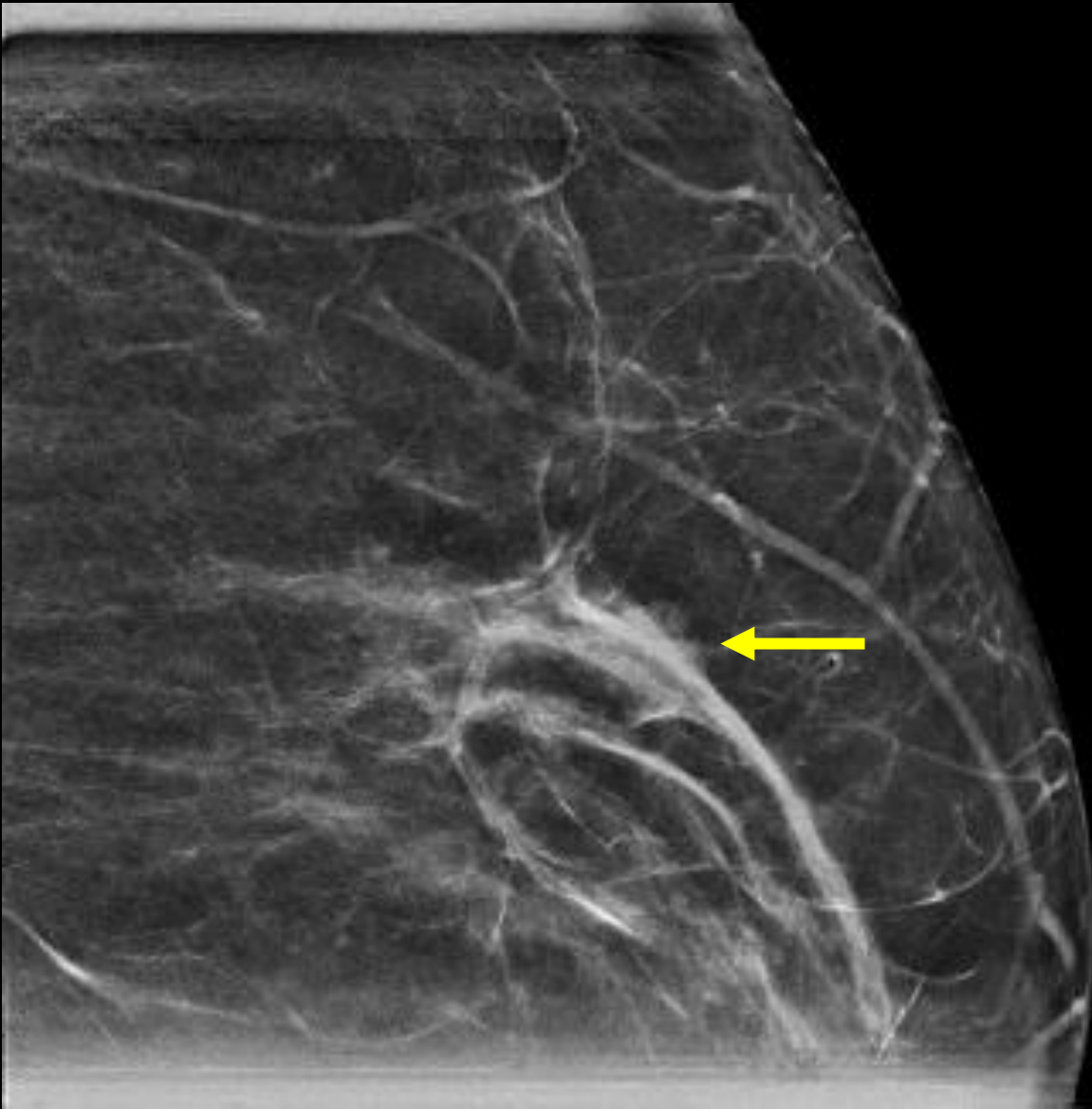
Overview

- Benefits
- Technique
- US-guided biopsy of calcifications
- “Second-look” ultrasound and biopsy
- Radiologic-pathologic concordance

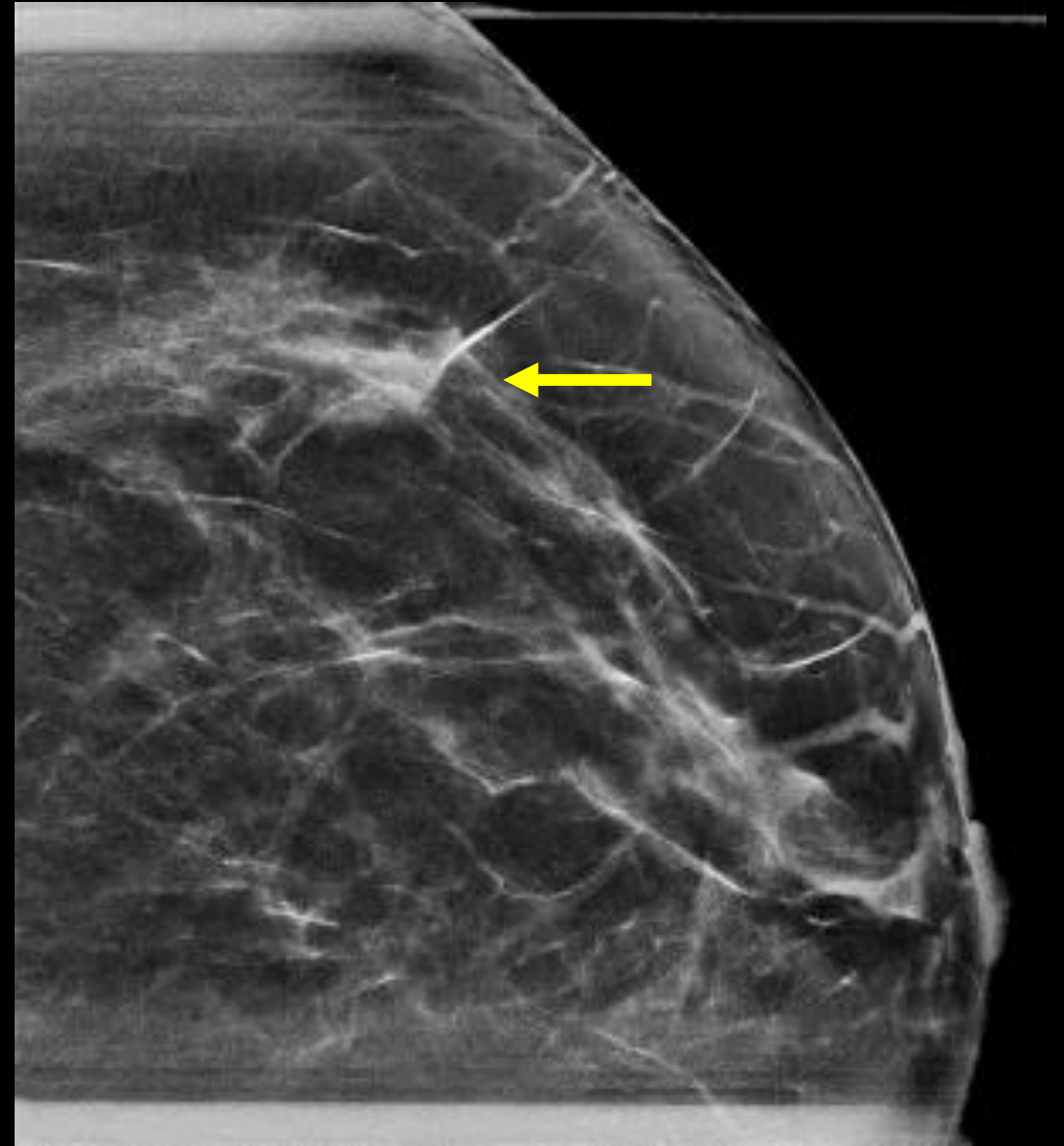
Radiologic-Pathologic Concordance

Clinical and imaging findings (pre-test probability) should “match” pathology (biopsy) results. Remember also to include temporal change in your assessment.

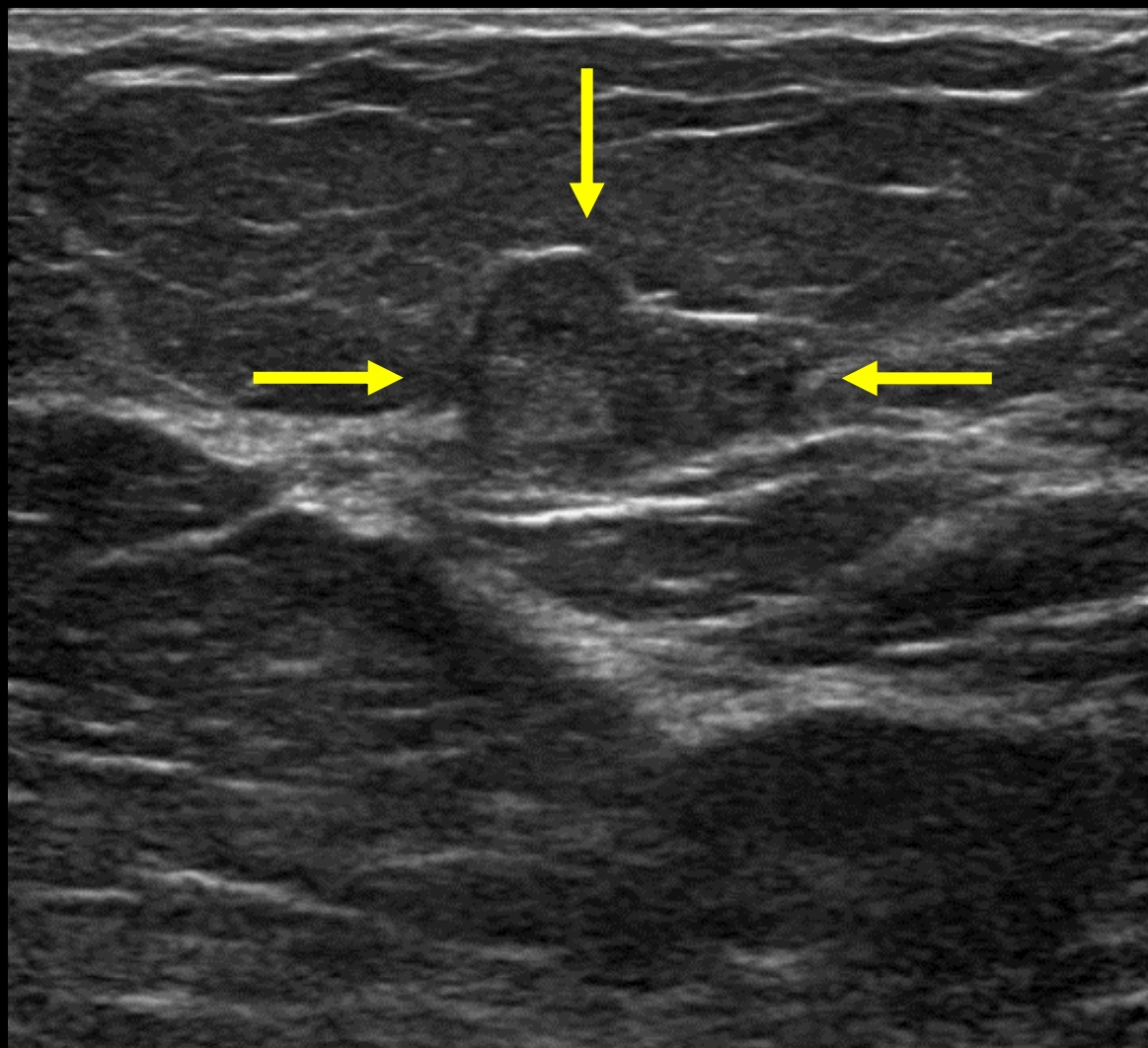




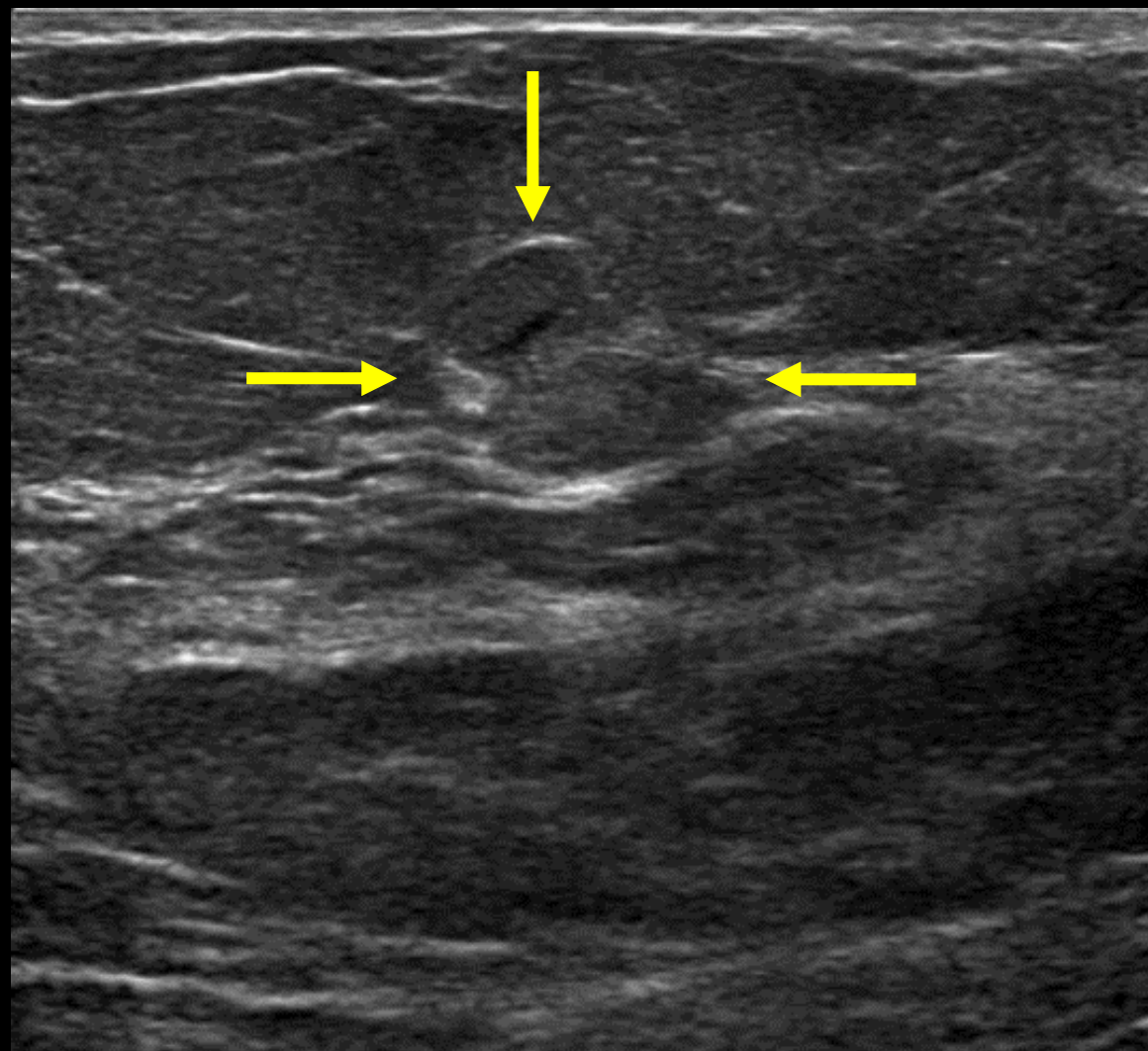
LM



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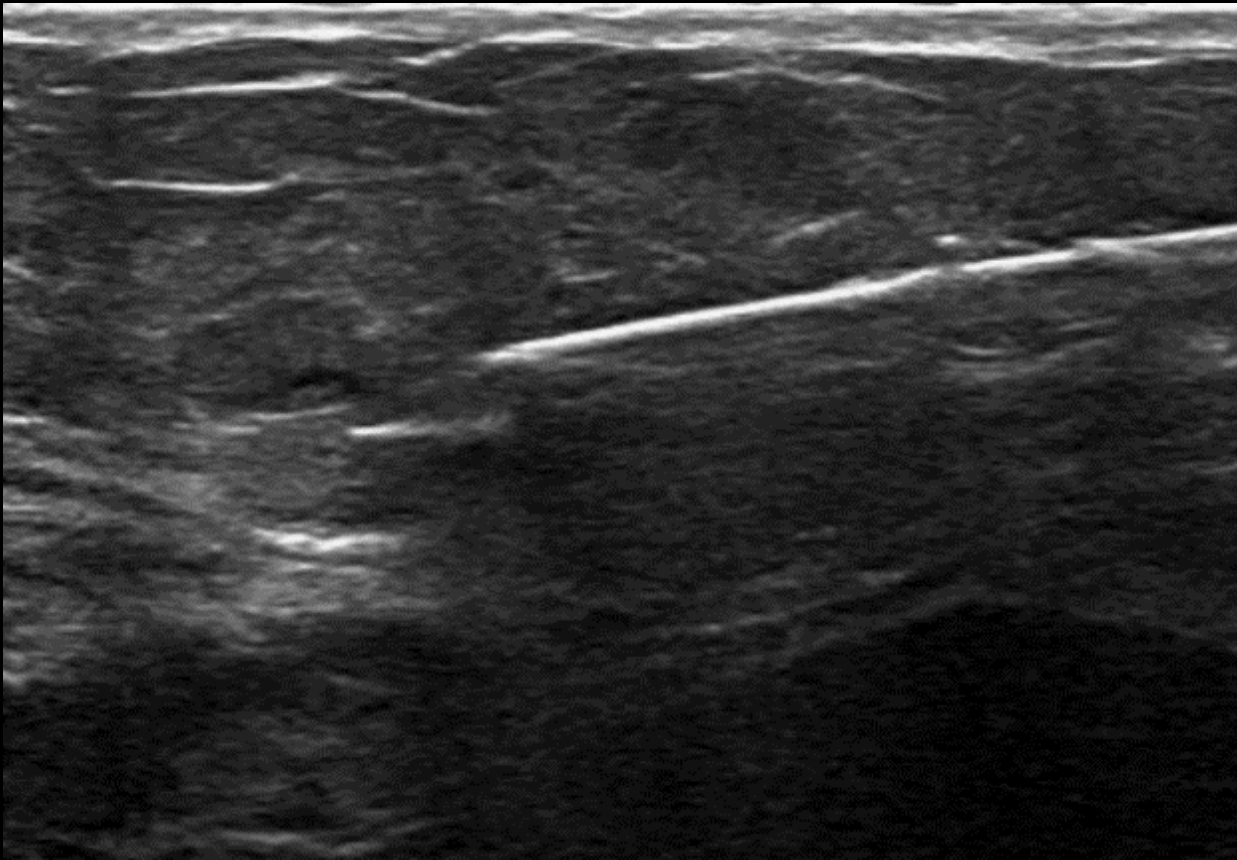


Longitudinal

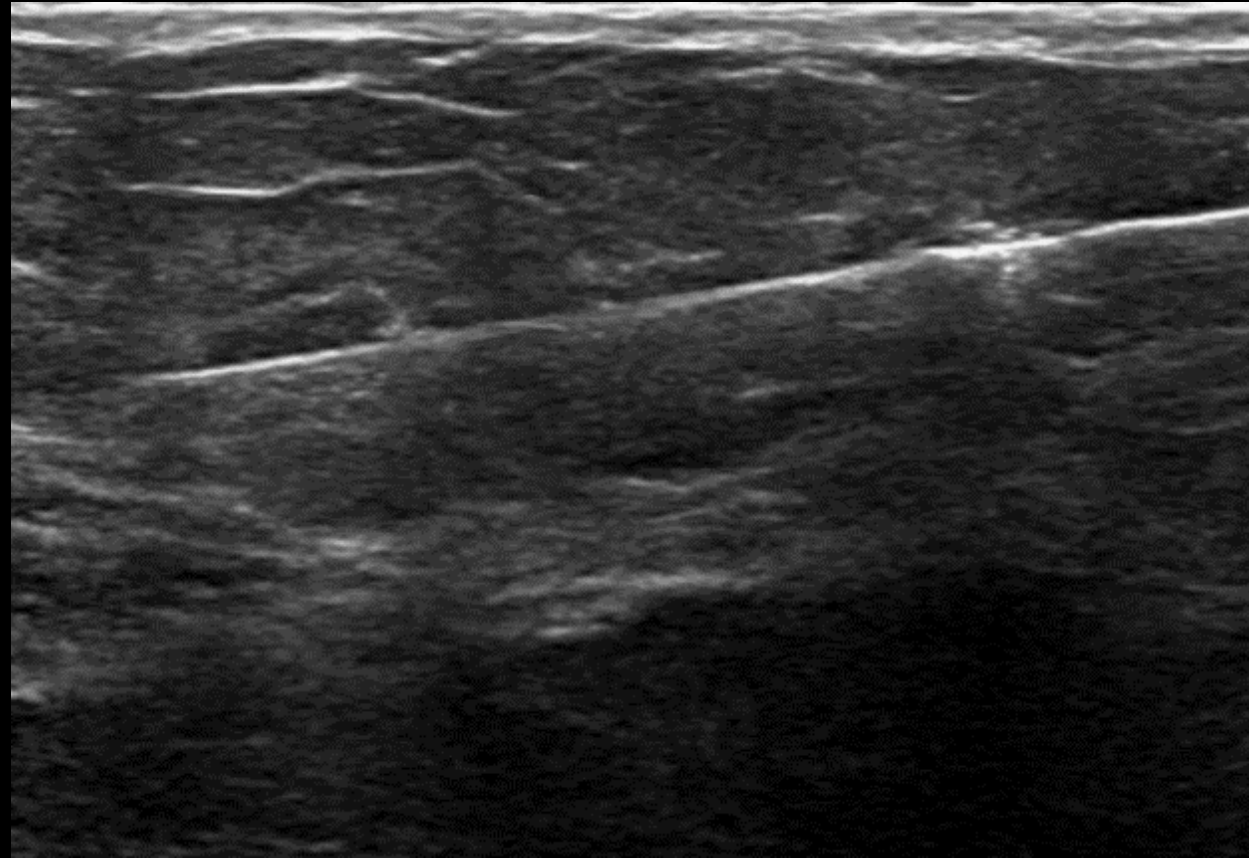


Transverse

US-guided Core Biopsy (Automated Spring Loaded Needle)

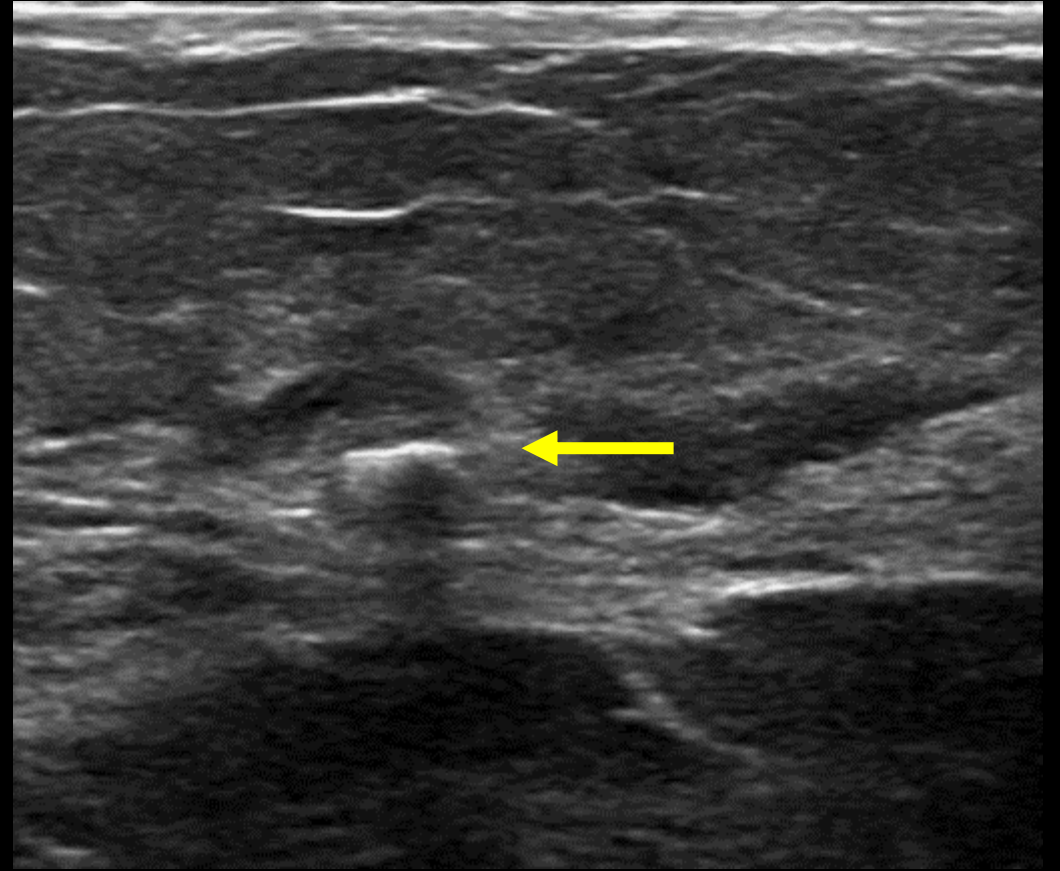
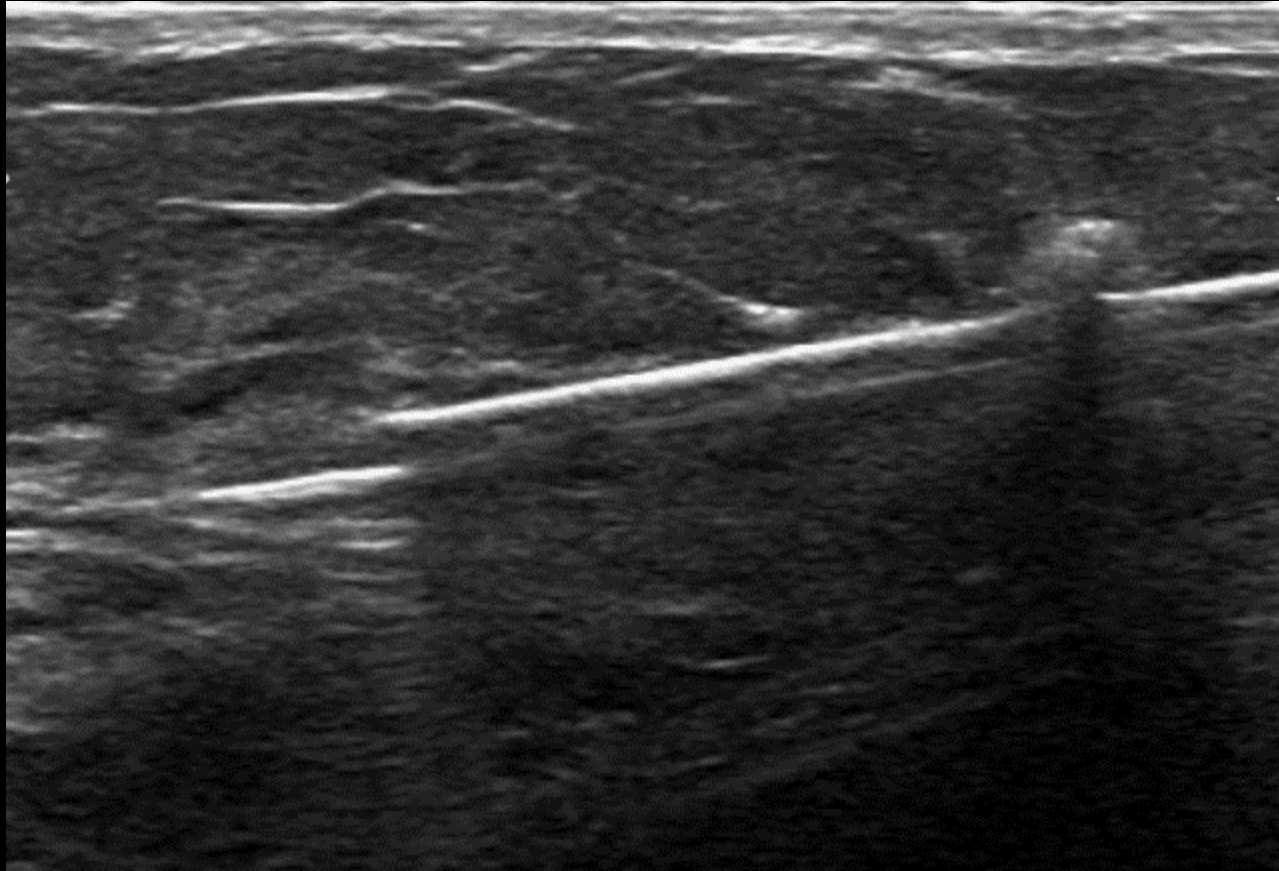


Pre

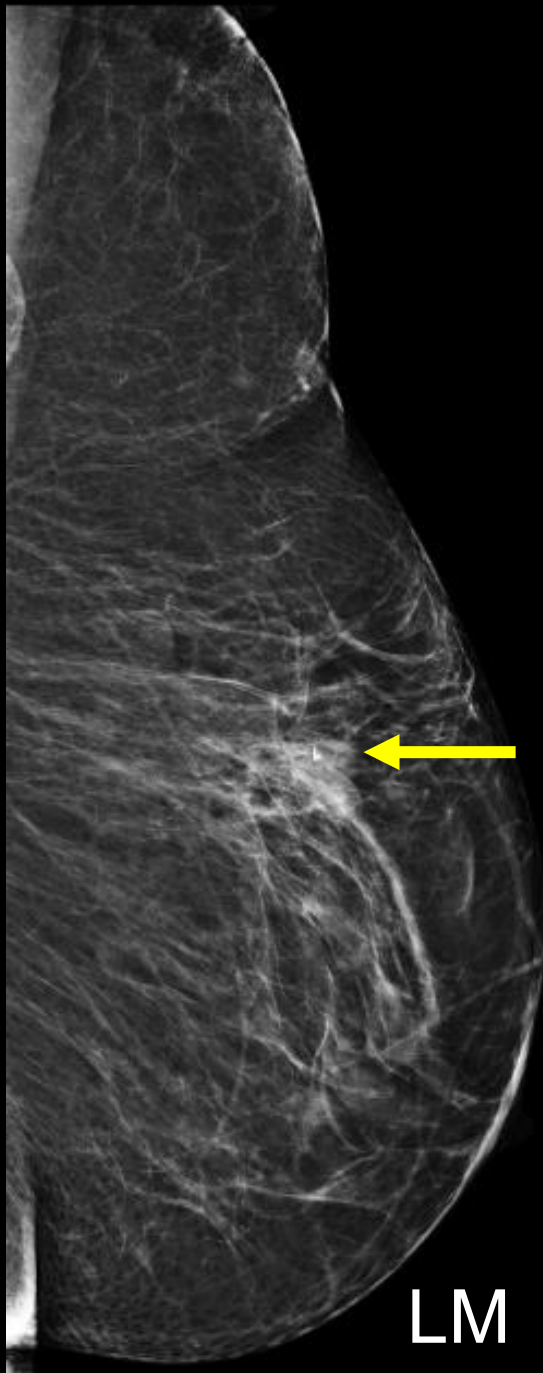


Post

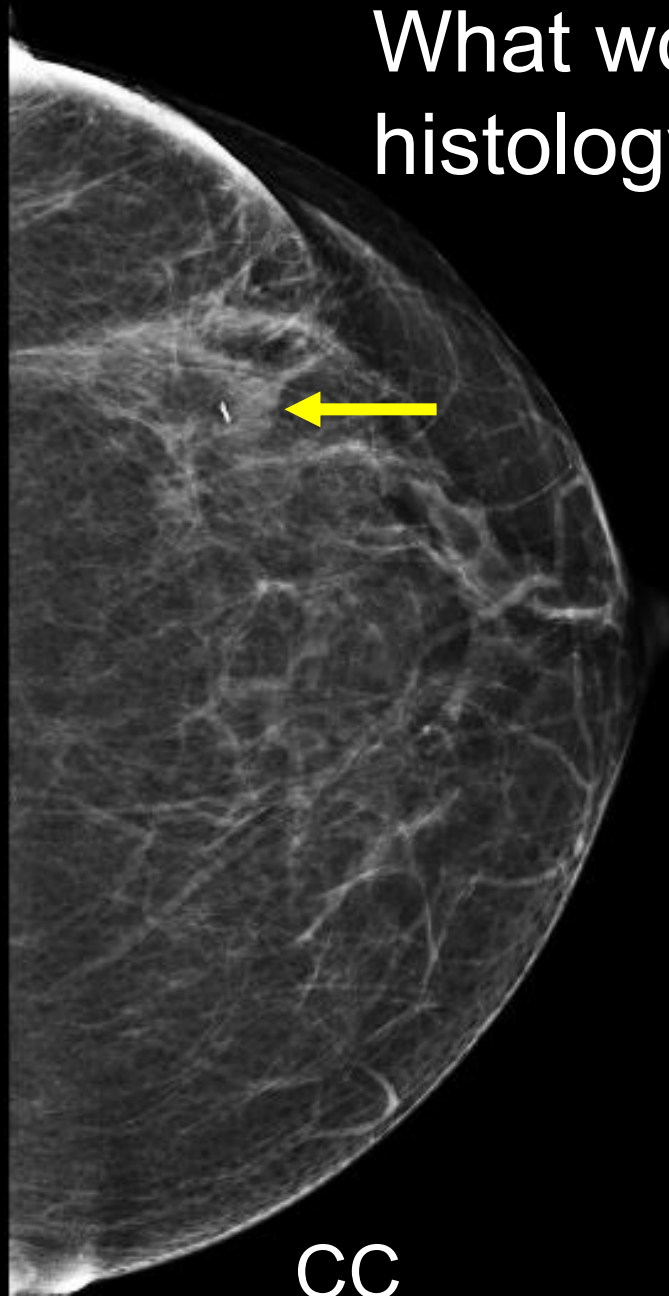
US-guided Biopsy Clip Placement



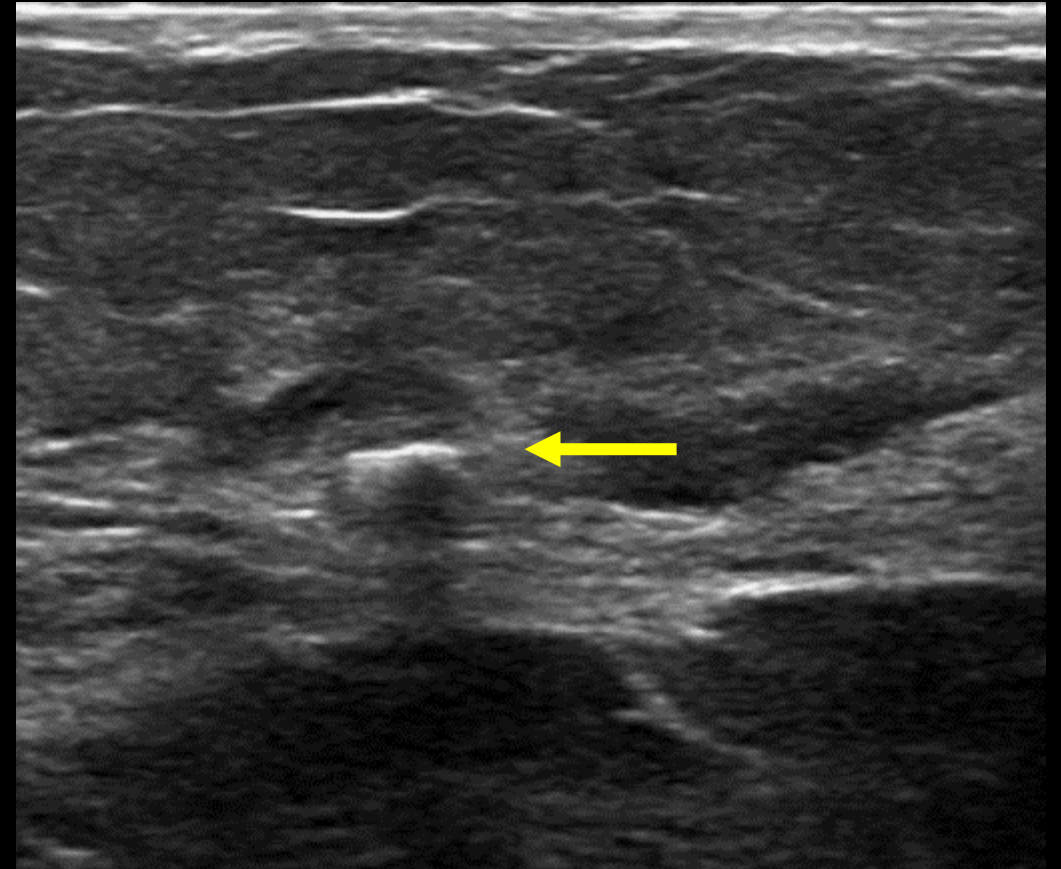
What would be considered concordant histology?



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CC



Mucinous Carcinoma

Thank you

JWLeung@mdanderson.org

#drjessicaleung