Breast Imaging Overview

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Session Objectives

- To discuss the appropriate recommendations for breast cancer screening (both in the general population as well as in high-risk individuals)
- To compare and contrast screening and diagnostic mammography
- To provide a template for generation of a standard mammography report (including breast density, potential breast masses, potential breast calcifications, breast architexture, and potential skin changes)
- To illustrate the appropriate indications for breast sonography (including mass characterization as well as guidance for biopsy)
- To provide examples of breast biopsy techniques (including stereotactic core biopsy, ultrasound-guided core biopsy, and MRI-guided core biopsy)

BREAST CANCER STATISTICS

- Statistics courtesy of the American Cancer Society www.cancer.org
- Cancer second leading cause of death in US after heart disease
- Breast cancer second leading cause of cancer deaths in US females (after lung cancer)

ACR Breast Cancer Detection Guidelines

- For women *not* at high risk
  - Yearly mammograms starting at age 40 and continuing for as long as a woman is in good health.
  - Clinical breast exams (CBE) should be part of a periodic health exam (every three years for women in their 20s and 30s and every year for women 40 and over).
  - Breast self-exam (BSE) is an option for women starting in their 20s. Women should report any breast change promptly to their health care providers.
    - Please note that the American Cancer Society (ACS) and US Preventative Task Force (USPTF) have guidelines for mammographic assessment that differ from those of the American College of Radiology (ACR)

ACR Breast Cancer Detection Guidelines

- Women at increased risk for breast cancer (lifetime risk of 20% to 25% or greater)
  - Have known *BRCA1* or *BRCA2* gene mutation
  - Have first degree relative (parent, sibling, child) with *BRCA1* or *BRCA2* gene mutation, and have not had genetic testing themselves
  - Had radiation therapy to the chest between the ages of 10 and 30 years
  - Have Li-Fraumeni syndrome, Cowden syndrome, or Bannayan-Riley-Ruvalcaba syndrome (or a first degree relative with one of these syndromes)

ACR Breast Cancer Detection Guidelines

- For women at high risk (lifetime risk of breast cancer: 20% to 25% or greater)
  - Yearly mammogram and MRI, starting at age 30 (or potentially as early as 25) and continuing for as long as a woman is in good health.
  - Clinical breast exams (CBE) should be part of a periodic health
  - Breast self-exam (BSE) is an option for women starting in their 20s. Women should report any breast change promptly to their health care providers.

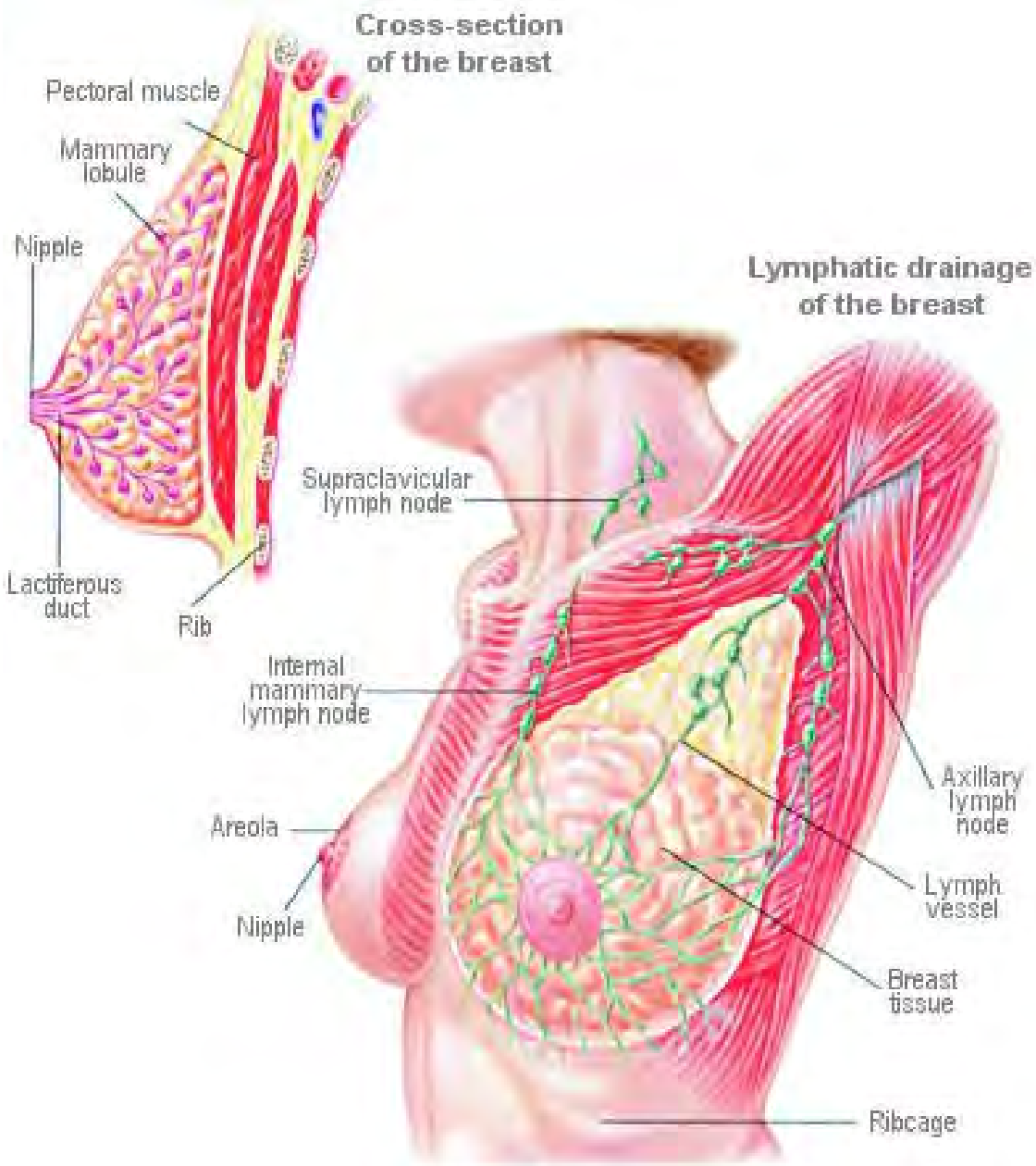
Modalities for breast imaging

- Mammography
  - Screening
  - Diagnostic
- Sonography
- MRI
- Nuclear medicine
  - Sentinel node
  - Positron emission tomography (PET)

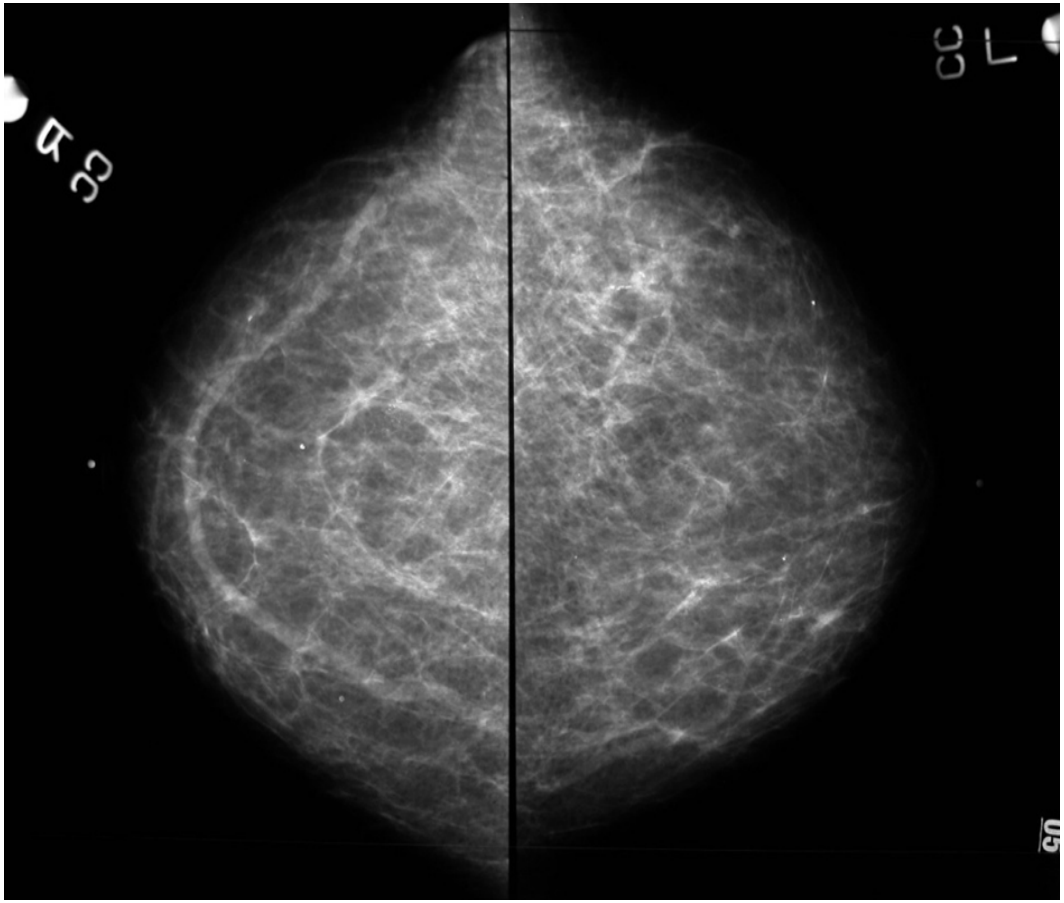
Mammography

- Mammography is the best single screening tool currently available to detect breast cancers
- Images for the standard screening examination maximize tissue visualization balanced against dose and cost
- Craniocaudal (CC) and Mediolateral oblique (MLO) views of each breast are standard
- Some modification allowed for variants in anatomy, with the goal to maximize tissue visualization

Anatomy of the Breast

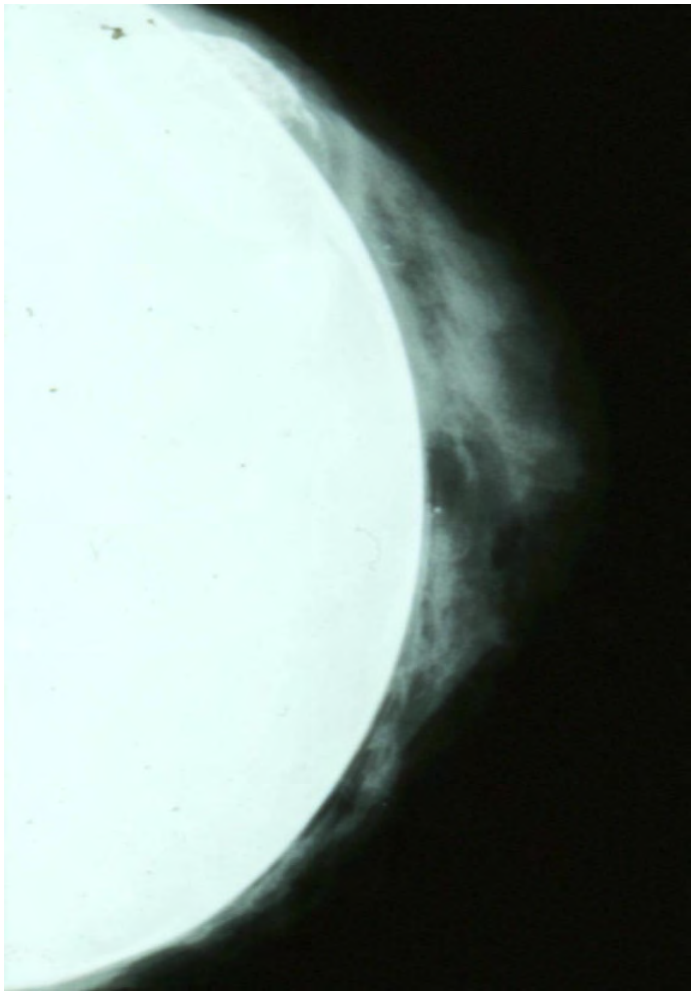


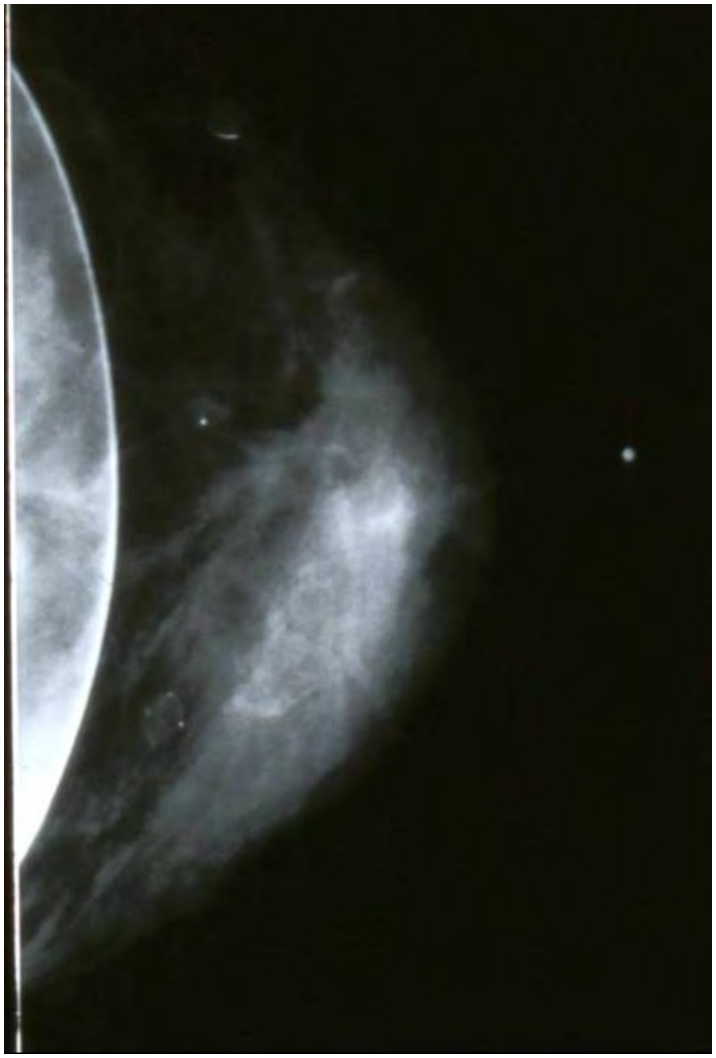
Craniocaudad view (CC)



Mediolateral Oblique View (MLO)

Implant Displacement Views





Screening Mammography Regulation

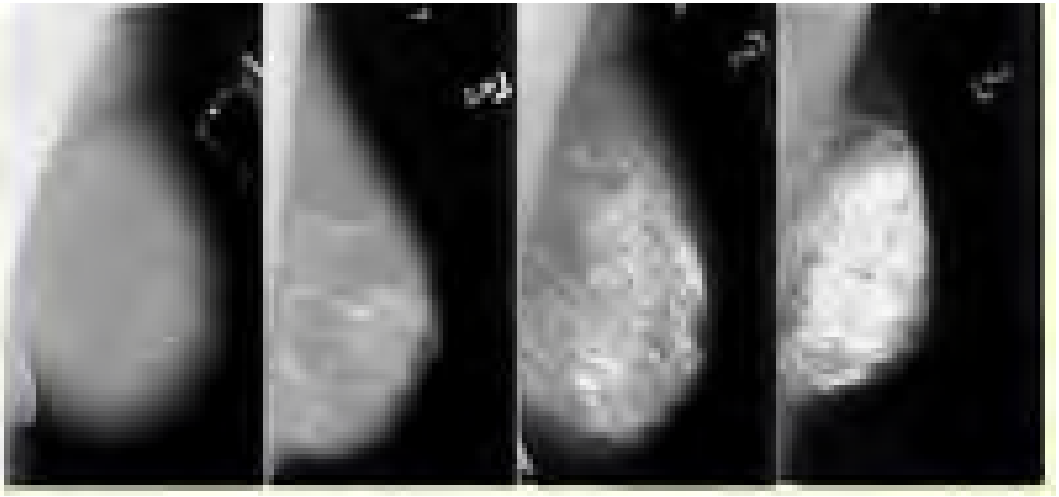
- Mammography Quality Standards Act (MQSA) of 1992 regulated the quality control for, acquisition of, reporting of screening mammography as well as qualifications for personnel and facilities involved in providing mammography
- http://www.fda.gov/cdrh/mammography/ frmamcom2.html

Standardized mammogram report

- **'The breasts are almost *entirely fatty*. There are no mass lesions, suspicious calcifications, architectural distortion, or skin thickening'**
- BI-RADS: Breast Imaging Reporting and Data System
  - Category 0: needs additional imaging evaluation (or comparison with prior mammograms)
  - Category 1: negative
  - Category 2: benign finding
  - Category 3: probably benign finding (3-6 month follow-up)
  - Category 4: suspicious abnormality (Biopsy should be considered)
  - Category 5: highly suggestive of malignancy (appropriate action should be taken)
  - Category 6: known biopsy-proven malignancy (appropriate action should be taken)

Parenchymal Density: BI-RADS

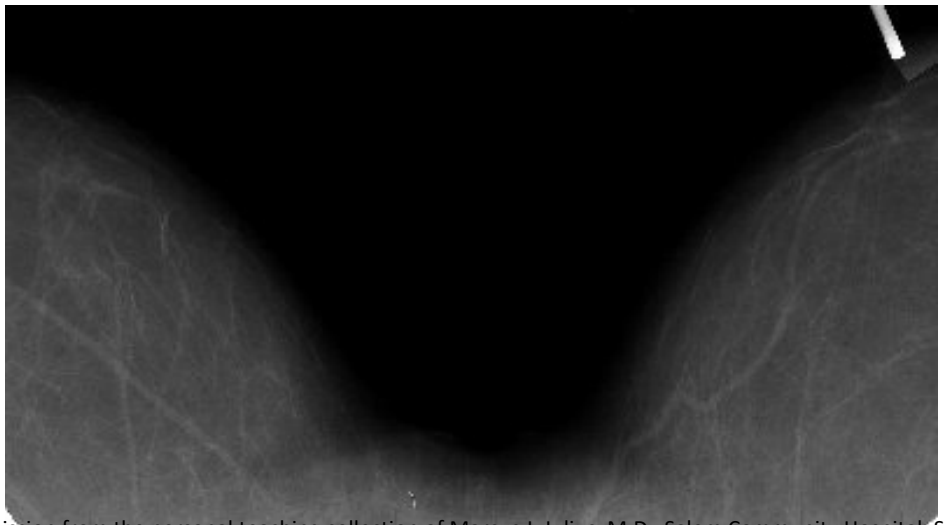
- category 1, almost entirely fat
- category 2, scattered fibroglandular densities
- category 3, heterogeneously dense tissue
- category 4, extremely dense tissue.

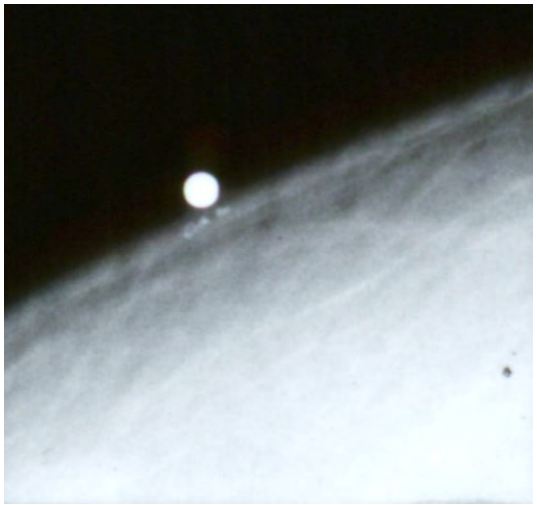


Also assess for symmetry of the tissue density

Diagnostic Mammography

- Performed in context of a *clinical symptom* (e.g. palpable mass, skin changes, nipple discharge, breast pain) or *abnormal screening mammogram*
- Often begins with CC and MLO views
- Special views added as pertains to the findings
  - Spot compression
  - Magnification
  - Alternate positions (e.g. XCCL, CL, ML, LM, rolled, tangential)



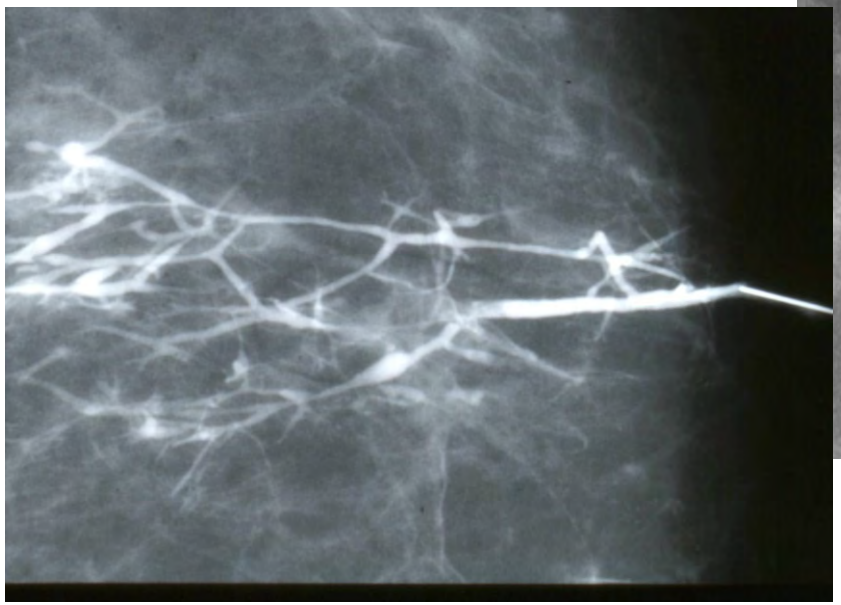


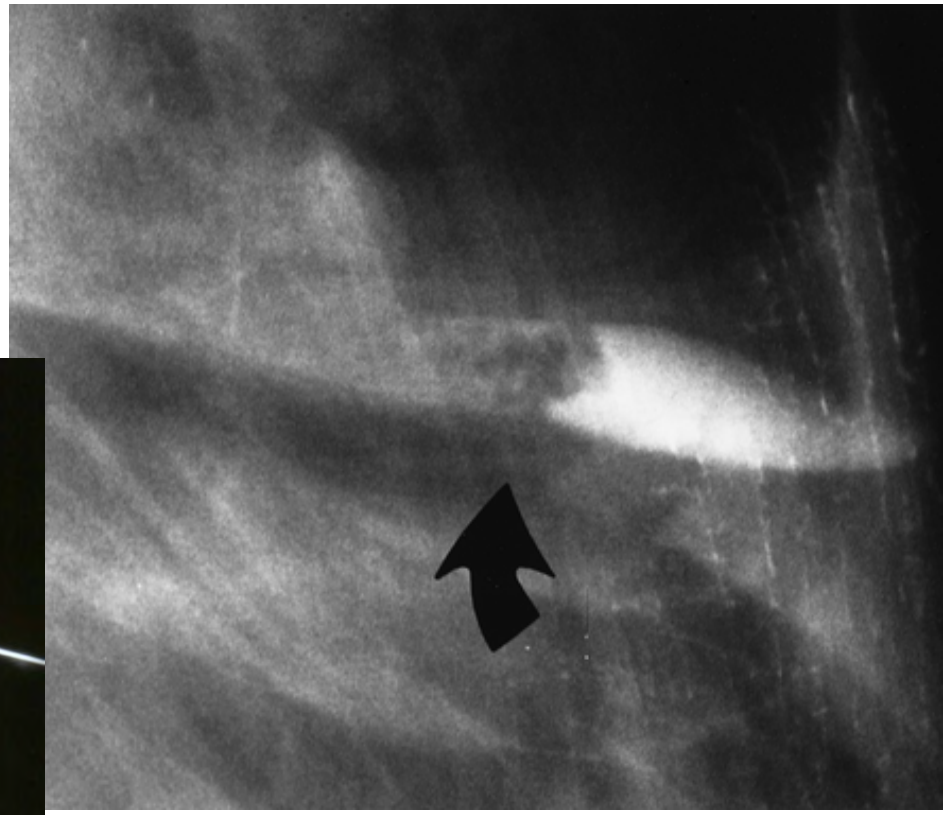
Ductography

- Helps define the cause of unilateral, single-pore, spontaneous nipple discharge
- Catheter inserted into duct orifice with discharge and contrast injected
- Mammogram performed after contrast injection

Ductography

- Ectasia
- Fibrocystic changes
- Papilloma
- DCIS



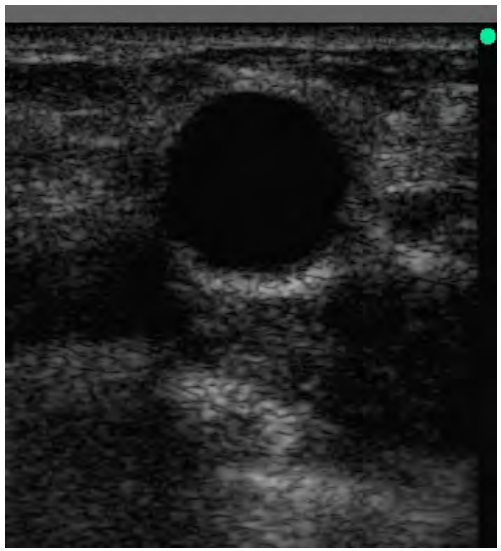


Computer-Aided Detection (CAD)

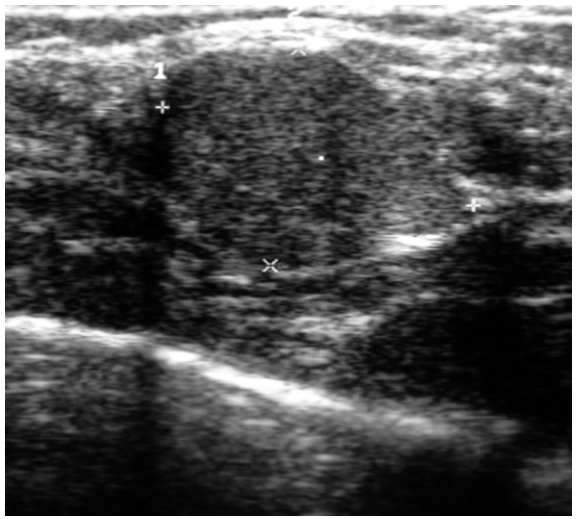
- Provides a “second read” for mammograms
- Not intended as only means of interpretation
- May increase cancer detection rate and promote earlier detection by alerting reader to areas on the mammogram for further scrutiny
- Potential limitation: can increase call back and biopsy rates (especially for insecure readers)

Breast Ultrasound

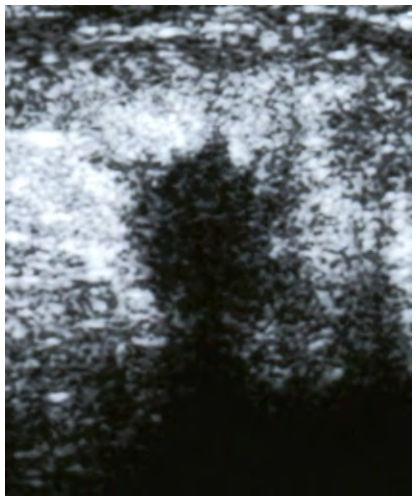
- Mass characterization
  - Echogenicity
  - Margin contours
  - Sound transmission
  - Vascularity
- Can help identify masses obscured on mammography by dense tissue
- Can assess palpable abnormalities occult on mammogram



Cyst



Fibroadenoma



Cancer

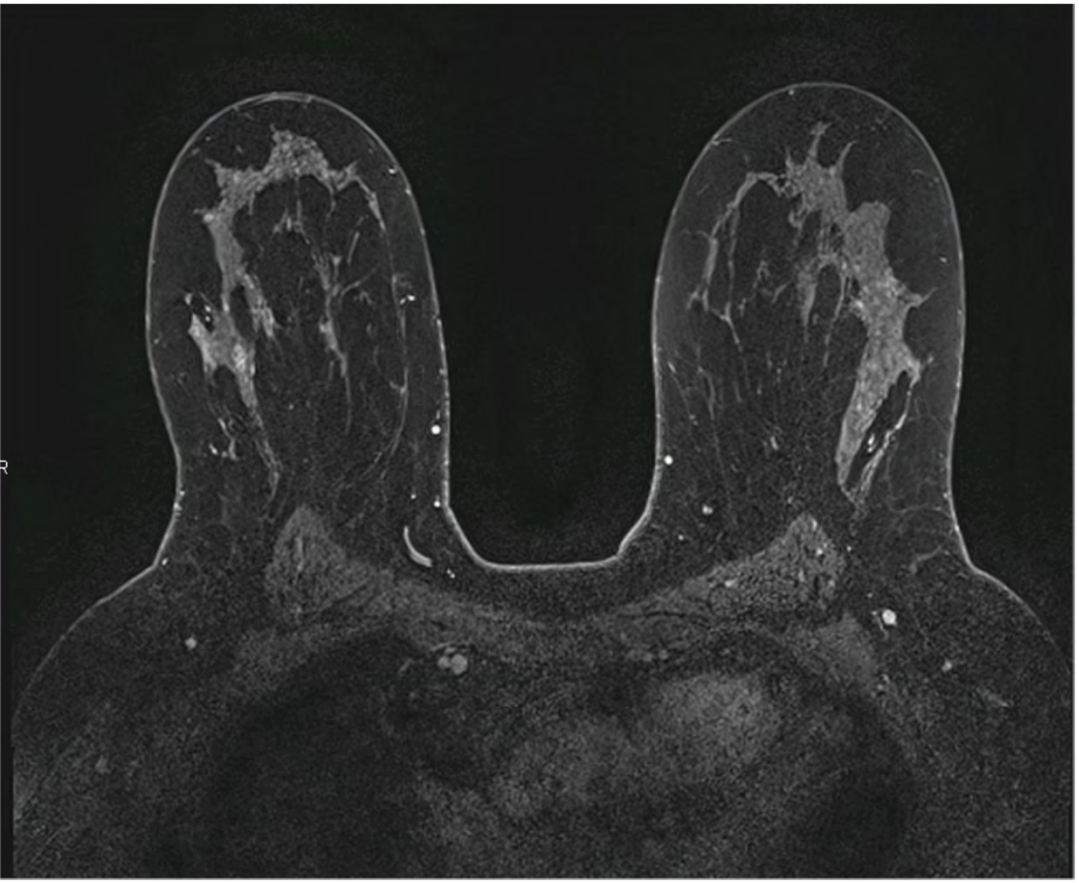
Breast MRI

- Indications
  - High risk women (in addition to annual mammograms)
  - Potential use in pre-operative staging (to assess for unsuspected multi-centric and/or contralateral neoplasia)
  - Assess neo-adjuvant chemotherapeutic response
  - Previous lumpectomy, evaluate for local recurrence
  - Implants (to assess integrity)
  - [Very dense breast tissue, limiting sensitivity of mammography]
- Does ***NOT*** replace mammography

Breast MRI

-Prone position.
-12- minute scanning time.
-Images both breasts (but order based on side of concern in diagnostic cases).
-Requires gadolinium contrast (GFR > 30).
-Screening: 2nd week of cycle (days 7-14) to minimize enhancement.

Breast MRI



Normal bilateral breast MRI

3T MRI:

- **Higher detail imaging than older MRIs and ultrasound.**
- **Distinguishes benign cystic masses from solid masses.**

3-Dimensional Imaging:

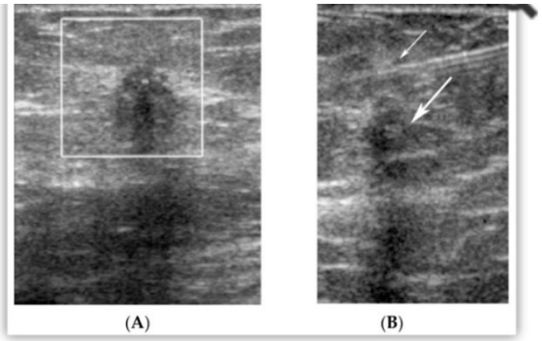
Nuclear Medicine

- Sentinel lymph node localization
  - Utilizes Tc-99m sulfur colloid
    - Injected into the area of the tumor and/or around the periphery of the breast at the nipple-areolar complex
  - Visible (blue) dye is also injected by the surgeon at the time of surgery
  - Visualization of the dye as well as localization of the radioactivity (by a hand-held probe) assists in detecting the sentinel lymph node

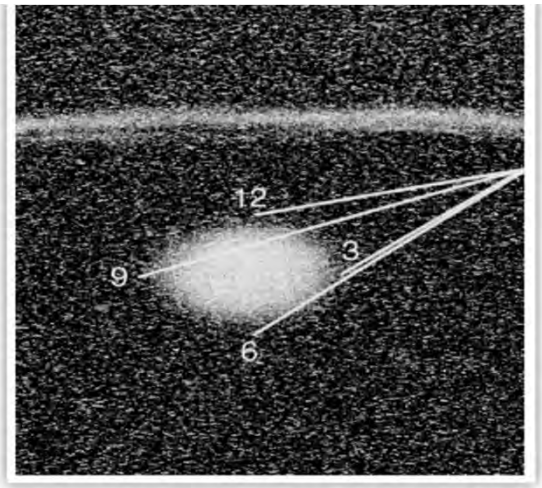
Sentinel lymph node

- *Sentinel Lymph Node Hypothesis*: tumor cells migrating from a primary tumor colonize one or a few lymph nodes BEFORE involving other lymph nodes
  - SLN can be successfully identified in >90% cases using a combination of blue dye and radioactive colloid

SNL injection technique



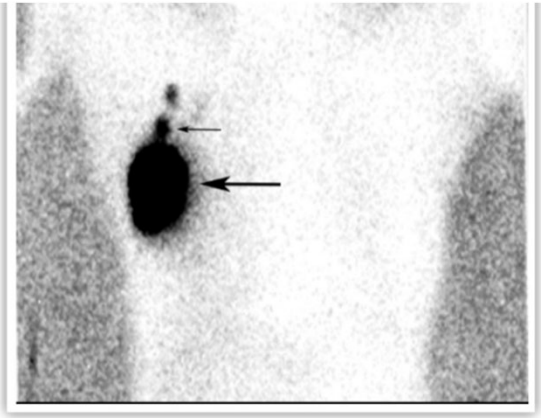
(**A**) A hypoechoic mass (white box), representing a known invasive ductal carcinoma, was targeted for SLNB with sonographic guidance. (**B**) The needle is seen at the 12 o'clock position (small arrow) relative to the malignant mass (large arrow).



The diagram illustrates the technique for SLNB with sonographic guidance. Using one needle, peritumoral injections are performed at the three, six, nine and 12 o'clock positions.

SLN imaging

Anterior planar images following radiopharmaceutical injection.

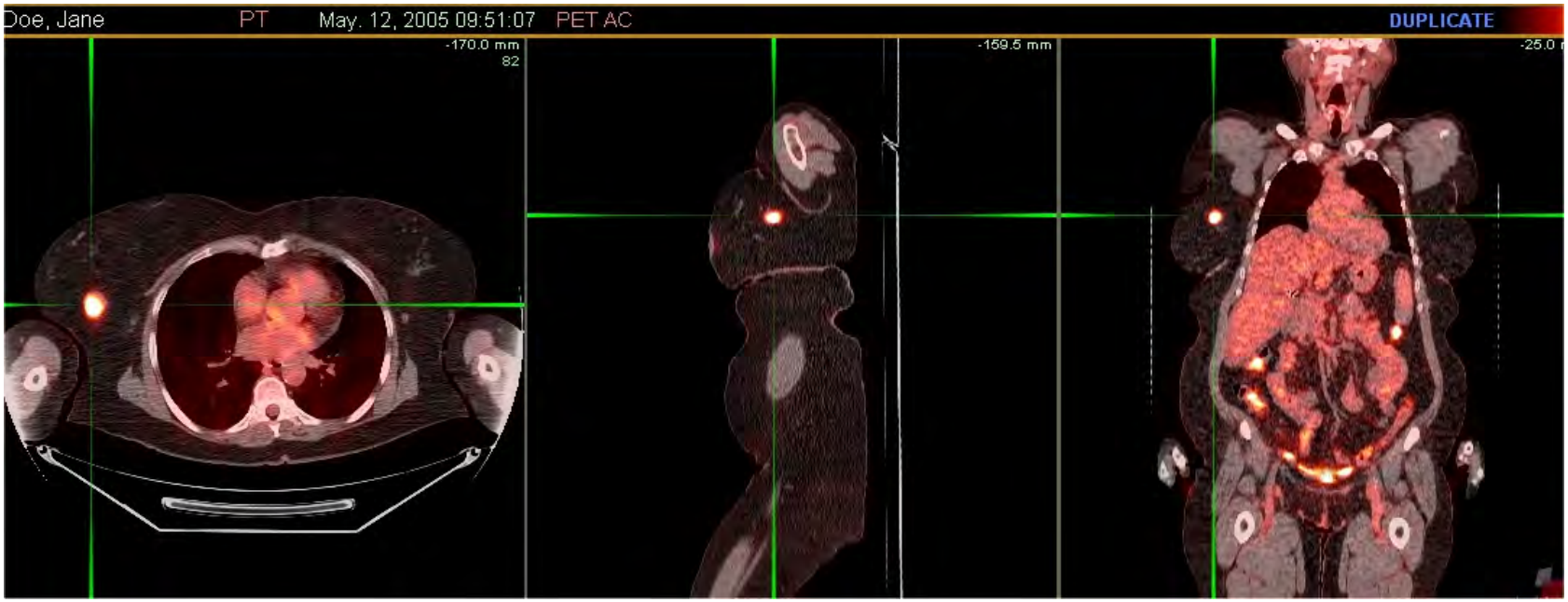


An injection site in the upper outer quadrant of the right breast (large arrow) is seen adjacent to a low axillary SLN (small arrow).

The lateral image shows the SLN (thin arrow). Marked uptake is noted in the tumor bed at the injection site (thick arrow).

PET

- Imaging after intravenous administration of 2-deoxy-2-[18F] fluoro-D-glucose, FDG
- Dependent on increased glucose metabolism in tumor
- Accuracy in breast similar to breast MRI for cancer detection, but detects disease outside field of view of breast MRI



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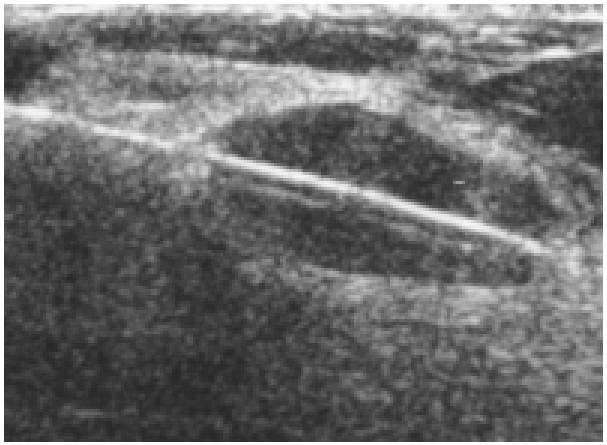
Imaging Guided Breast Biopsy

- Ultrasound core or vacuum-assisted core
- Stereotactic vacuum-assisted core
- MRI core

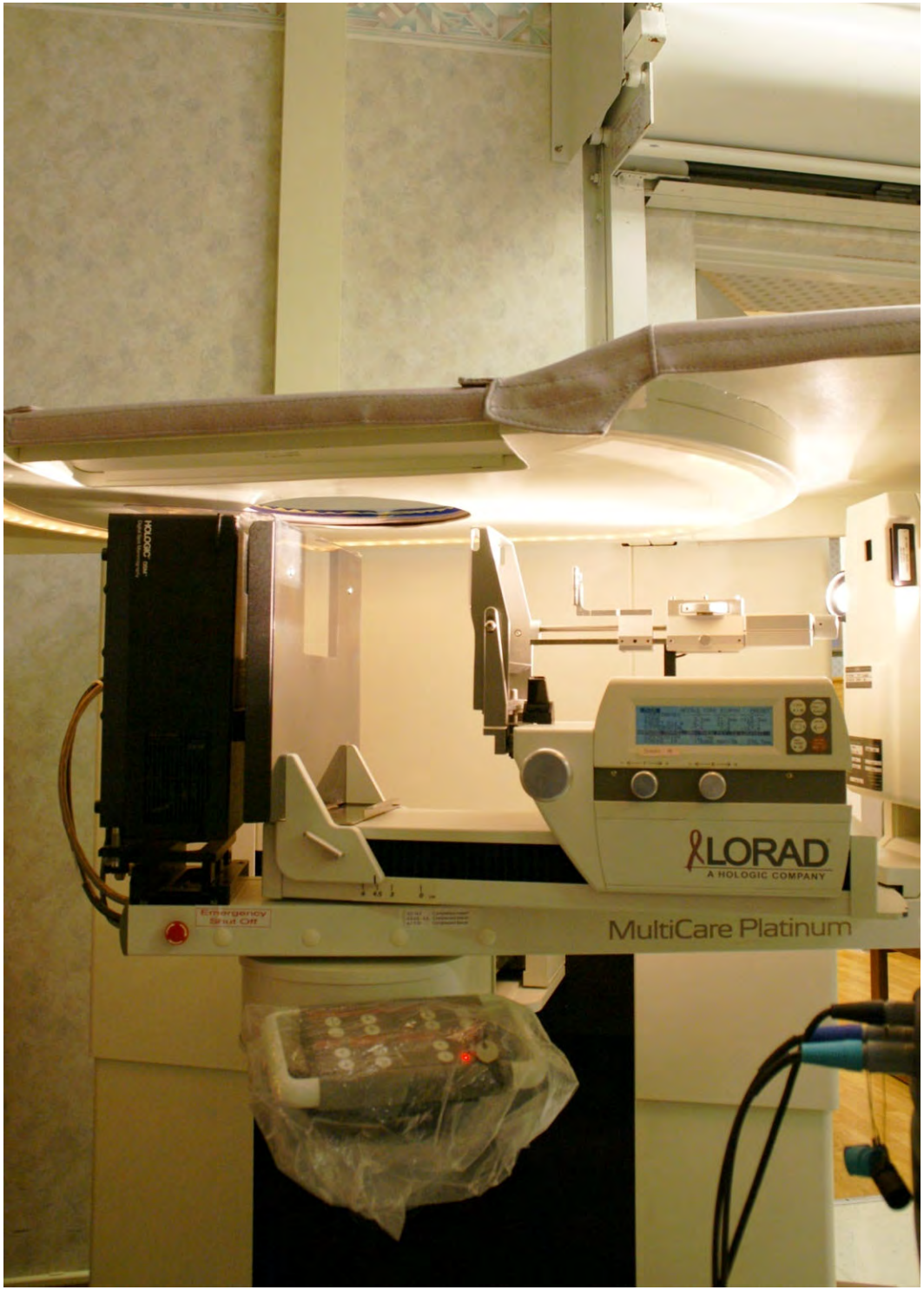
Ultrasound Guided Biopsy

- Same high frequency linear transducer as for diagnostic breast ultrasound
- Needle inserted under ultrasound observation along plane of image



Stereotactic Breast Biopsy

- Mammographic guidance
- Prone or upright positioning
- Usually vacuum assisted core device (Mammotome)
- Specimens imaged (if calcifications were target)
- Clip marker placed at site of biopsy (for future reference)



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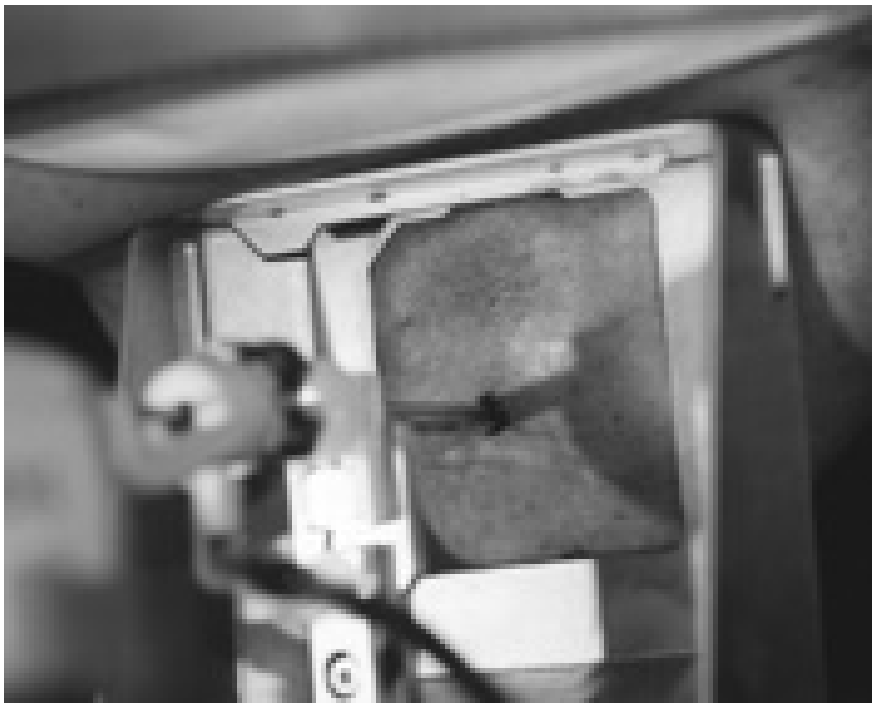
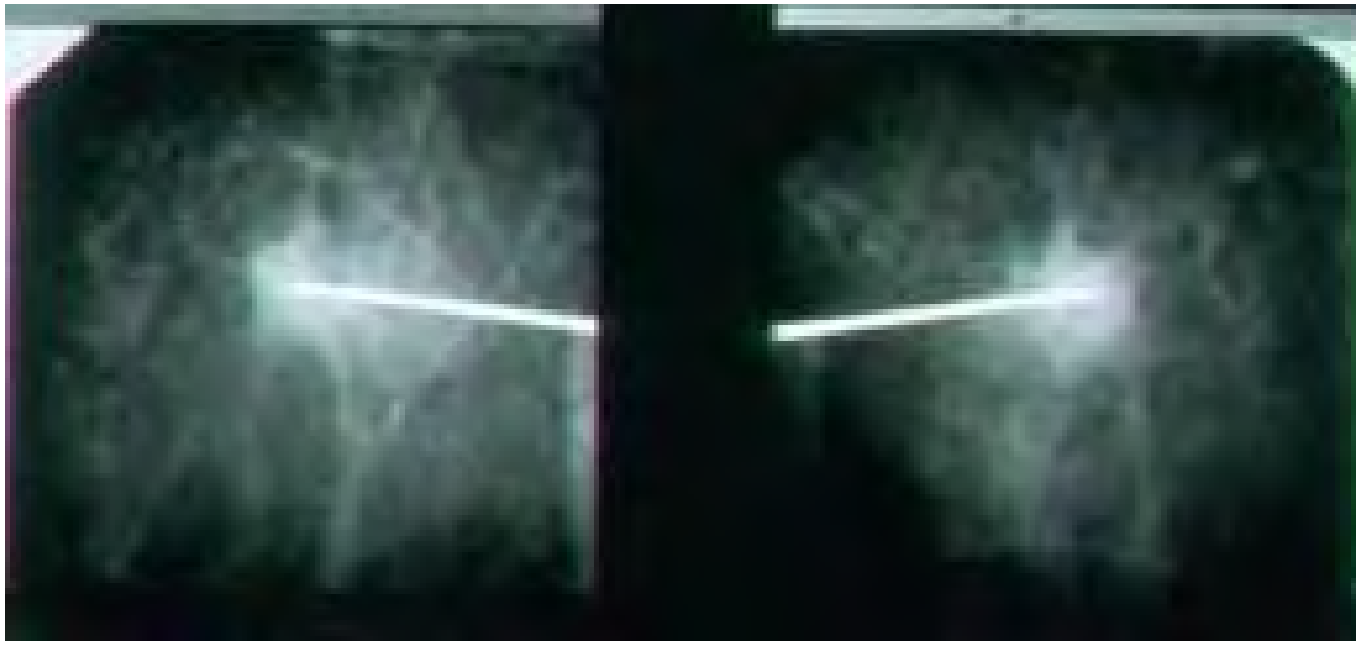
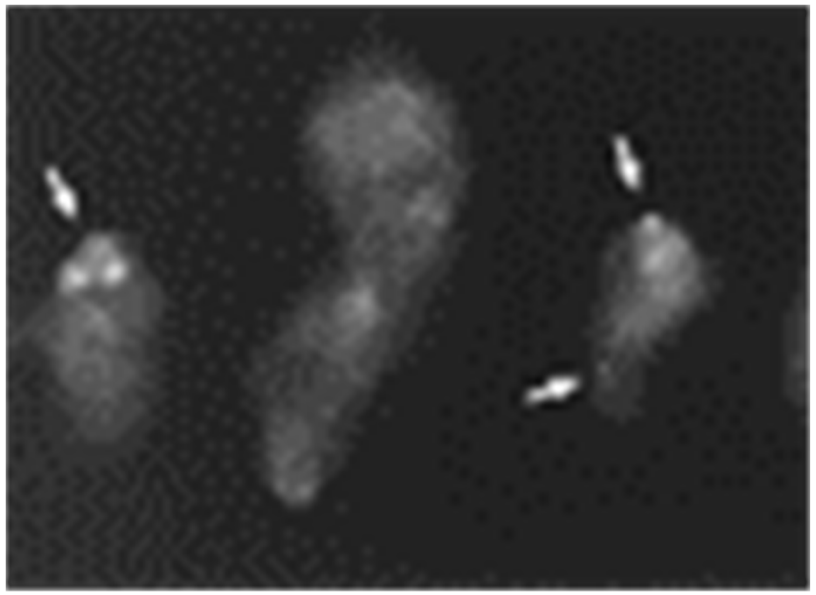
Stereotactic Breast Biopsy

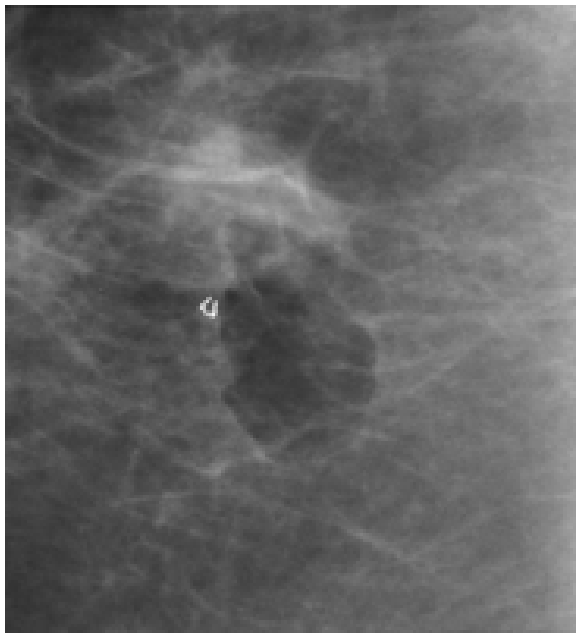


Stereotactic core biopsy

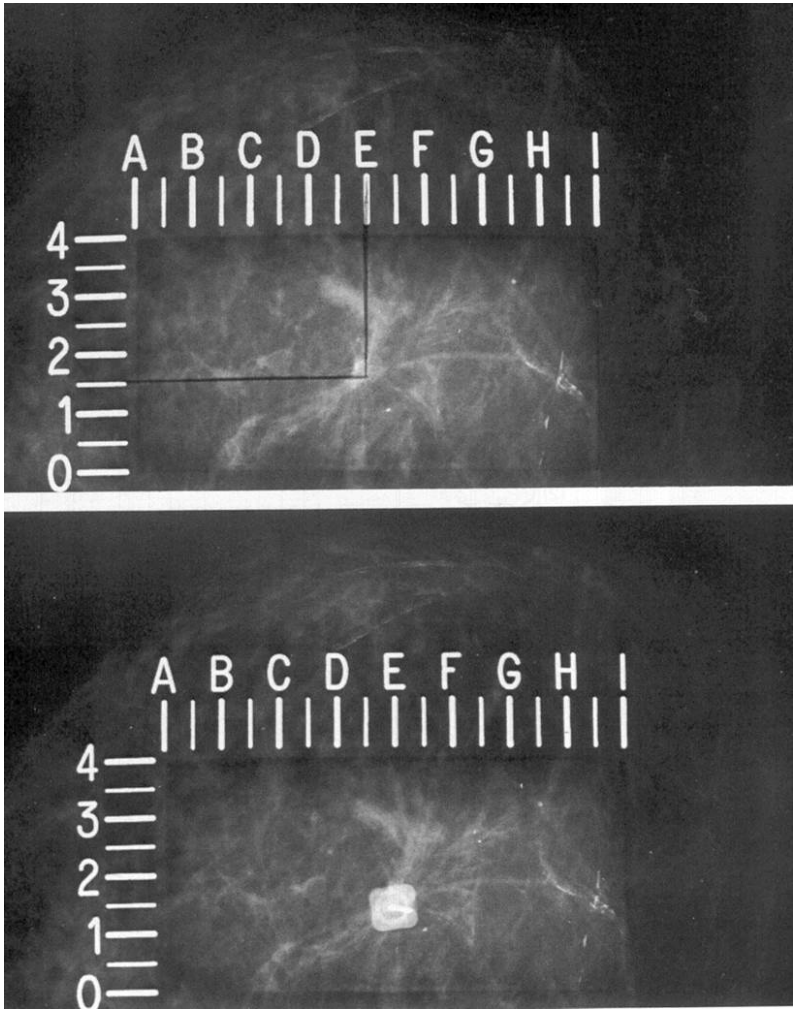


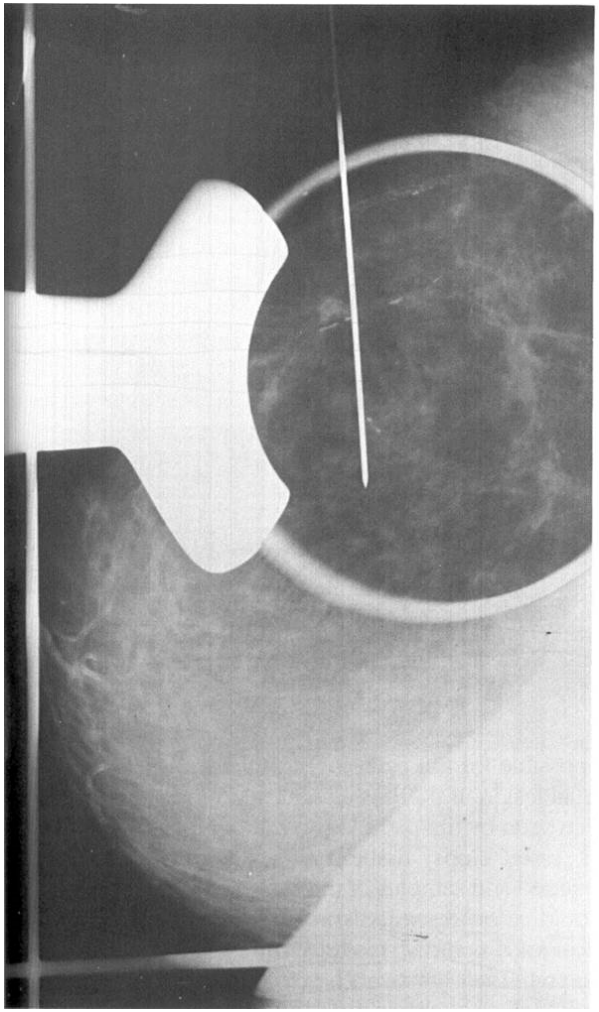
Stereotactic Breast Biopsy





Needle localization





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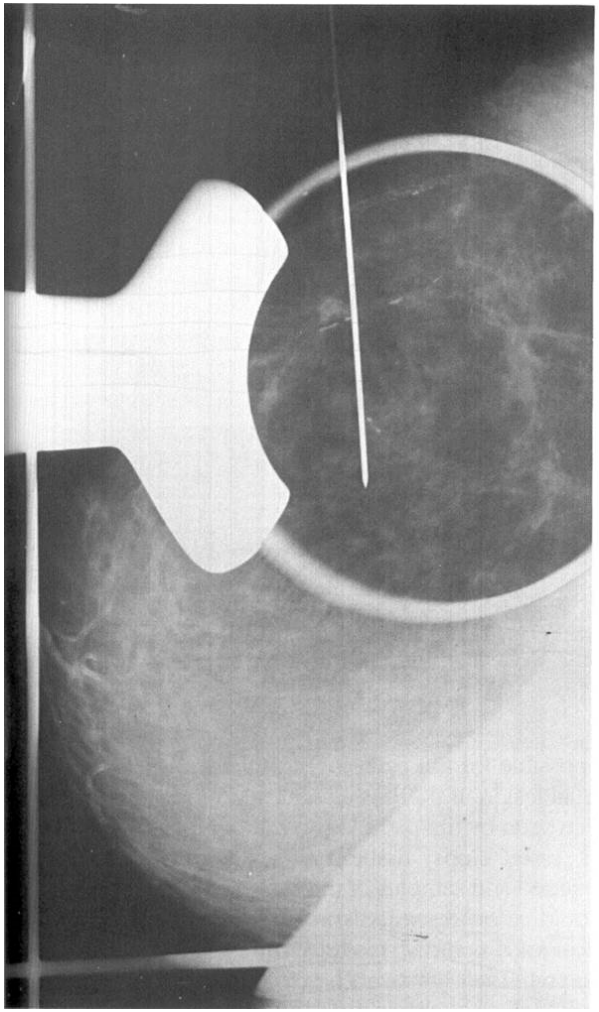
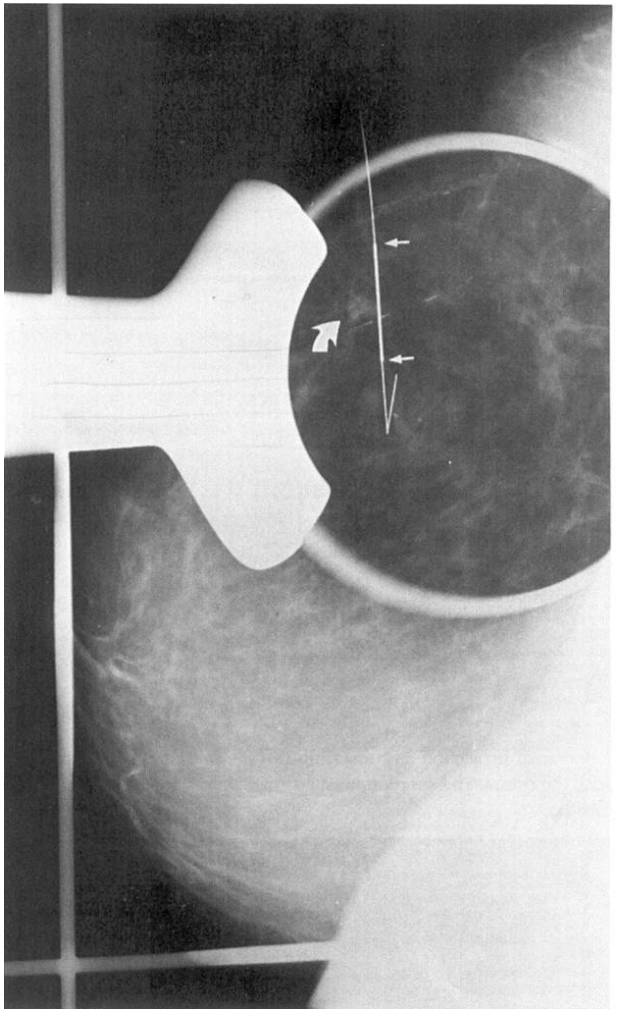
Needle localization





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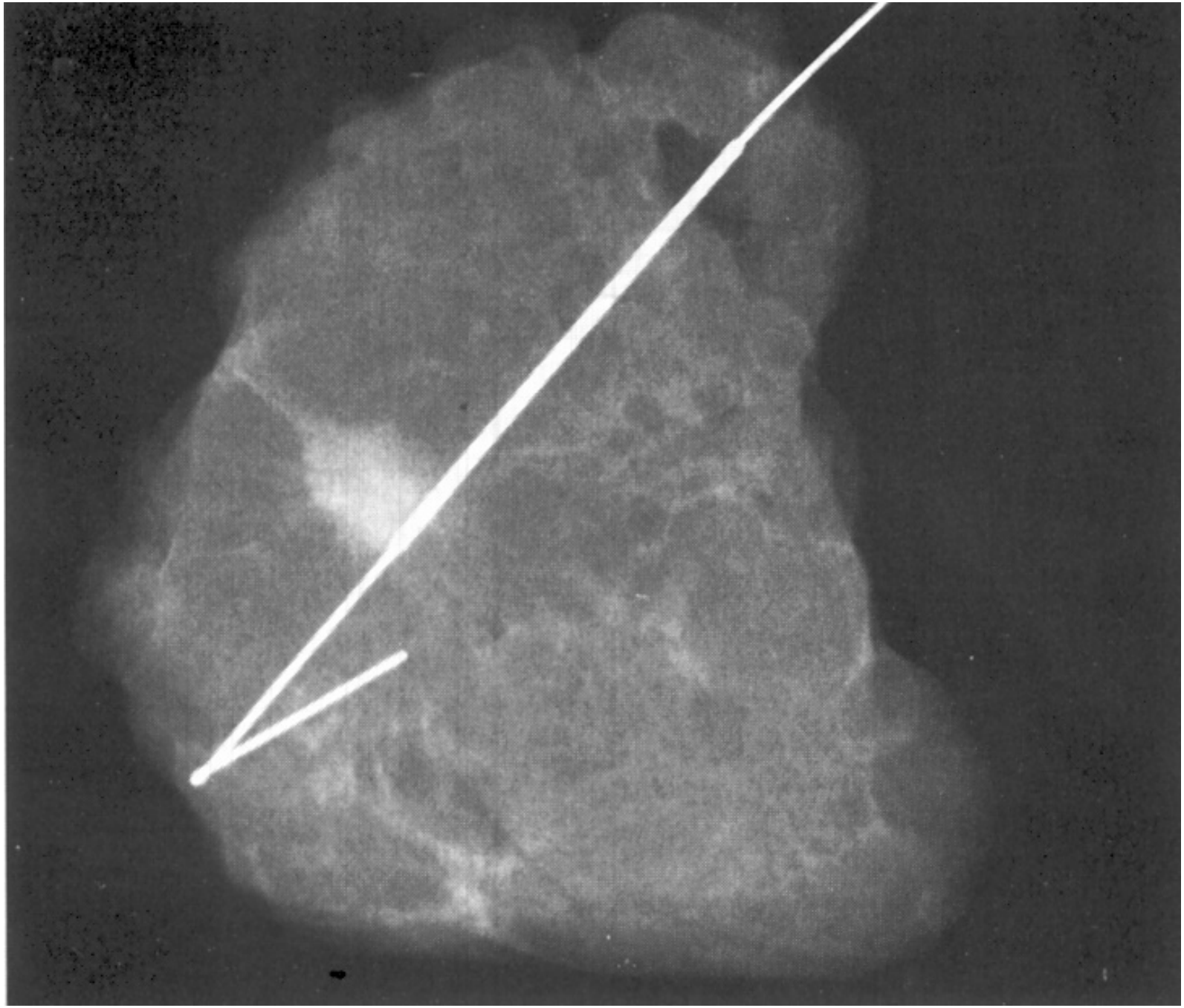
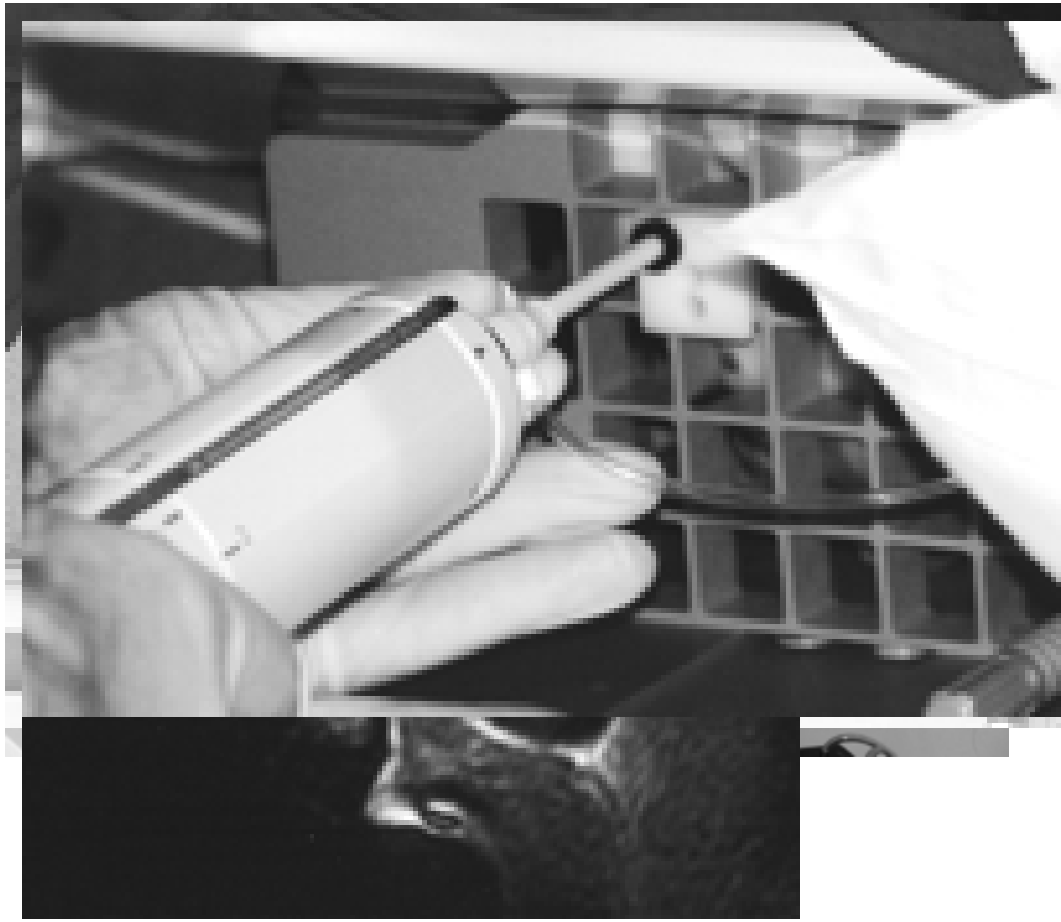


Specimen radiograph

MRI Guided Breast Biopsy

- Procedure Factors
  - Needle must not cause too much field distortion that it precludes imaging
  - Utilizes localization grid apparatus to place needle
  - Necessary when lesion is only visible on MRI



Breast Imaging Overview

- Summary
  - Please correlate this breast imaging lecture with your other medicine, pathology, and pharmacology lectures on breast health and disease
  - Please review this lecture in preparation for your Reproductive imaging PI session