3rd International Congress of Breast Disease Centers 2013

THE BREAST CENTER :
A MODEL TO IMPROVE PATIENT CARE

New Imaging Modalities for better Screening and Diagnosis

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Breast Cancer Statistics (Israel)

- Breast cancer is the most common female cancer
- About **4000** women are diagnosed with breast cancer each year and about **900** die of the disease
- Lifetime risk of developing breast cancer: 1 in 8
- The earlier the disease is detected, the higher the chances of a cure - reaching nearly 90%.
- **Breast cancer mortality rate is declining, probably due to improved screening and treatment**

Breast Imaging

- **Screening -** asymptomatic women

- **Diagnostic -** work-up of a breast complaint or abnormal finding

Screening

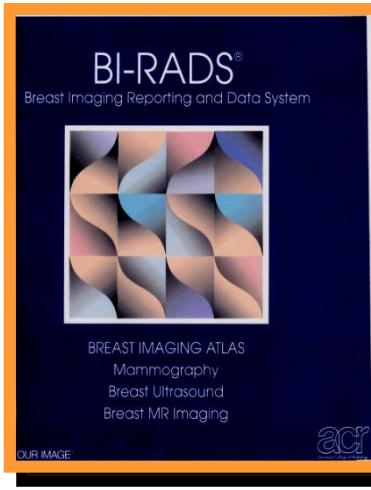
- Mammography became clinically available in 1970
- **Mammography is the only screening test proven to reduce mortality**
  - FDA approved screening tool
  - **The only test proven to reduce mortality**

. **15%-30%**

» Cancer. 2001;91(9):1724

MAMMOGRAPHY QUALITY CONTROL

- BI-RADS - The Breast Imaging Reporting and Data System - developed by the American College of Radiology
-
- To standardize the mammography report
  - Findings , conclusions
    - Mammography, extended for US , MRI

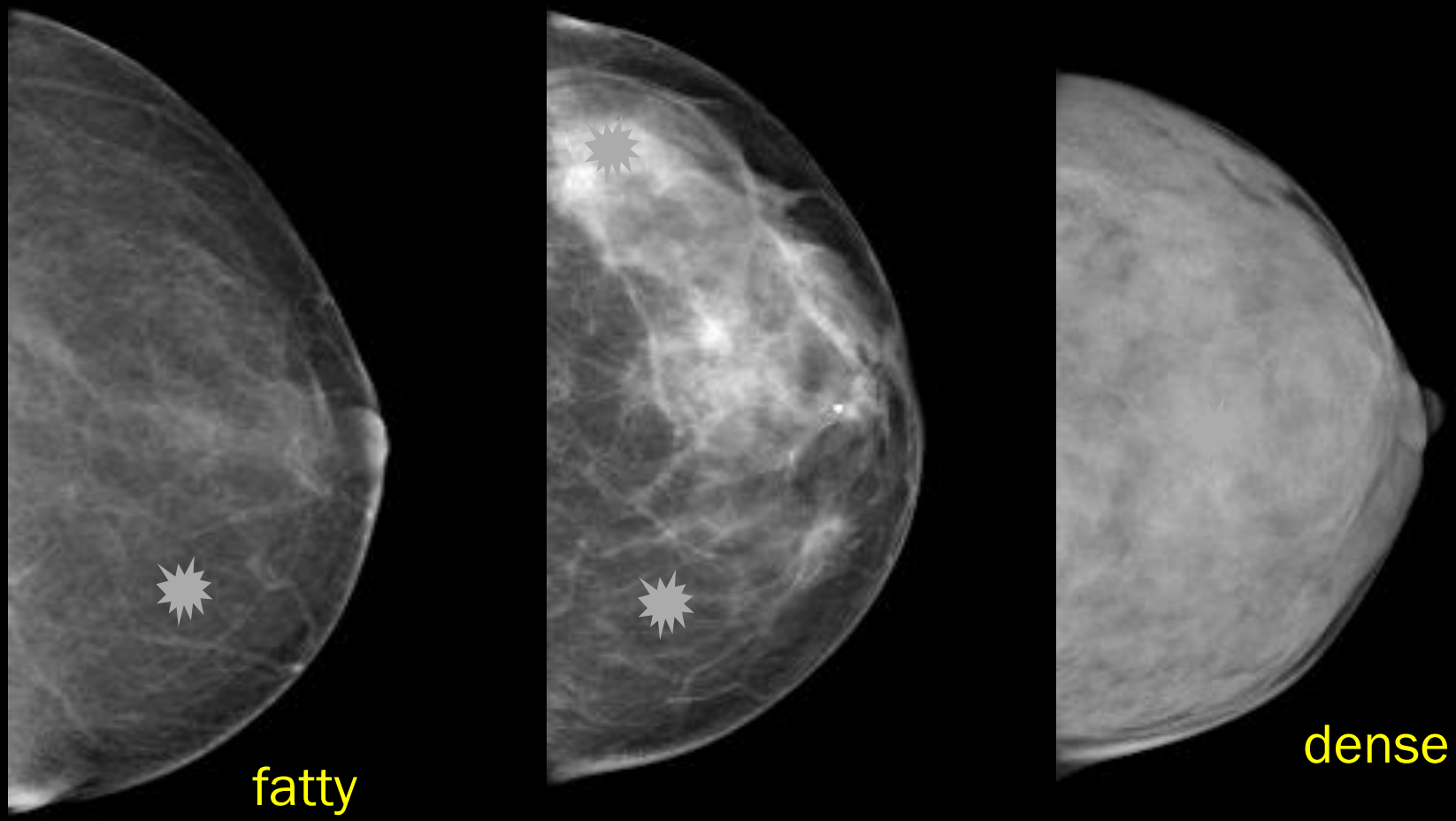


- The FDA mandates that all mammography reports should have the final BI-RADS assessment category

Mammography Limitations

- Dense breast
- Augmented breast
- Post op. breast

Mammography



Mammography

- The prototype of the mammography unit was developed in 1965.

- Many technical advances have been made since then to improve
  - Image quality
  - To reduce the radiation dose

- Develop other breast imaging modalities
  - To provide earlier diagnosis of breast disease
  - More accurate assessment of disease extent and treatment response
  - Improve the detection of recurrence

Diagnostic Performance of Digital versus Film Mammography for Breast-Cancer Screening

Etta D. Pisano, M.D., Constantine Gatsonis, Ph.D., Edward Hendrick, Ph.D., Martin Yaffe, Ph.D., Janet K. Baum, M.D., Suddhasatta Acharyya, Ph.D., Emily F. Conant, M.D., Laurie L. Fajardo, M.D., Lawrence Bassett, M.D., Carl D'Orsi, M.D., Roberta Jong, M.D. and Murray Rebner, M.D.

N Engl J Med
Volume 353;17:1773-1783
October 27, 2005

Study Overview

- Study of **42,760** asymptomatic women
- The **overall diagnostic accuracy** of **digital** and **film mammography** as a means of screening for breast cancer was **similar**
- **DIGITAL MAMMOGRAPHY was better**
  - Women under the age of 50 years
  - Women with radiographically dense breasts
  - Premenopausal or perimenopausal women

Full field digital mammography

- Advantages over film screen mammography
- **Greater contrast resolution, especially in dense breasts**.
  - better visualization of skin and peripheral breast tissue

- The ability to **post process the image** by changing contrast and brightness, and by enlarging the image, increase the ability to detect subtle abnormalities.

- The ability to send images electronically (teleradiology). facilitating double reading

- The ability to store images in optical drives for future reference.
- **Lower average radiation dose**
  - Eur J Radiol. 2007;64(3):419.

Computer-Aided Detection for Mammography - CAD

Computer-Aided Detection for Mammography

- **Computer-aided detection (CAD) technology basically works like a second look.**
- **The computer marks abnormalities on the digitized films – Detection , Diagnosis/classification**
- **The radiologist can decide whether the marked areas are suspicious and require further examination.**
- **The final interpretation is still made by the radiologist**

Why do we need CAD

Double reading could increase detection by - 15%

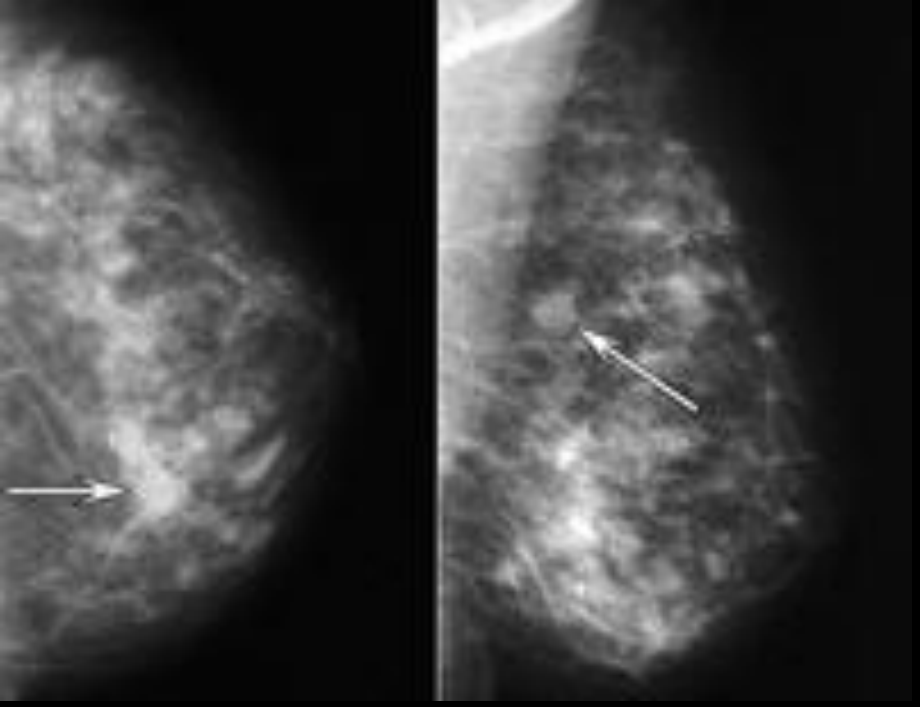
- **Shortage of experienced radiologists**
- **The cost of true double reading**

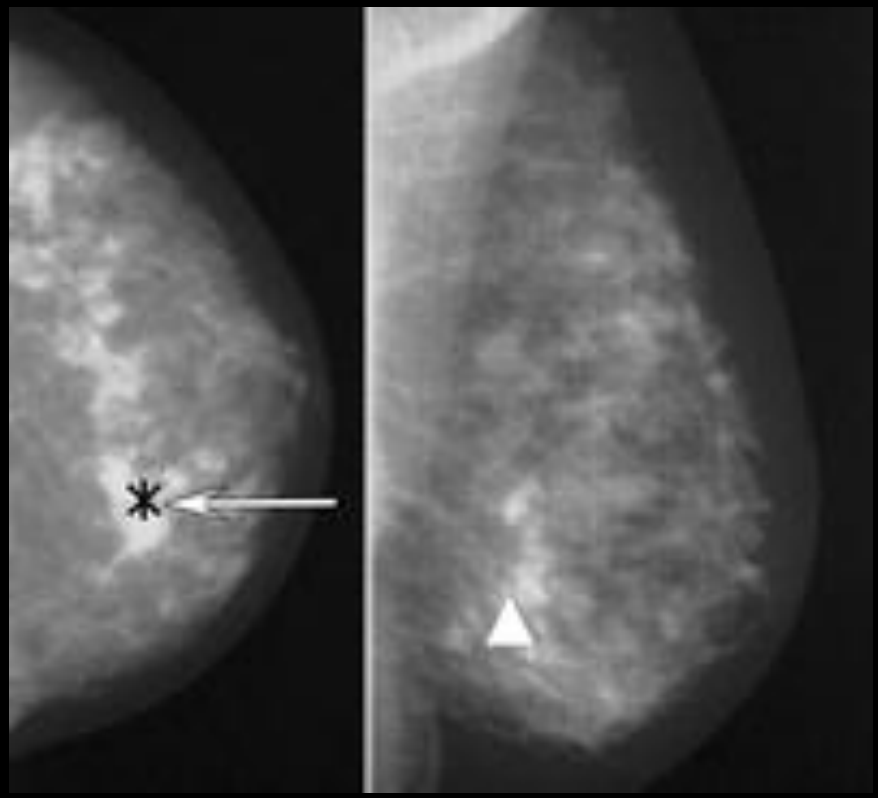
Computer-aided detection

- **High Sensitivity - for the detection of cancers on screening mammograms.**
  - **All cancers - 90%**
    - **86–88% for masses**
    - **98% for microcalcifications**
  - **CAD has the potential to decrease the false-negative rate from 31% to 19%**

Computer-aided detection

- **Specificity is a problem with CAD systems.**
  - **CAD tends to mark a high number of "normal" areas as abnormalities**
  - **High rate of false-positive**
    - **The number will vary according to the level of sensitivity**
    - **between 2 – 4 false prompts per study 1 - false prompt per image**





69-year-old woman with invasive ductal carcinoma

CAD – In Summary

- CAD may **improve sensitivity** of screening mammogram to a limited extent.
-
- Higher recall rate – potential overdiagnosis.
- High costs associated with the equipment
- CAD has not been proven to improve mortality rates from breast cancer screening

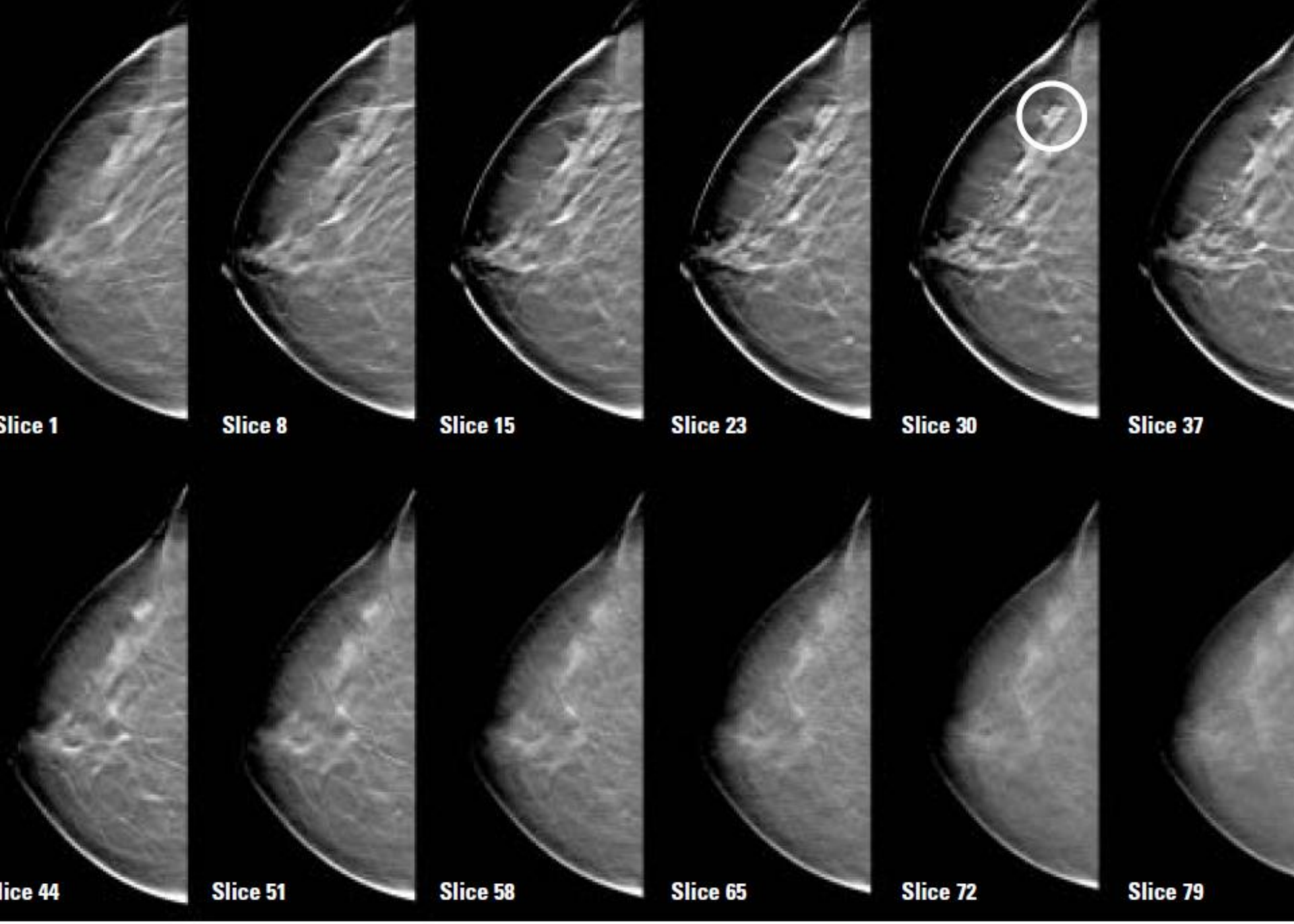
Tomosynthesis

Tomosynthesis

- Tomosynthesis is a *modification of digital mammography* - moving x-ray source and digital detector

- A 3D volume of data acquired , reconstructed to thin sections

- Thin slice reconstruction improves the delineation of a lesion in the slice
  - Reduce or eliminate the tissue overlap effect.



re 6b: Reconstructed tomosynthesis slices. An invasive lobular carcinoma can be clearly seen in slice 30.

Tomosynthesis

- Screening setting
  - Decrease recall rates
- Diagnostic setting
  - Improves lesion characterization

- This technique shows promise in screening women with dense breast tissue and with high risk for breast cancer.

  - Reading time twice for digital mammography.
  - The examination longer exposure time of 10 seconds per acquisition compared to standard digital mammography,
    - **Increase the radiation dose**
    - Increase motion artifacts

» AJR 2009;193(2):586
» Eur Radiol. 2010;20(7):1545.
» AJR . 2010;195(2):W172

Contrast-Enhanced Mammography

Dual Energy Contrast-Enhanced Mammography

- **A pair of low- and high-energy images digital mammography system.(GE)**

- **Low energy** exposures - **conventional mammography** 26–32 kVp

- **High energy** - For iodine visualization - 45–49 kVp

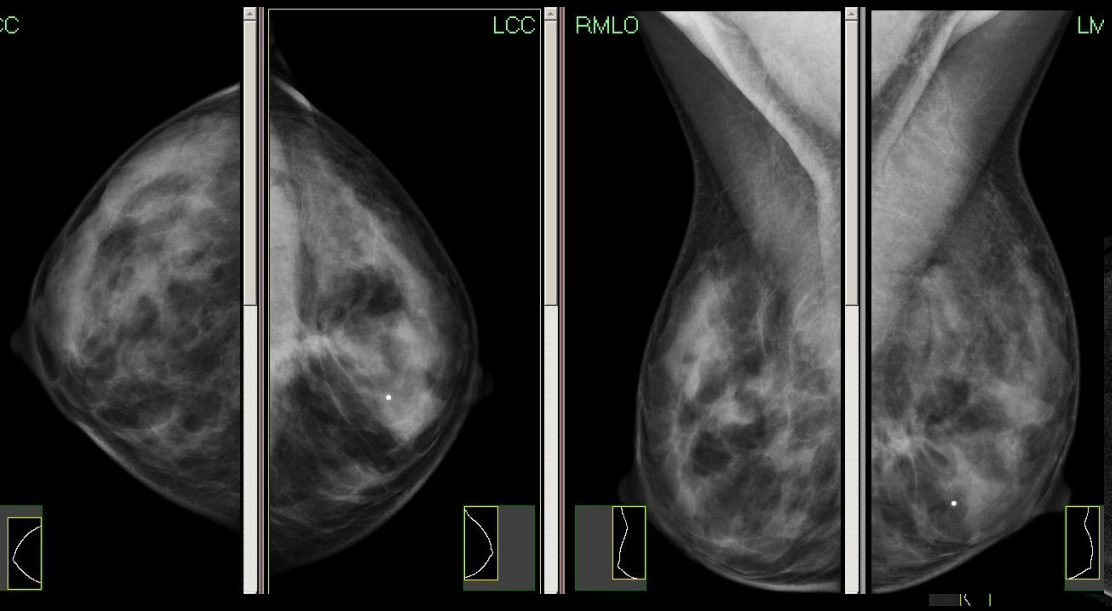
- I.V. - 1.5 ml/Kg - iodine non-ionic contrast agent

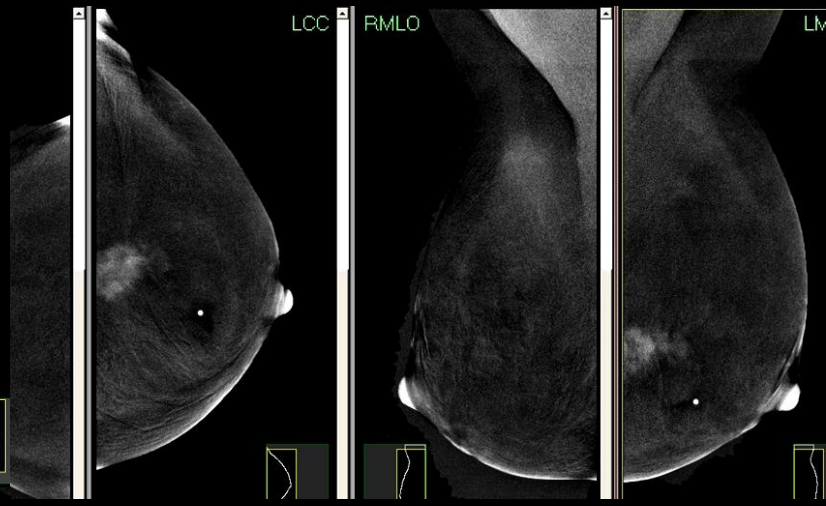
- The total X-ray dose - 1.2 times the dose of a standard digital mammogram

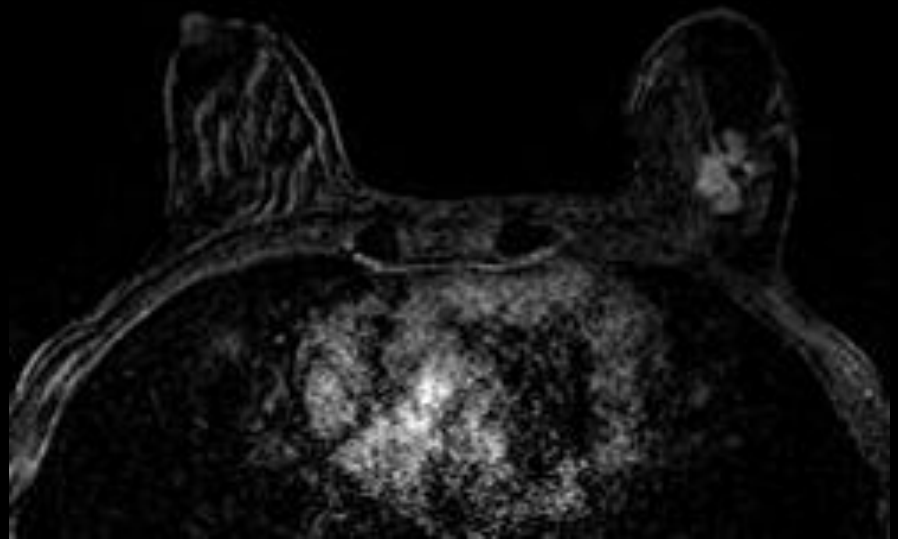
Dual Energy Contrast-Enhanced Mammography

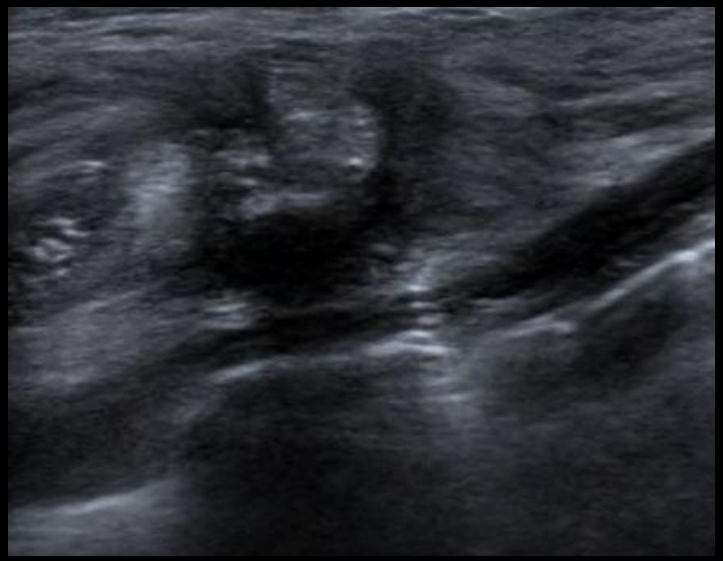
- 62 benign ; 80 malignant
- **Sensitivity - MX+CEDM – 93% ; MX - 78%**
- No loss in specificity
  - All 23 multifocal lesions were correctly detected by MX+CEDM vs. 16 and 15 lesions by MX and US respectively.
- **Conclusion; Initial clinical results show that CEDM has better diagnostic accuracy than mammography alone and mammography+ultrasound**
  - Eur Radiol (2011) 21:565–574

41y –LT. breast palpable lump

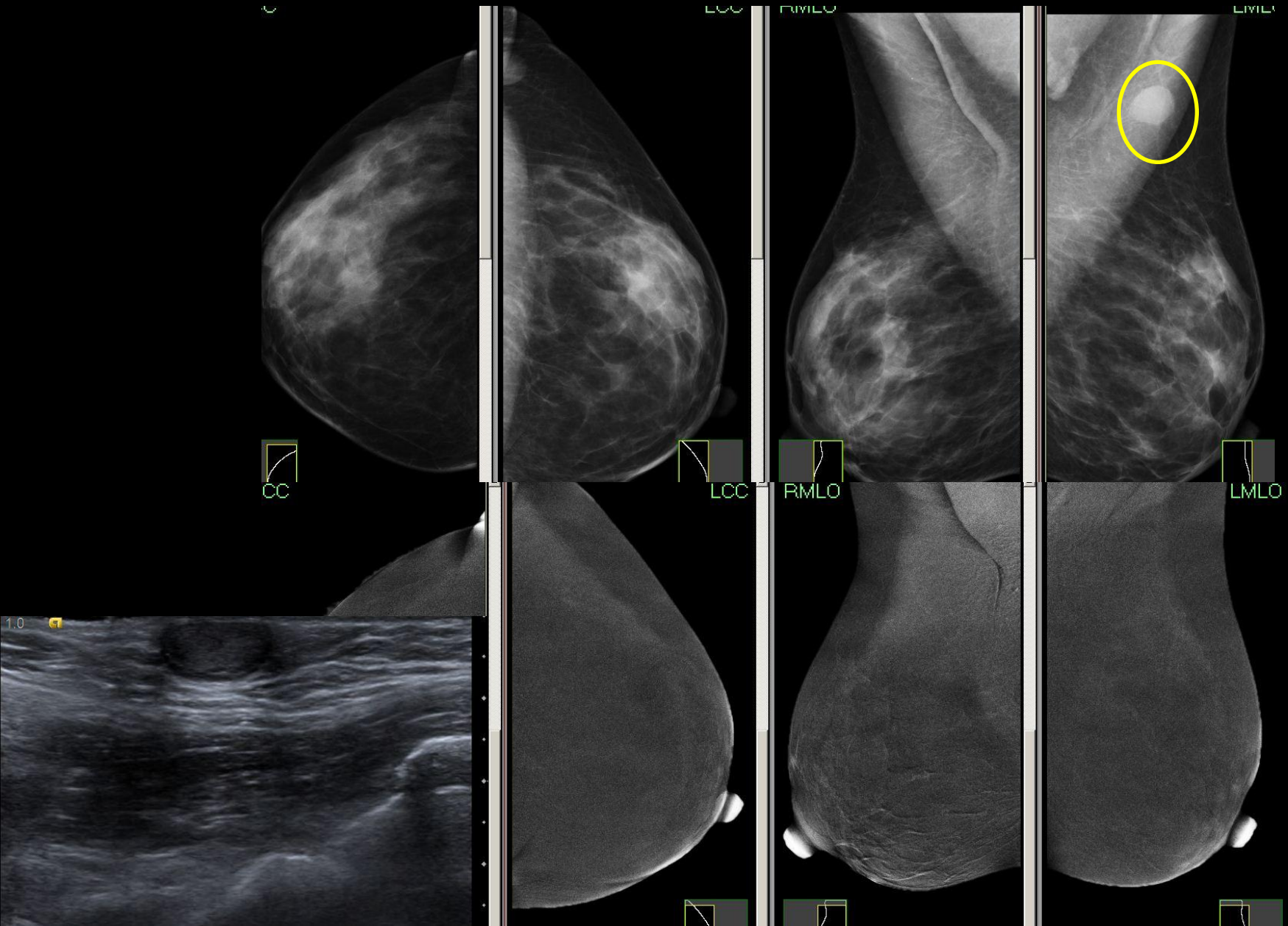








43y – LT. Axilla Lump



Dual Energy Contrast-Enhanced Mammography

- **Diagnostic**- **identifying angiogenesis** associated with a carcinoma in mammography.
  - **Problem solving" in the case of equivocal mammography and ultrasound**
  - **Advantage** - **fast imaging technique** with immediate availability
    - **Analogous to contrast-enhanced MR imaging**

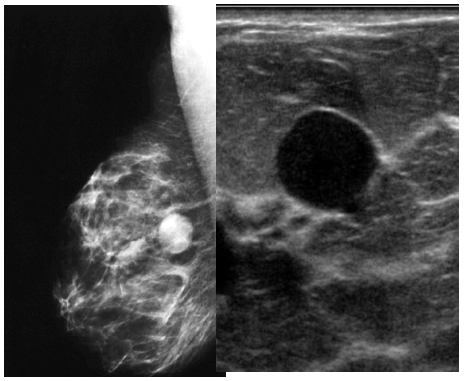
- **Screening** - Potential to increase the cancer detection rate- dense breast

Breast Ultrasound

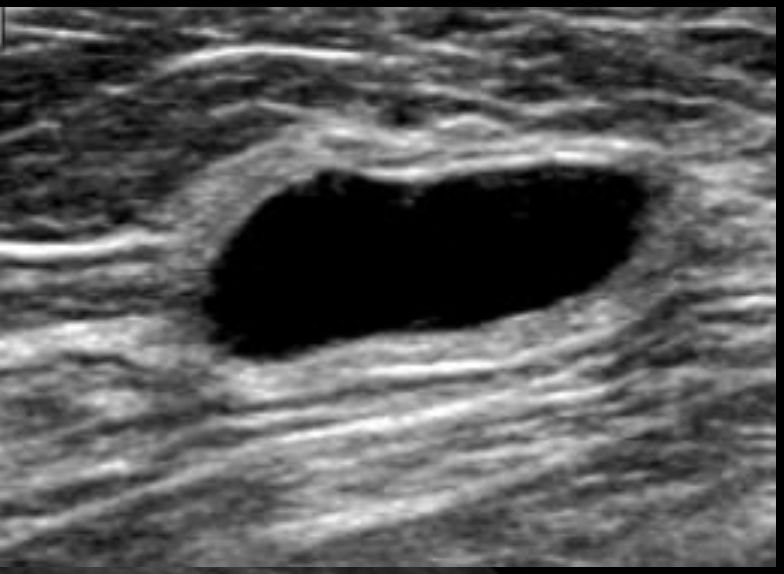
Breast US – Indications

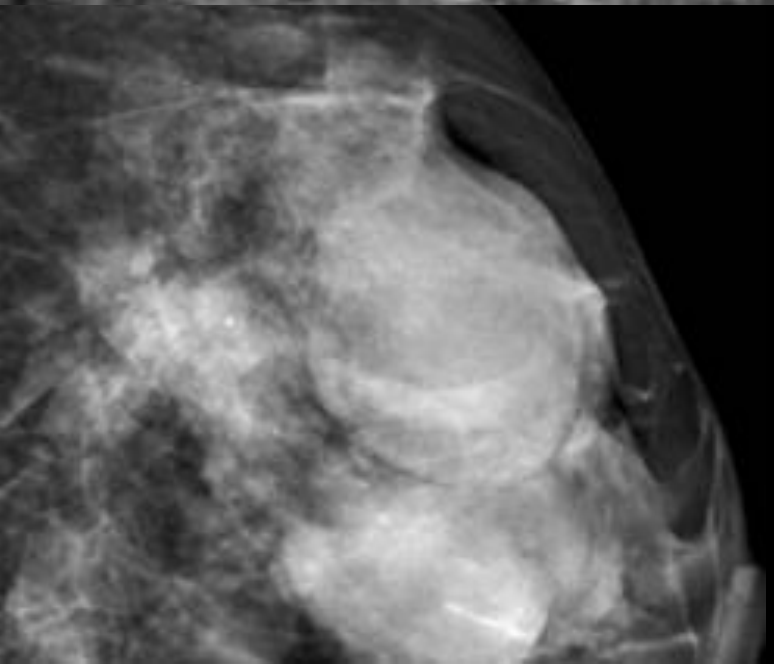
The most useful adjunct to mammography

- Evaluation mammography findings – cyst /solid
- Evaluation palpable lump (normal mammography)
- Breast examination in young women<30, pregnant,lactating
- **Adjunct to mammography in dense breast**
- US guided biopsy
- **Not for screening?**

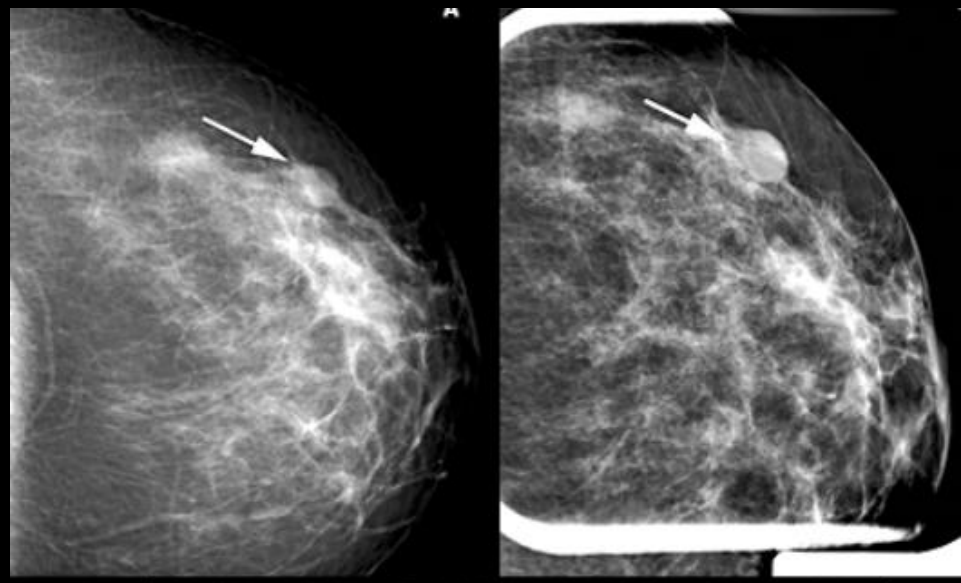


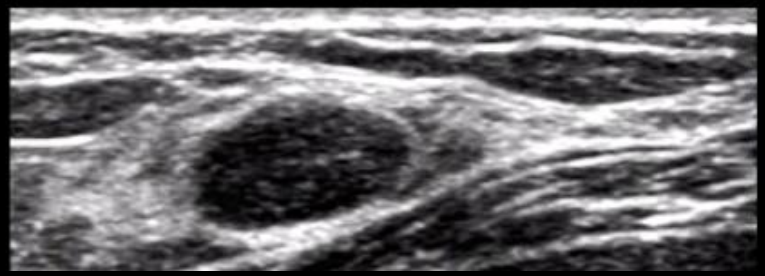
Benign breast cysts



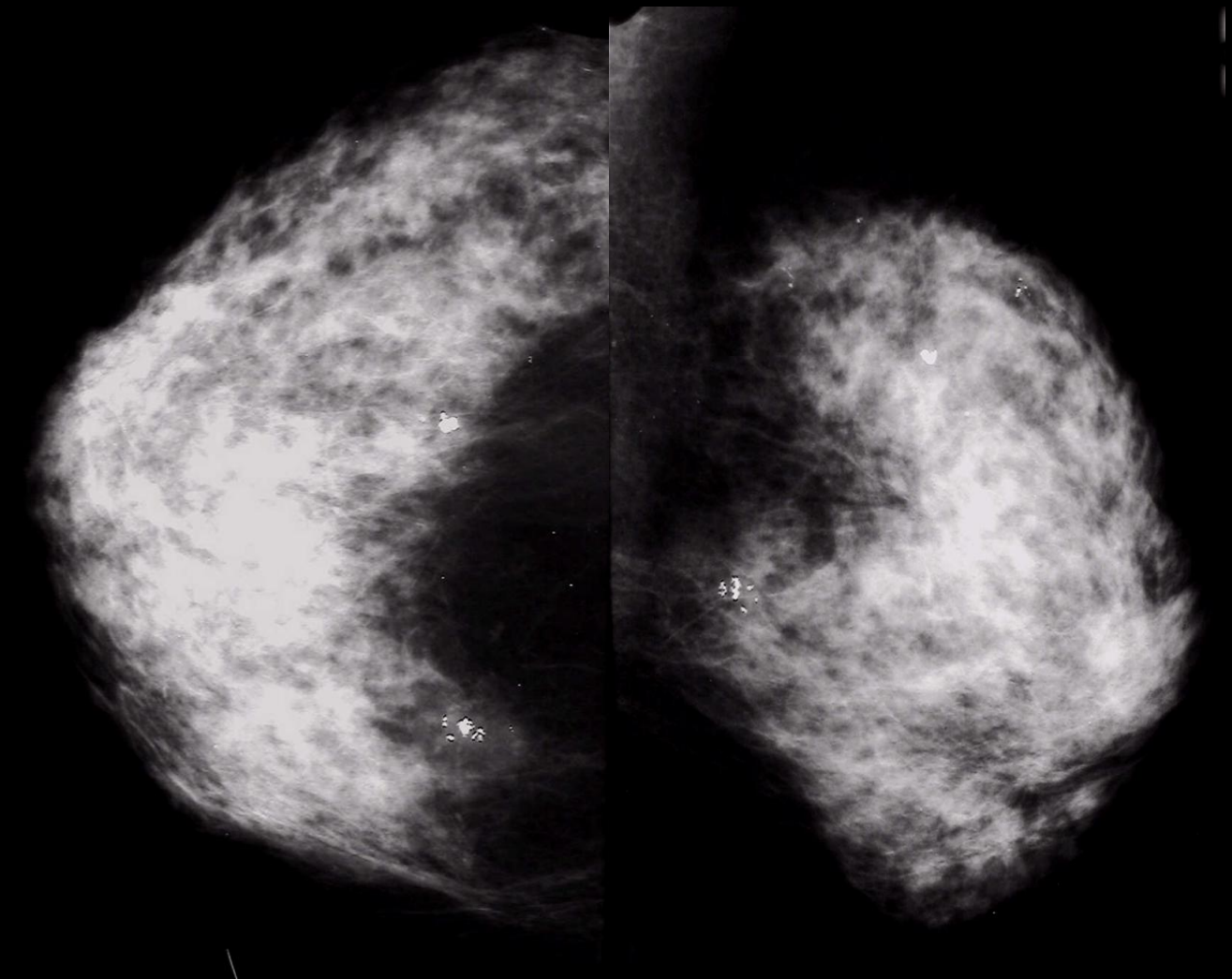


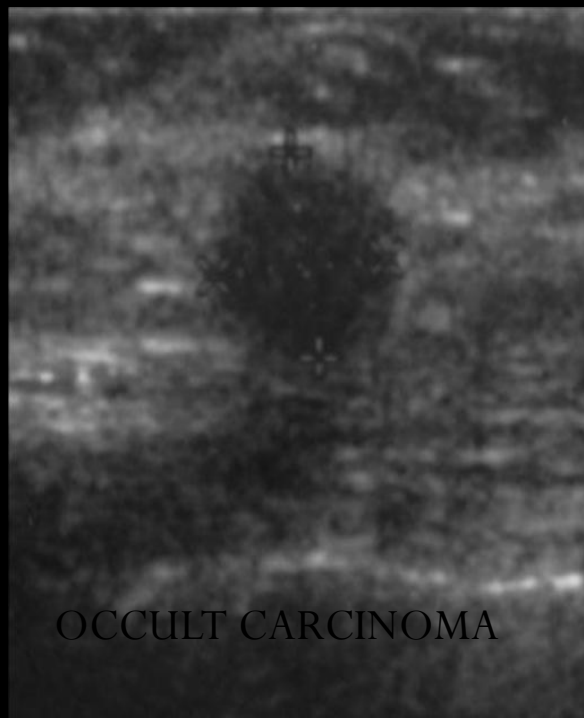
Benign solid nodule





68 y, Lt. mastectomy, mammography reveals high breast density; carcinoma seen at ultrasound





Ultrasound And Screening

- Supplemental screening in women with dense breasts
  - Limitation of mammography
  - The recognition of the increased risk of breast cancer in women with dense breasts

US – Screening ?

- CHANGE
- ***2007*** – US for screening breasts is an area of research
- ***2011*** – Data support US screening plus mammography in women with dense breasts at high risk of breast cancer

Supplemental screening in women with dense breasts

- US screening of women with dense breasts
  - **Detects 0.8 - 10.0 additional cancers per 1000 women screened**
  - False positives - biopsy positivity rate < 10%

- Radiology. 2012
- Improved breast cancer detection in asymptomatic women using 3D-automated breast ultrasound in mammographically dense breasts. Giuliano Clin Imaging. 2012

- **ELASTOGRAPHY**
- **ABVS – Automated Breast Volume Scanner**

US- elastography

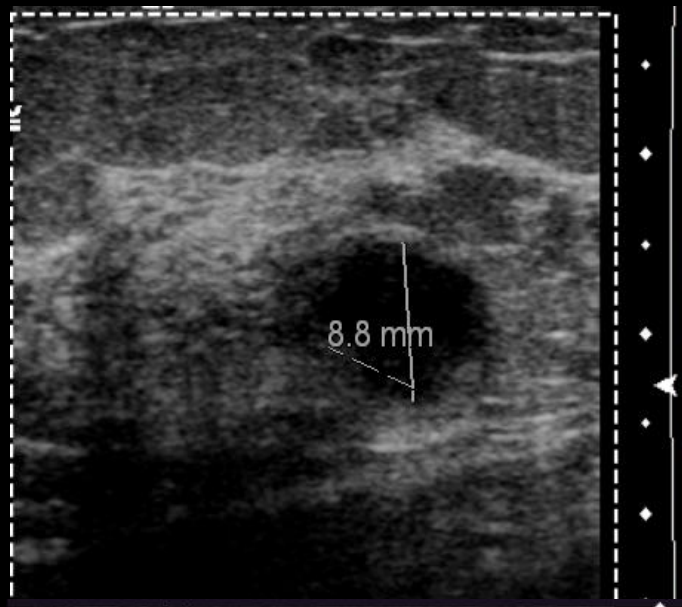
Palpation - assessment of shape and rigidity:

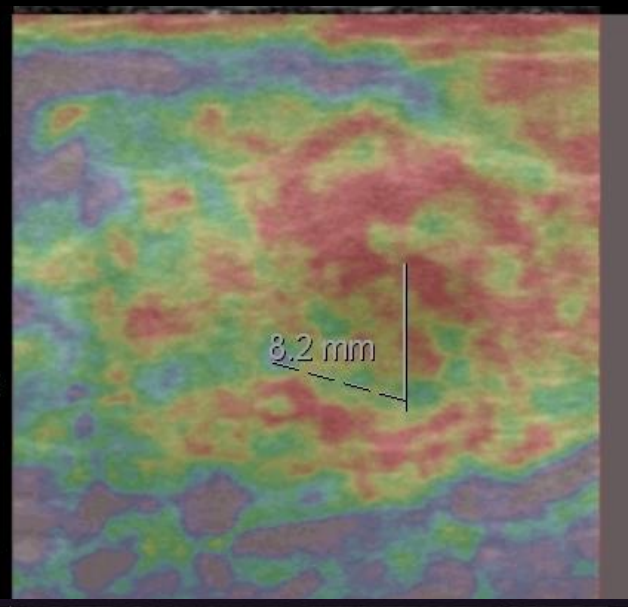
US- elastography is a noninvasive imaging technique that can be used to depict relative tissue stiffness or displacement (strain) in response to a force

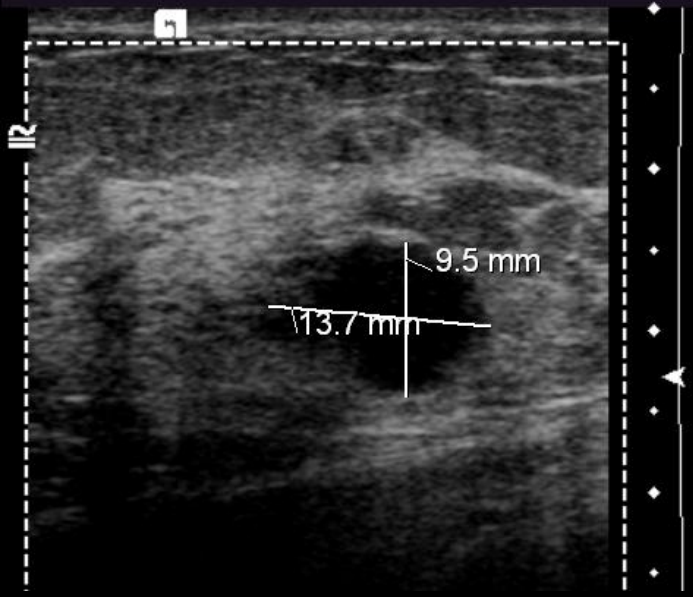
Elastography = external compression (stress)
deformation of the tissue (strain)

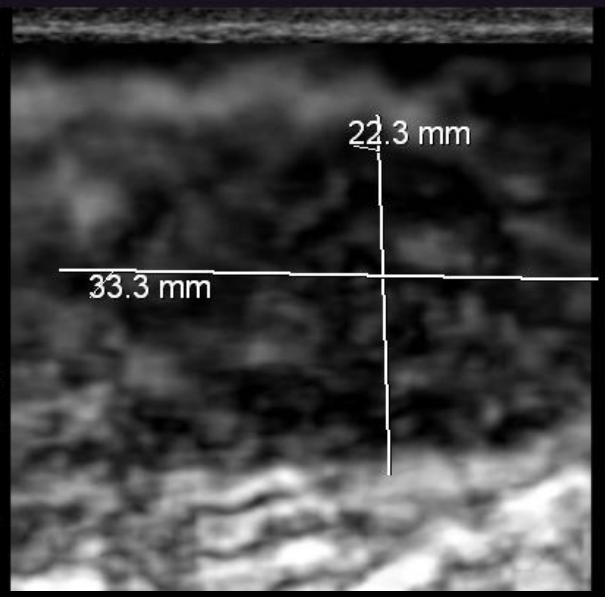
- **The strain map of ultrasound elastography is superimposed on a conventional B-mode US**

48 year – palpable RT. Breast lump





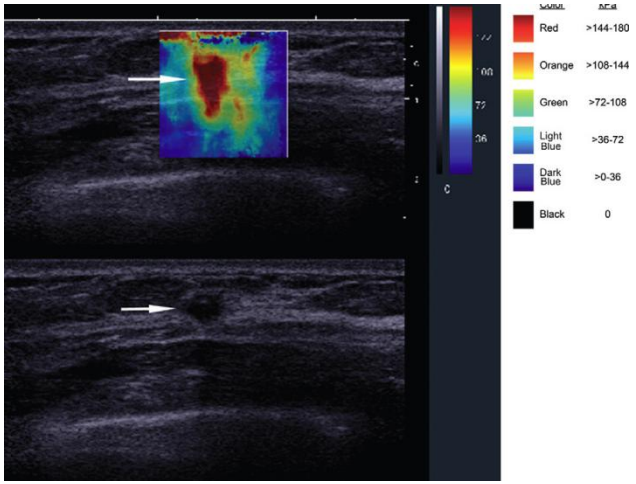




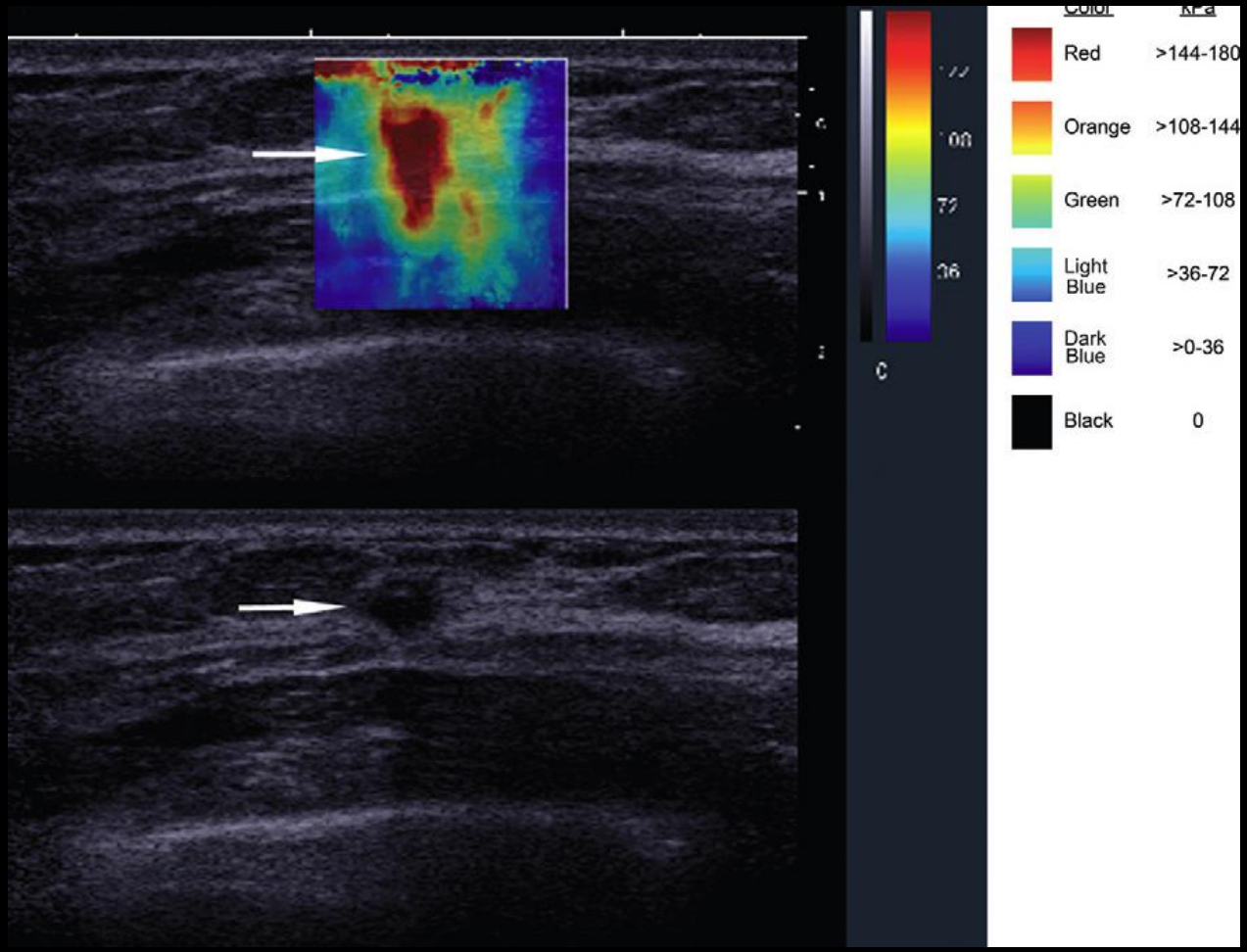
INVASIVE DUCT CARCINOMA

Shear wave elasticity (SWE)

- Features measured with SW elastography;
  - Quantitative elasticity – kPa
    - Reference values are not yet well established
      - >50-70Kpa - malignant
  - color scale linked to kPa
  - Size ratios relative to B-mode imaging
  - Shape at SW elastography
  - Homogeneity of elasticity

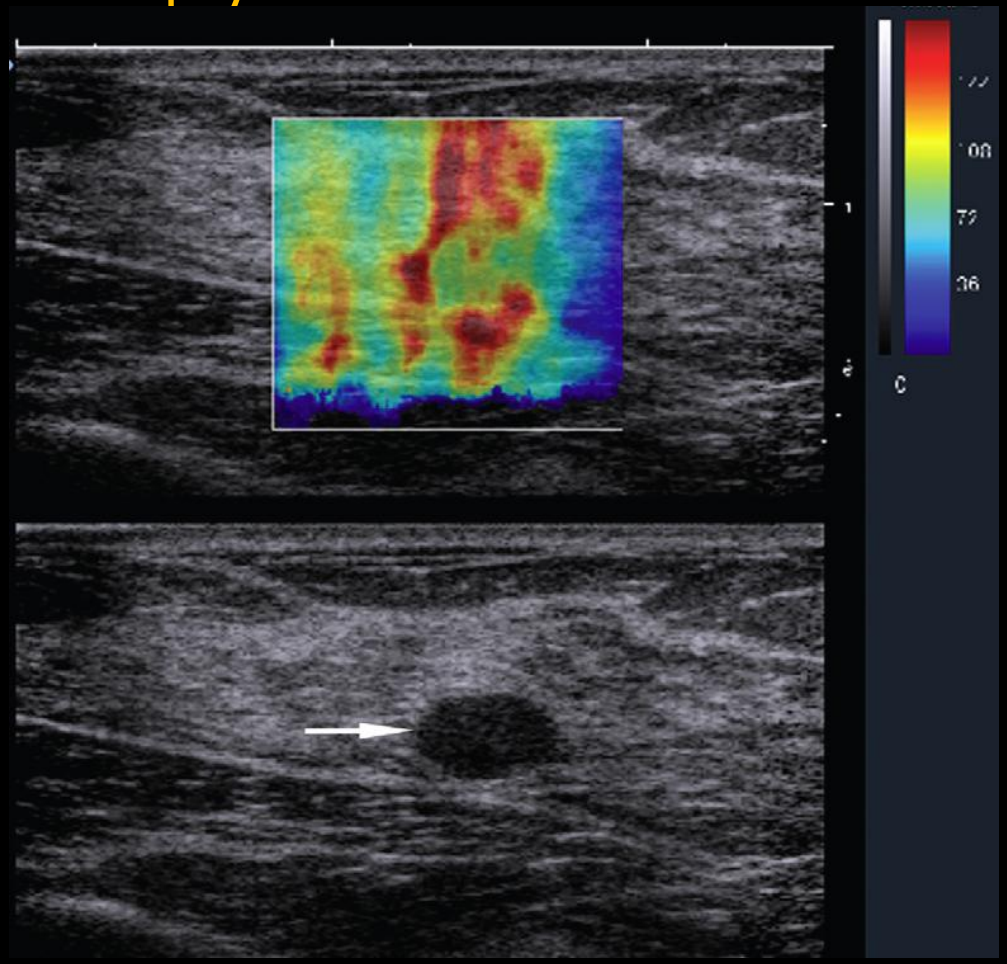


A 6-mm irregular hypoechoic mass in a 58-year-old
Biopsy - infiltrating ductal carcinoma

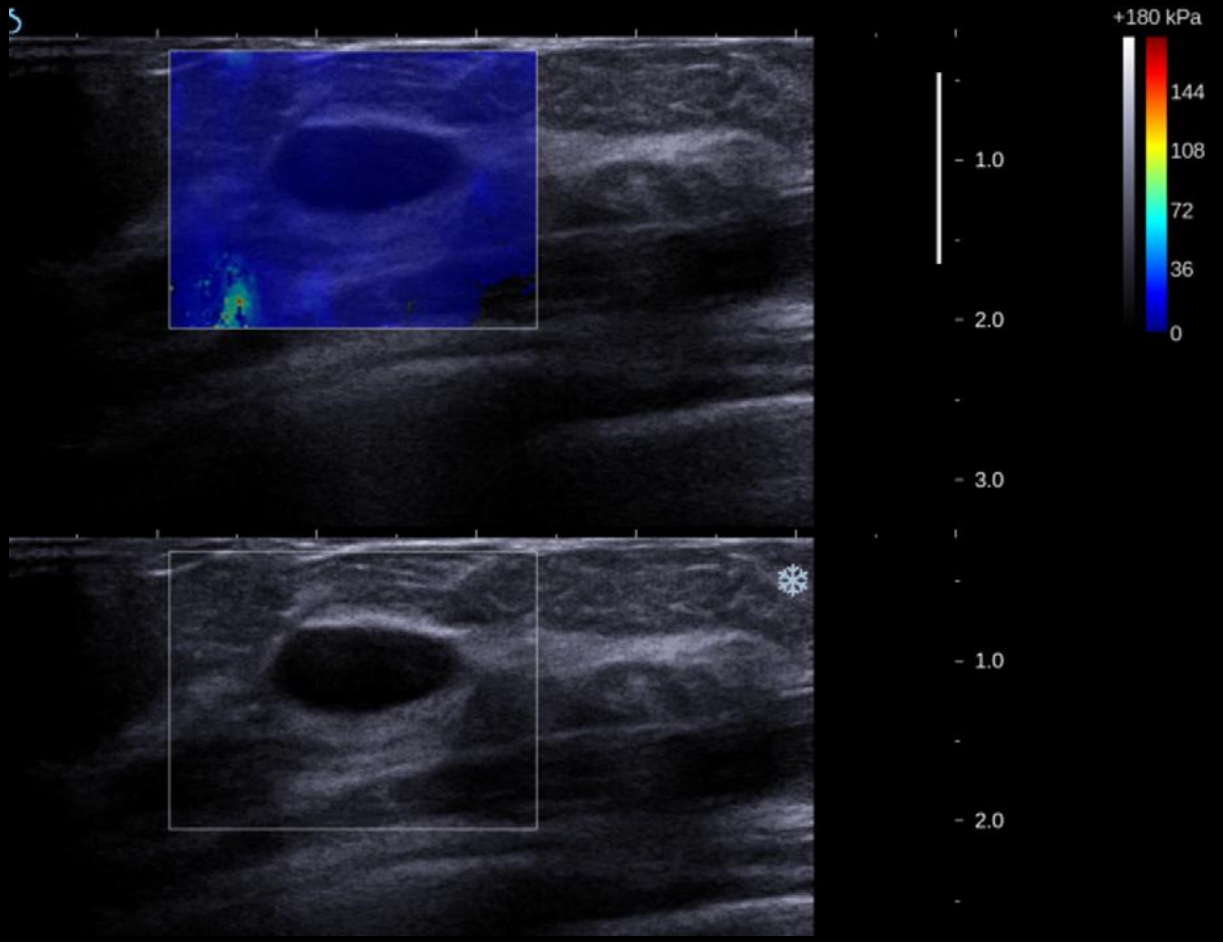


An oval, circumscribed mass considered to be BI-RADS category 3 in a 67-women .

Biopsy invasive ductal carcinoma.



Benign cyst - blue color : 0 kPa



In Summary – Elastography

- Breast elastography is now an adjunct tool in breast ultrasonography.
- Easy to perform , short in a routine examination

- **Applications**
  - Characterization of solid nodules
    - BI-RADS 3 and BI-RADS 4a, in order to try to reduce unnecessary breast biopsies.
  - Differentiation between solid and cystic lesions

- In the future - US elastography **may be used to reduce biopsy rates for breast lesions**

ABVS - Automated Breast Volume Scanner

US

- **Ultrasound is a complementary technique to mammography**
  - Dense breasts and is part of the standard of care in diagnostic procedures.

- Manual US examinations
  - time-consuming
  - operator dependant
  - Evaluation of already captured images.

ABVS

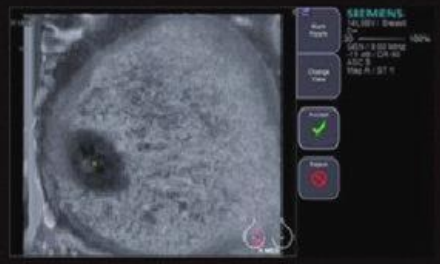
- Dedicated breast scanner - full-field volumes
- Nonphysician acquisition for 2 breasts in 15 min (60 seconds per view)
  - Coronal , 3d full volume of the breast
  - Conventional hand held US
- No operator dependent & variability - Scan consistent
- Improve clinical workflow
- Increased comfort for operator and patient

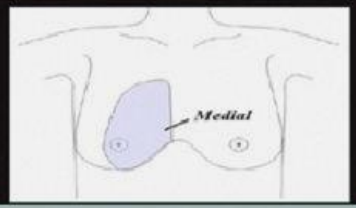
ABVS

- The FDA approved an automated ultrasound in Sep. 2012

- **Used as an adjunct to mammography for asymptomatic women with dense breasts and a negative mammogram**

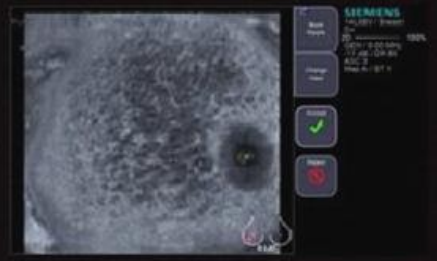
Right Medial (R MED) View

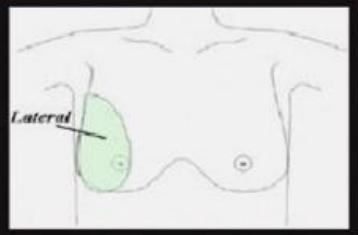




- Medial position starts with the pod tilted in a thumb down angle, with nipple area compressed toward operator

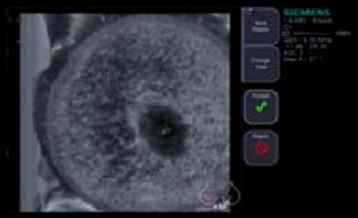
Right Lateral (R LAT) View

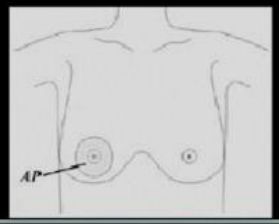




- Place the pod in a thumb up angle with all of the breast tissue compressed toward the sternum.

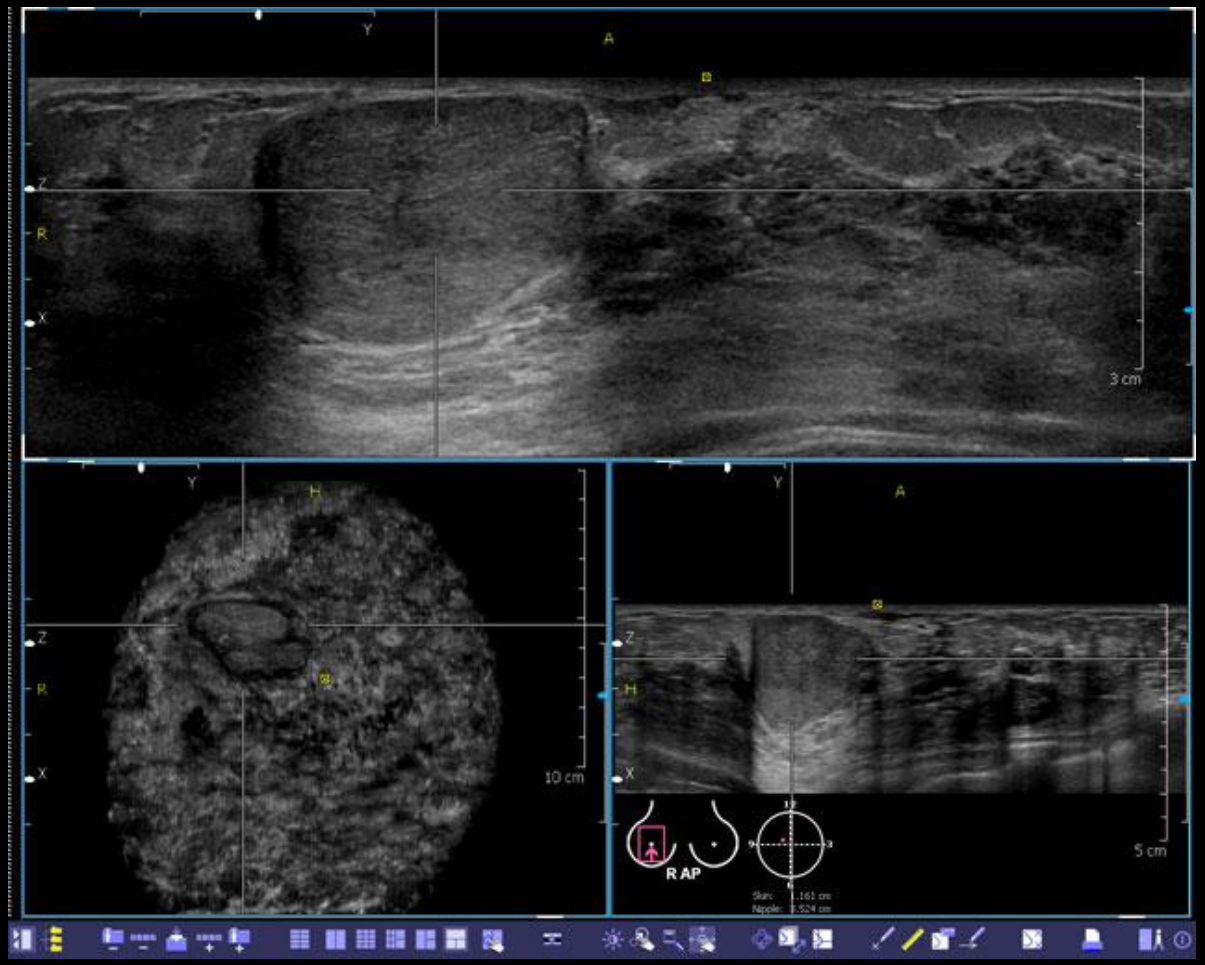
Right Anterior Posterior (R AP) View



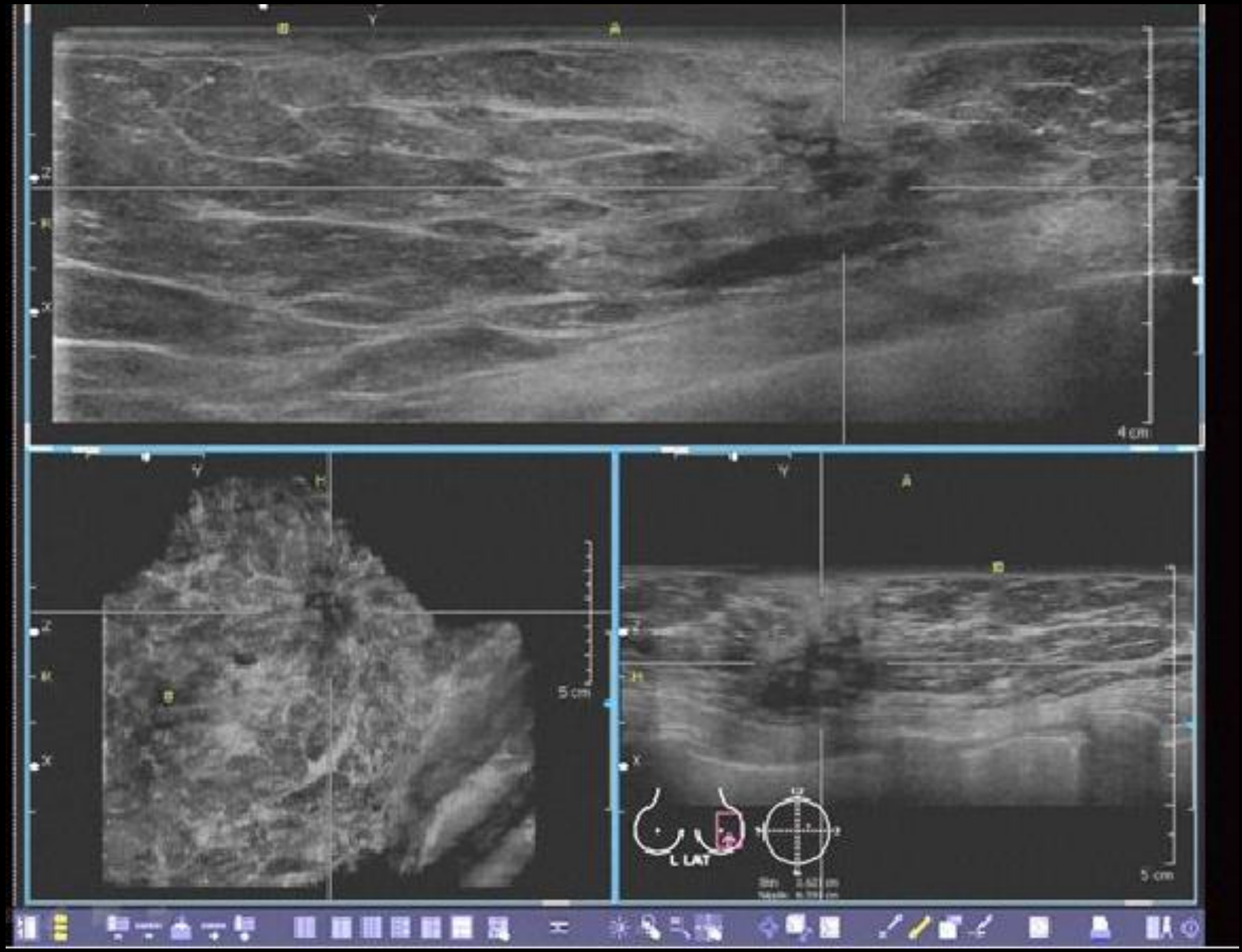


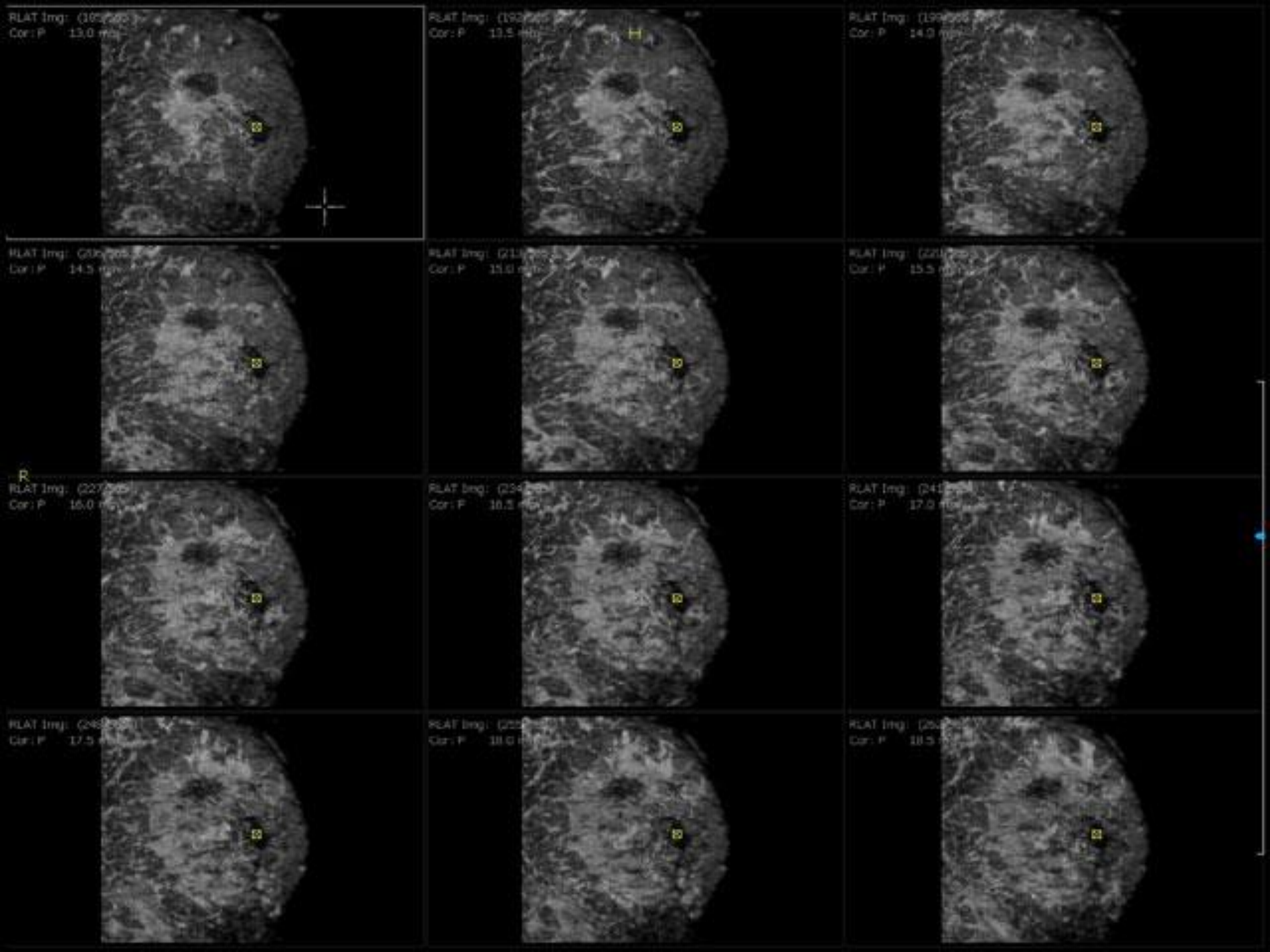
- Center the nipple with the probe arrow located in the center of the footprint

Fibroadenoma



Carcinoma


4 cm
5 cm
L LAT
5 cm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Breast MRI

- Mammography/US -are anatomic imaging

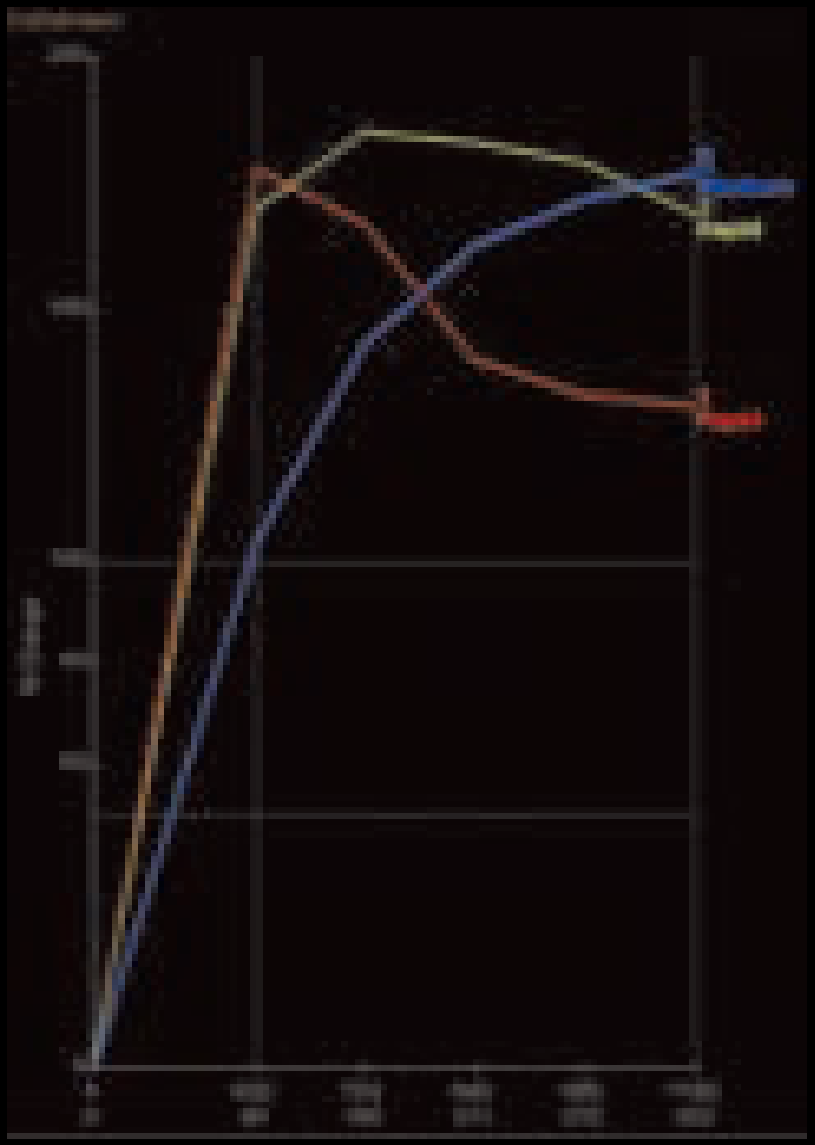
- The use of MRI for breast cancer detection is based on the concept of tumor angiogenesis or neovascularity
  - Breast MRI relies on demonstrating the vascular characteristics of a lesion – IV contrast.

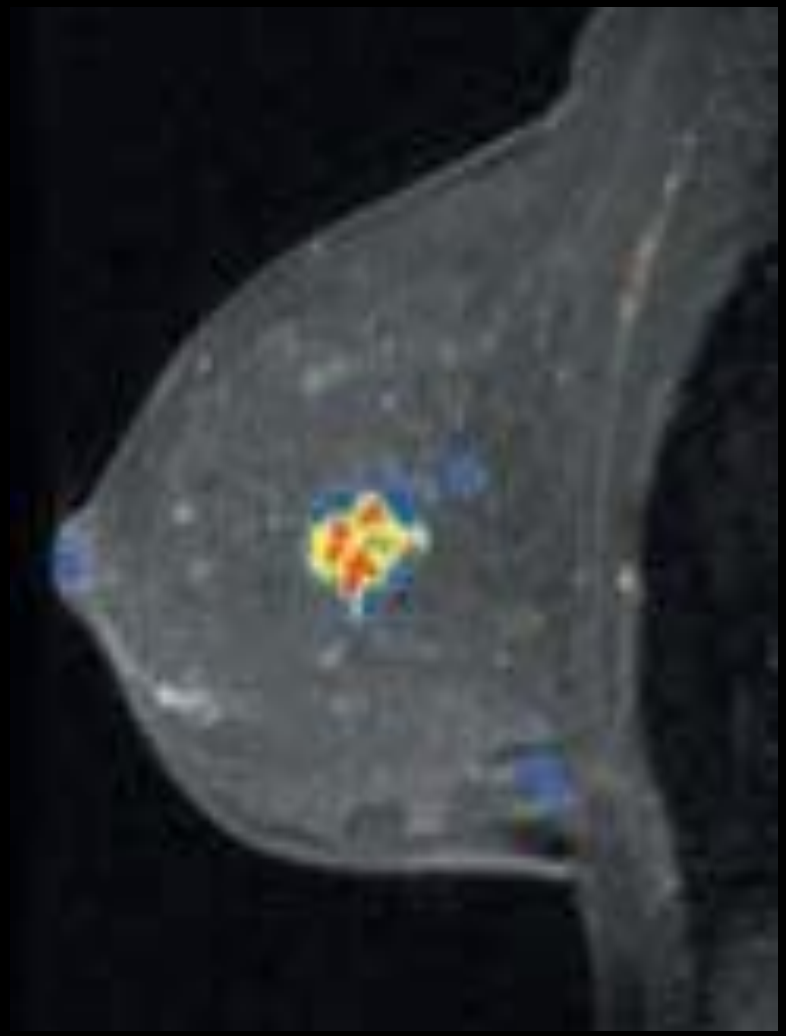
- MRI evaluates morphology and enhancement patterns.

Vascular Characteristics

- Malignant lesions - angiogenesis, increased number of blood vessels
- Strong and fast enhancement
- Increased permeability of blood vessels and A-V shunts.
- Rapid washout of contrast

CADstream Angiogenesis Maps





Breast MRI

- **Sensitivity – 71-100%**

- **Specificity variable < 65%**
  - Overlap in the enhancement pattern of benign and malignant lesions

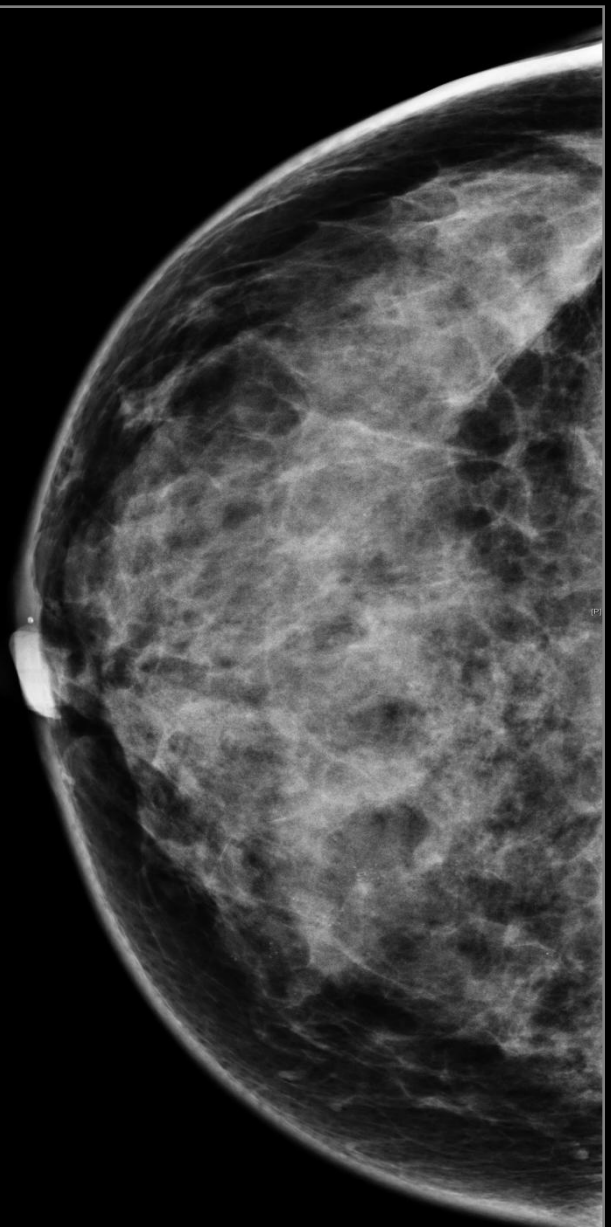
» Acta Radiol. 2007;48(8):838

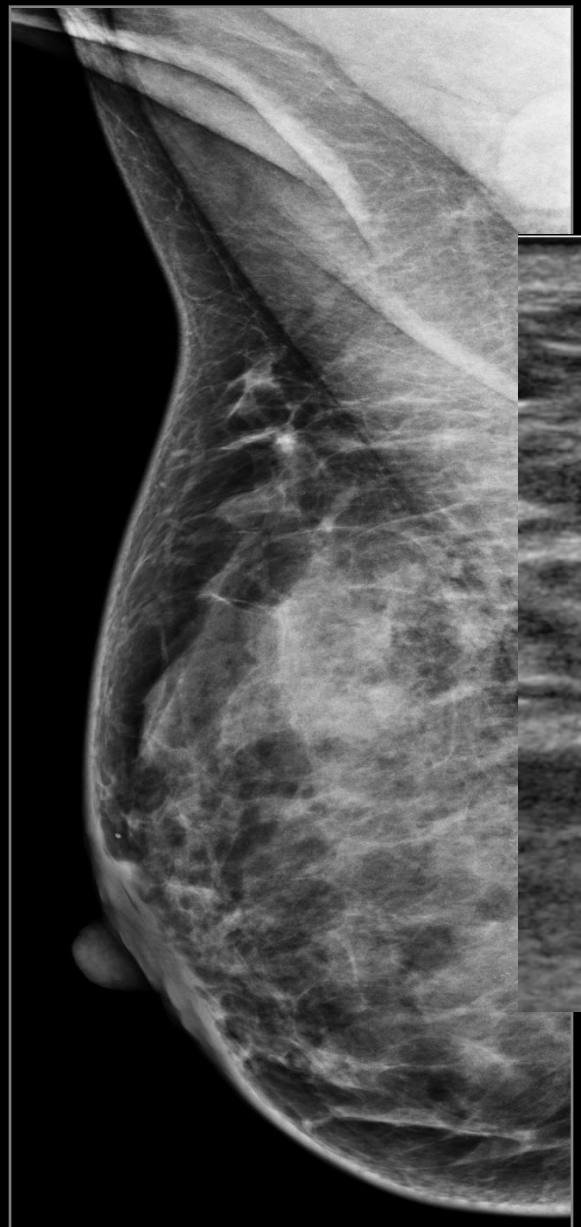
» Top Magn Reson Imaging. 2008;19(3):143.

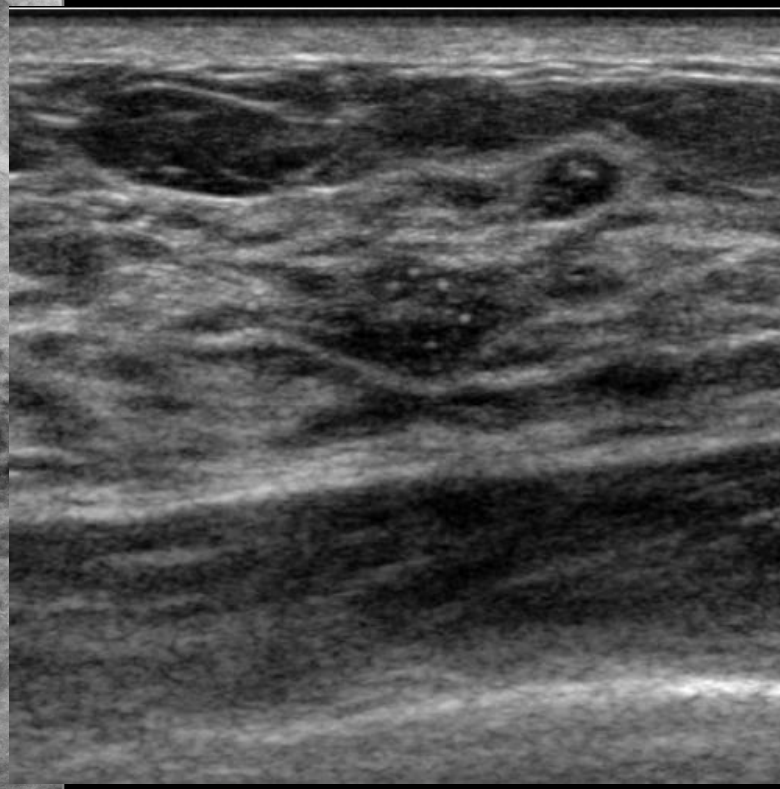
Indications for Breast MRI

- **Diagnostic**
  - Extent of disease
    - Pre-op
    - Post lumpectomy r/o residual dis. - close or positive margins
  - Response to neoadjuvant chemotherapy
  - History of breast cancer – r/o recurrence
  - Search of occult primary with Ax LNs
  - Silicone implant rupture
  - Equivocal Exam
- **Screening**
  - High risk/ Personal Hx of breast cancer

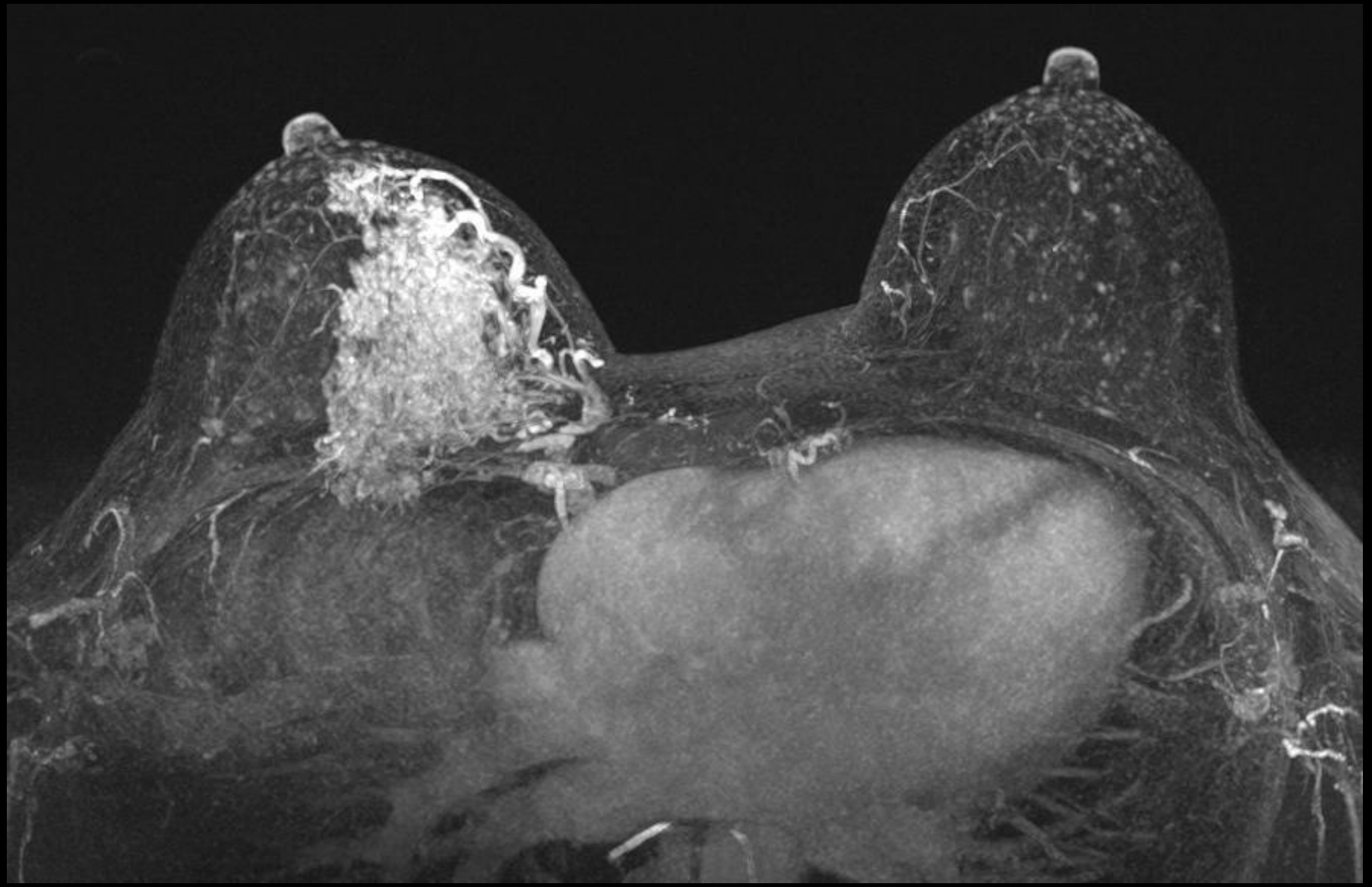
38 y- Family Hx. Mammography – cluster microcalcificatoins







PREOP MRI



Following MRI – surgery changed from lumpectomy to mastectomy

Overview: Published Results Sensitivity MRI vs Mammography in Women with High Familial Risk for Breast Cancer

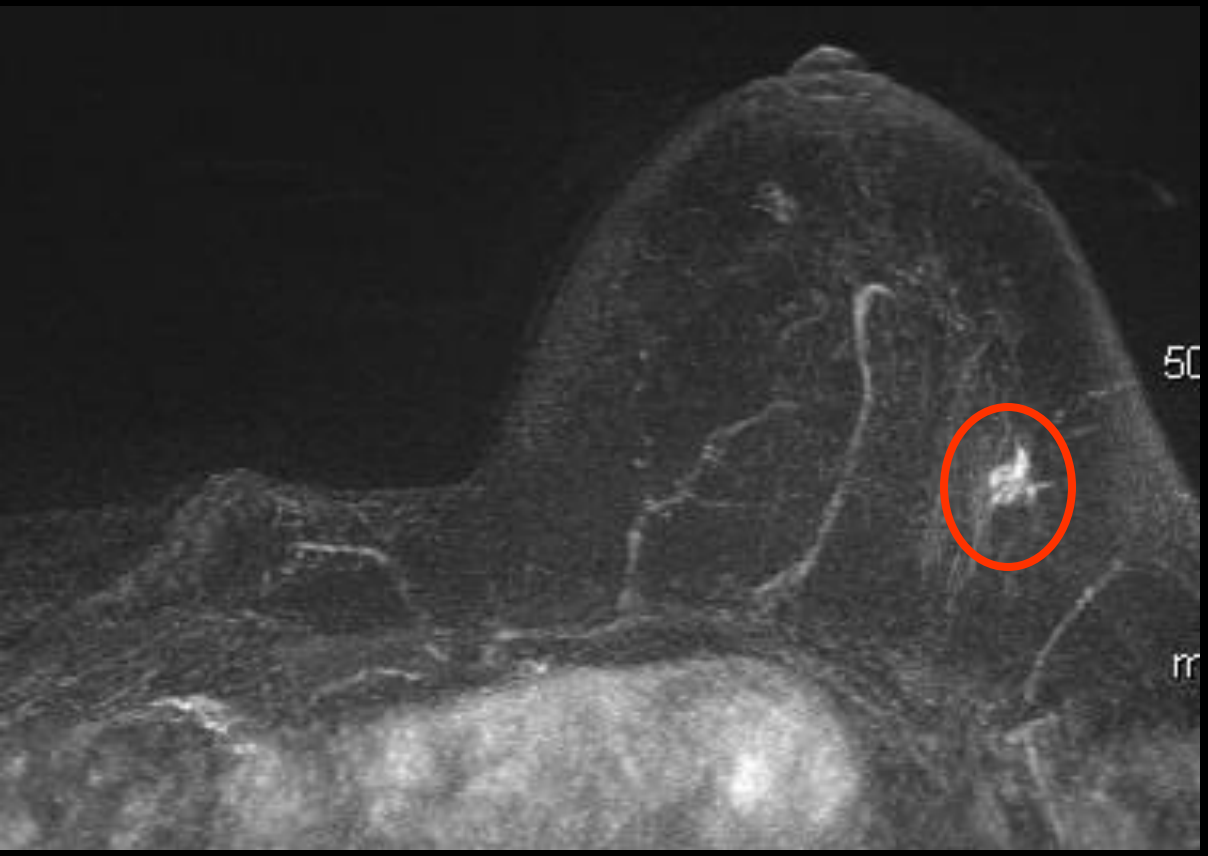
AUTHOR	# Pats	# Ca Detected	MRI Sensitivity-Specificity	Mammography Sensitivity-Specificity
Kuhl, 2000	192	12	100% - 95%	32 % - 93%
Tilanus-Lindthorst, 2000	109	3	100% - 94%	0 % - NP
Stoutjesdisjk, 2001	179	14	100% - 93%	42 % - 96%
Warner, 2001	196	7	100% - 91%	28 % - 99.5%
Trecate, 2003	24	4	100% - NP	0 % - NP
Kriege, 2004	1909	45	71% - NP	40 % - NP
Warner, 2004	236	22	73% - 99%	36 % - 99%
Leach, 2005	649	35	77% - 81%	40 % - 93%
Kuhl, 2005	618	12	83% - NP	42 % - NP
Kuhl, 2005	529	43	91% - 97%	33 % - 97%
Sardinelli, 2007	278	18	94% - NP	59 % - NP

Kuhl, Radiology 2007

Sensitivity in High-Risk Women

- Sensitivity of mammography: 28%-59%
- Sensitivity mammography + ultrasound + clinical breast examination: 49%-67%
- Sensitivity of MRI: 71%-100%

54 y, BRCA1, Rt mastectomy, screening MRI in left breast revealed 1 cm carcinoma not shown on mammography



Breast MRI – Limitations

- Variable specificity - 30%-85%
  - May lead to high false positive rate
- MRI-guided biopsy – for lesions seen only on MRI

MRI-Guided Breast Biopsy

Obtain a histologic diagnosis of lesions detected on MRI

Nuclear Breast Imaging

- Functional breast imaging techniques

  - *Breast specific gamma imaging –BSGI -* **Breast scintigraphy with 99mTc-SestaMIBI**

-

  - *Positron emission mammography – PEM -* **with 18F-2-deoxy-2-fluoro-D-glucose (FDG)**

Breast Specific Gamma Imaging-BSGI

Gamma camera in a mammographic configuration to provide high-resolution, functional images

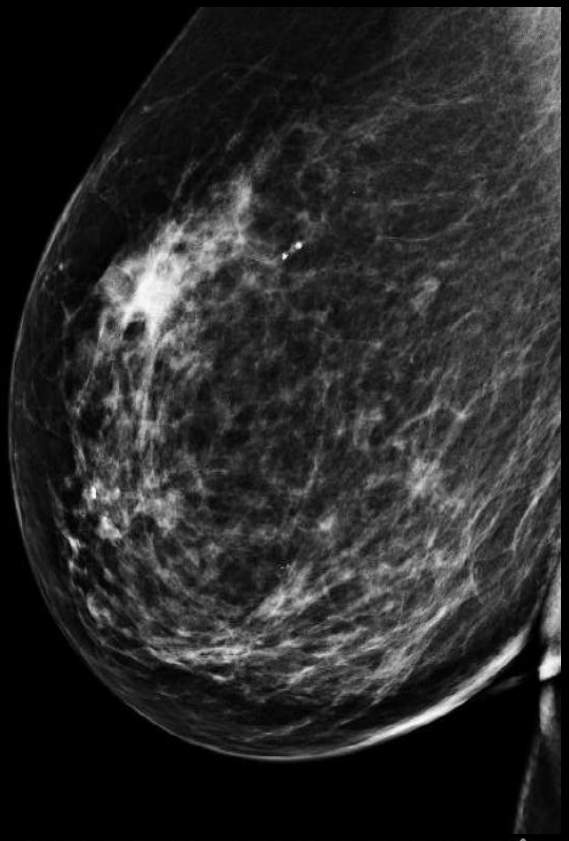
Image in positions comparable to mammography

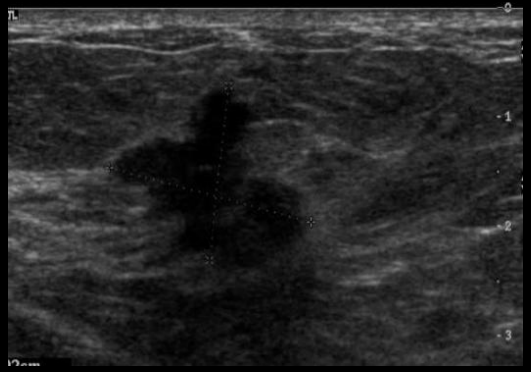
Breast Specific Gamma Imaging-BSGI

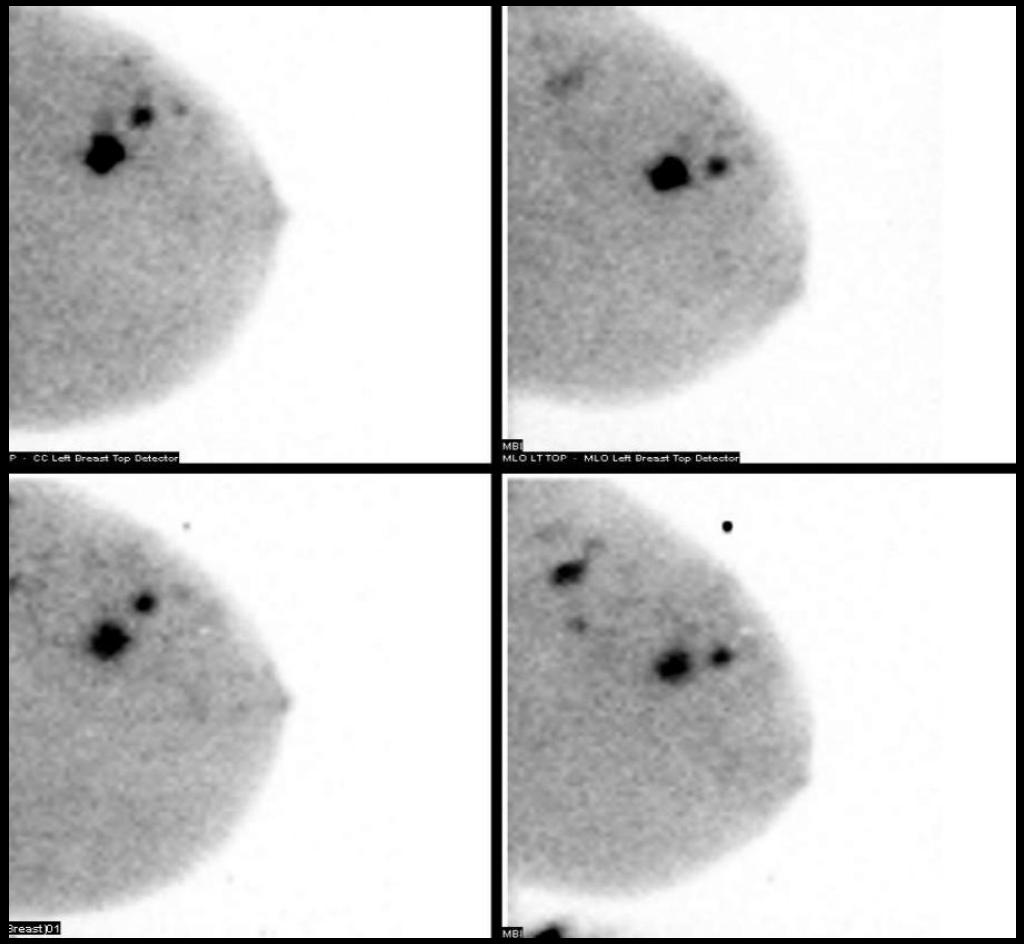
- In several observational studies- compared to MRI
- Sensitivity - equal MRI -96%
  - Sensitivity - 93.8% for the detection of DCIS
- Specificity greater than MRI – 59.5%

» Radiology 2005;237(1):274
» Radiology 2008;247(3):651
» AJR 2009;192(2):379

Mammography: Detected 2cm - MBI: Multiple foci of increased uptake







Nuclear Breast Imaging

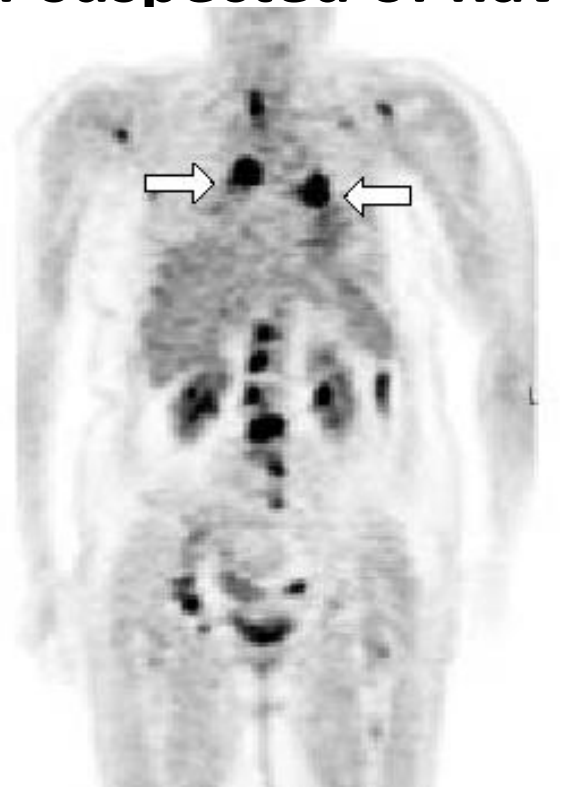
- **Diagnostic**
- Indications similar to of breast MRI
  - Extent of disease - preoperative assessment
  - High risk screening
  - Monitoring response to therapy

- **About 15% of women for whom MRI is indicated, do not undergo the procedure for various reasons:**
  - Pacemaker
  - Obesity
  - can't lie down for the required period of time
  - Claustrophobic
  - renal problems.

- Screening-Not for screening - Radiation exposure and radiation-related risks

PET -Positron emission tomography

- **PET is primarily used as a modality to delineate the presence and/or extent of malignancy in patients known to have or suspected of having tumors**



PET

- High sensitivity and specificity for tumors >8 mm in diameter
  - clinically palpable and sometimes readily evident with conventional imaging.
- Limitations
- Accuracy is lower for non-palpable tumors or lesions smaller than 8 mm in size.
- FDG uptake can be poor in some well differentiated tumors and in lobular carcinomas

Dedicated PET Mammography

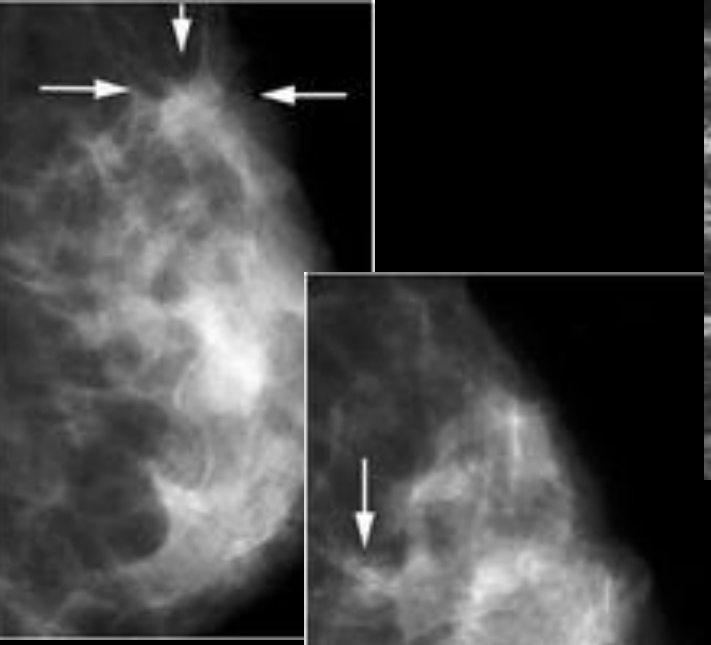
- **The compression paddle from the mammography unit provides mild compression against the lower PET mammography detector.**

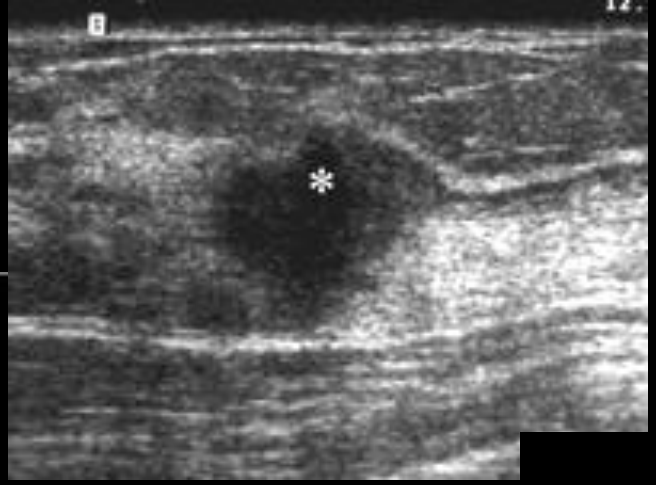
- **Less compression is used with the PET mammography unit than with conventional mammography**

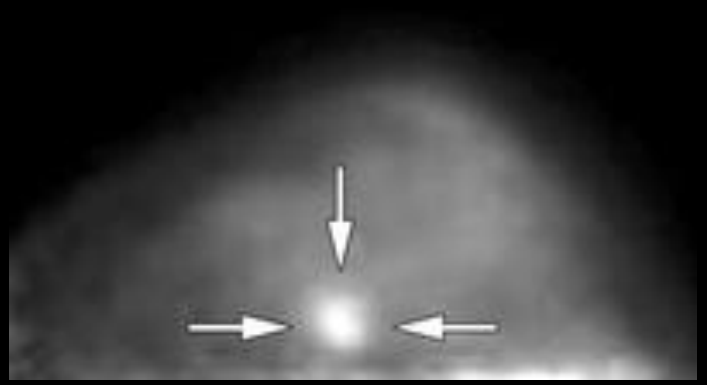
Positron emission mammography (PEM)

- High resolution- modification of PET
  - 2 mm in-plane resolution
  - Improve detection of small malignancies
- Sensitivity – 86 – 91%
- Specificity – 91- 93%
  - » Breast J. 2006;12(4):309

- Indications
  - Diagnostic-Preoperative assessment of disease extent
- NOT for screening
- PEM is still investigational.







41-year-old woman with a 1.8-cm mass in the left breast

US - solid mass

PET mammography image - single focus of increased FDG activity at the site of the mass.

Pathology - 2.0-cm invasive ductal carcinoma

In summary

- Screening - Mammography
  - Adjunct US (ABVS)
  - Other modalities : NOT YET , Research
    - Tomosynthesis , CEM,
  - **Population based screening – anatomic / functional**

- Diagnostic – Not just mammography
  - **Multi-modality optimal breast cancer diagnosis**
  - Personalized medicine - Specific for women
    - US, Automated 3D US, Contrast mammography, tomosynthesis , MRI , Molecular Breast Imaging

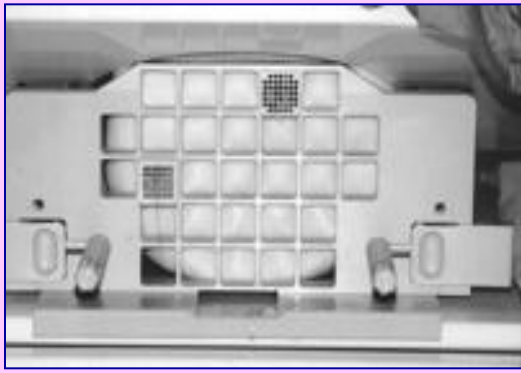
In summary

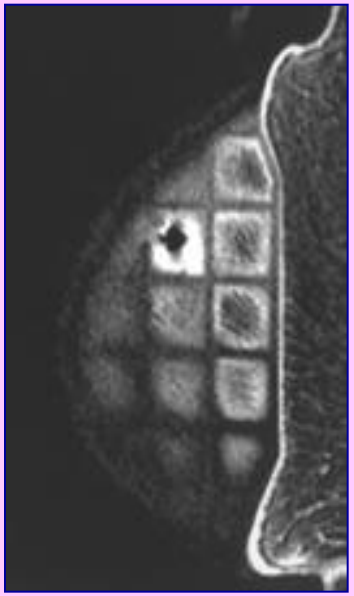
- **Screening**
  - Mammography limitations
  - Maybe reconsider as a single modality

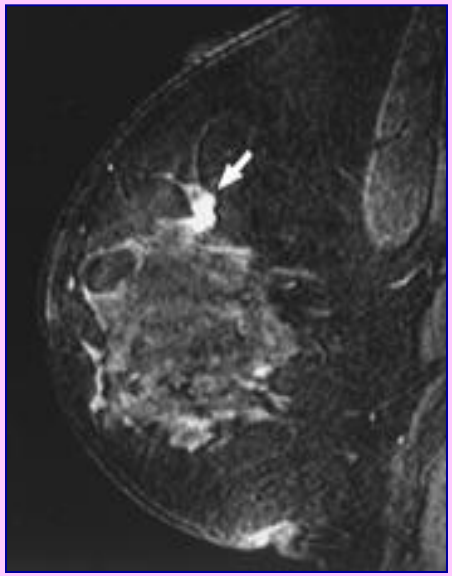
  - Women targeted approach
    - Risk assessment
    - Breast density

  - Adjunct modalities
    - US
    - CEDM
    - Tomosynthesis
    - MRI
    - Molecular breast imaging

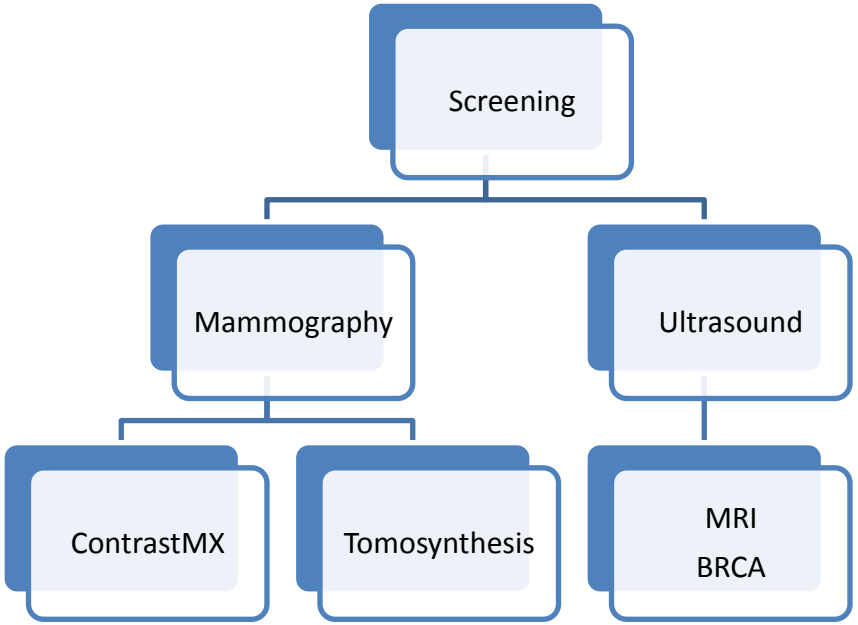
Thank You

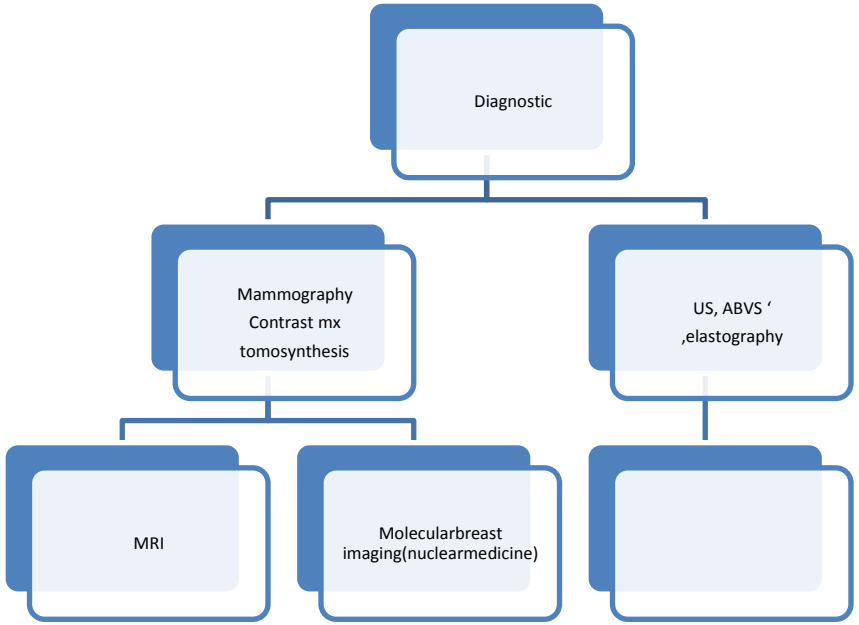






In summary


Screening
Mammography
Ultrasound
ContrastMX
Tomosynthesis
MRI
BRCA


Diagnostic
Mammography
Contrast mx
tomosynthesis
US, ABVS '
,elastography
MRI
Molecularbreast
imaging(nuclearmedicine)