Screening for Breast Cancer: State of the Art

Rachel F. Brem, MD FACR FSBI
Professor of Radiology , GWU
Co-Founder and CMO
The Brem Foundation

Lifetime Risk of Breast Cancer

- American Women
  - 1 in 8 (12.8%) will develop breast cancer
  - Most common cancer in women (excluding skin cancer)

Breast Cancer in the United States

- 316,950 invasive cancers
- 59,080 DCIS
- 376,030 new cases per year
- 130.8 per 100,000 women per year (2018-2022 data)

Breast Cancer in the United States

- 42,170 will die of their disease
- 14% of all cancer cases
- 16% of cancer deaths

Breast Cancer

- Leading cause of premature mortality in women
- 50,000-60,000 years of potential life lost annually in the US
- An average of 19 years of life lost per death

Breast Cancer in Men

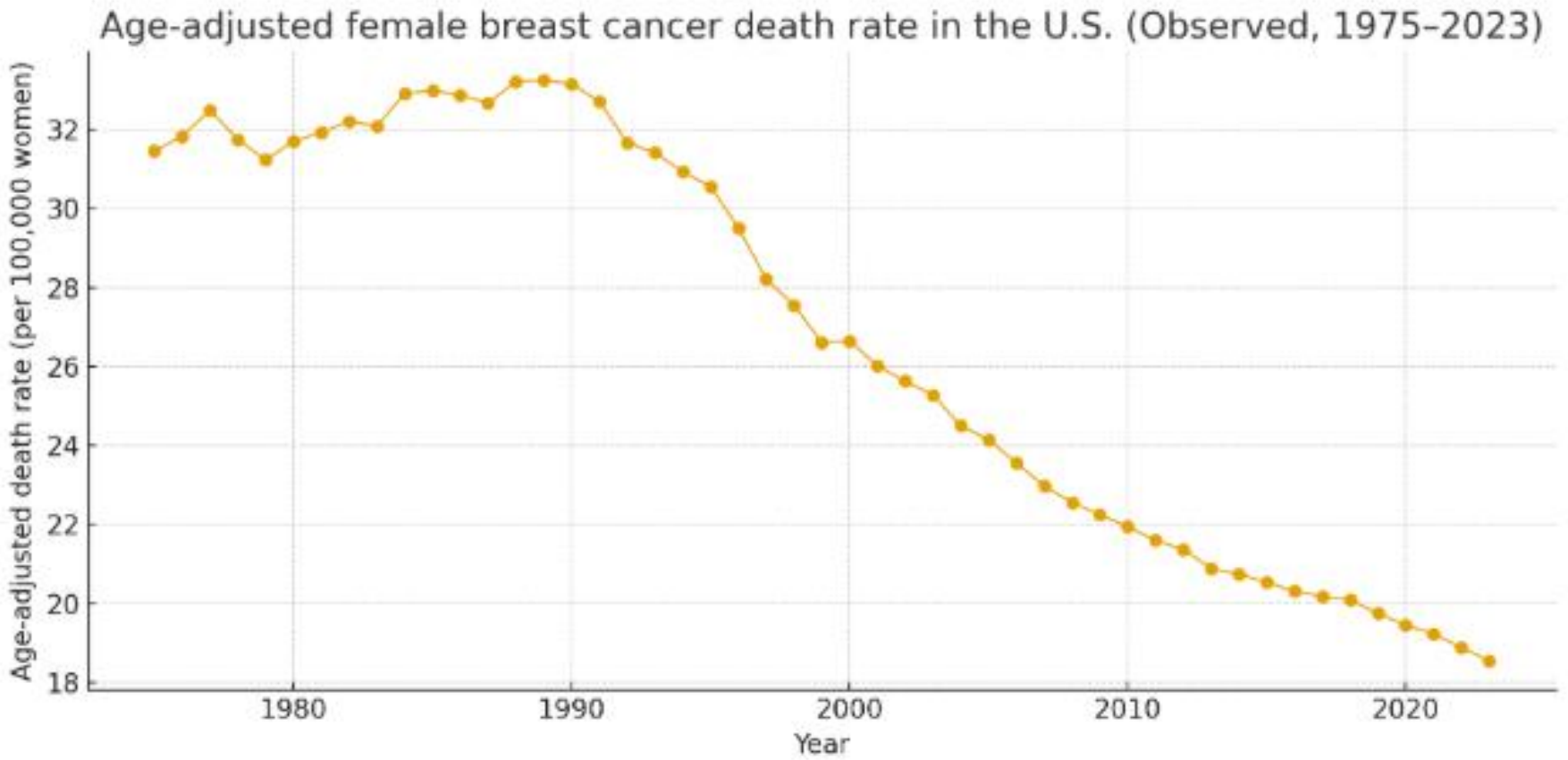
- 2,800 cases annually
- 500 die annually

Breast Cancer in the US

- Death rate has decreased by over 50% since 1989
  - Improved detection
  - Improved and targeted therapies

Breast Cancer: Survival

- Five Year survival rate: 91%
- Dependent on stage at diagnosis: 5 year survival
  - Localized disease >99%
  - Regional (LN positive) 87%
  - Metastatic 32%


Age-adjusted female breast cancer death rate in the U.S. (Observed, 1975–2023)
Age-adjusted death rate (per 100,000 women)
32
30
28
26
24
22
20
18
1980
1990
2000
2010
2020
Year

- 2/3 women with breast cancer diagnosed with localized disease
- As of 2022, 4,091,181 women in the US living with a history of breast cancer

New Invasive Breast Cancer by Age in US for 2019

Age	Number	%
<40	11,870	4%
40-49	37,150	14%
50-59	61,560	23%
60-69	74,820	28%
70-79	52,810	20%
80+	30,390	11%
All ages	**268,600**	

Cancer in Younger People in the US

- 71% increase in cancer incidence in people less than 40
  - Breast
  - Lung
  - Colon
- Nearly 20% of breast cancer in the US occur in women in their 40's
- Number one cause of cancer deaths in women 25-40

Do we have a “cure” for Breast Cancer?

- 99% survival of early stage breast cancer can we consider early detection as a “cure”?

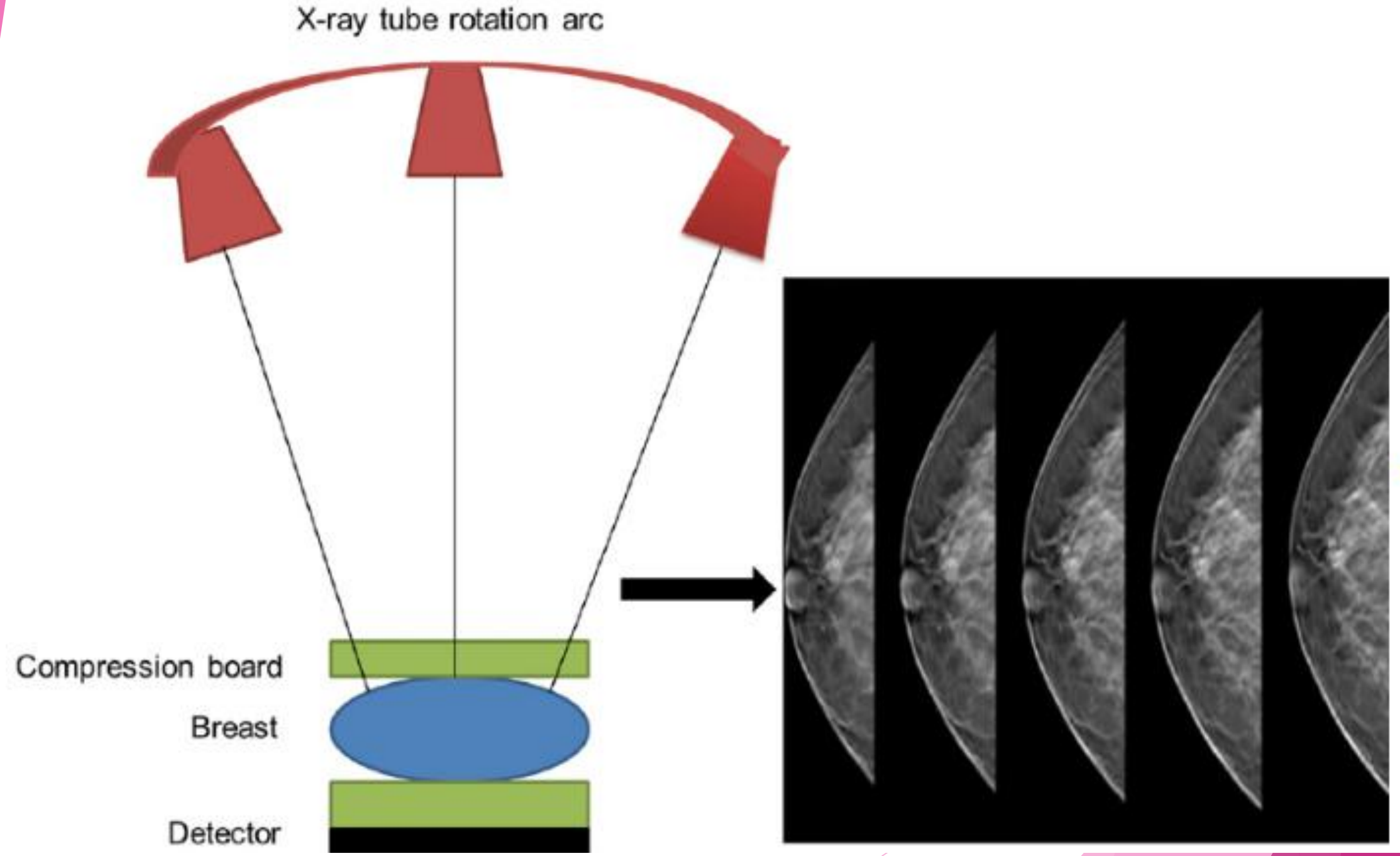
Breast Cancer Survival

- These figures emphasize the critical need for the detection of the earliest, most curable breast cancers
- Intensity of care is also significant

- How do we detect the earliest breast cancers

Screening Mammography

- An x-ray image of the breast used to check for breast cancer in people who have no signs or symptoms of the disease
- NOT for anyone with a new sign or symptom of breast cancer
  - Diffuse pain is ok
  - Focal pain is not


X-ray tube rotation arc
Compression board
Breast
Detector

2D vs 3D mammography in the US

- Over 80% of mammograms in the US are 3D
- All patients should be receiving 3D mammograms

Screening Mammography

- No Co-pay, no deductible
- Thought to be responsible for approximately 50% of mortality reduction
- By law, patient must receive their results in lay terms within 30 days of the examination
- Must contain breast density information (FDA, Sept 2024)

Mortality Reduction from Screening Mammography

- Regular screening mammography is associated with a approximately 40 % decrease in breast cancer mortality
- Many studies underestimate the impact due to older technology used, and inclusion of symptomatic patients

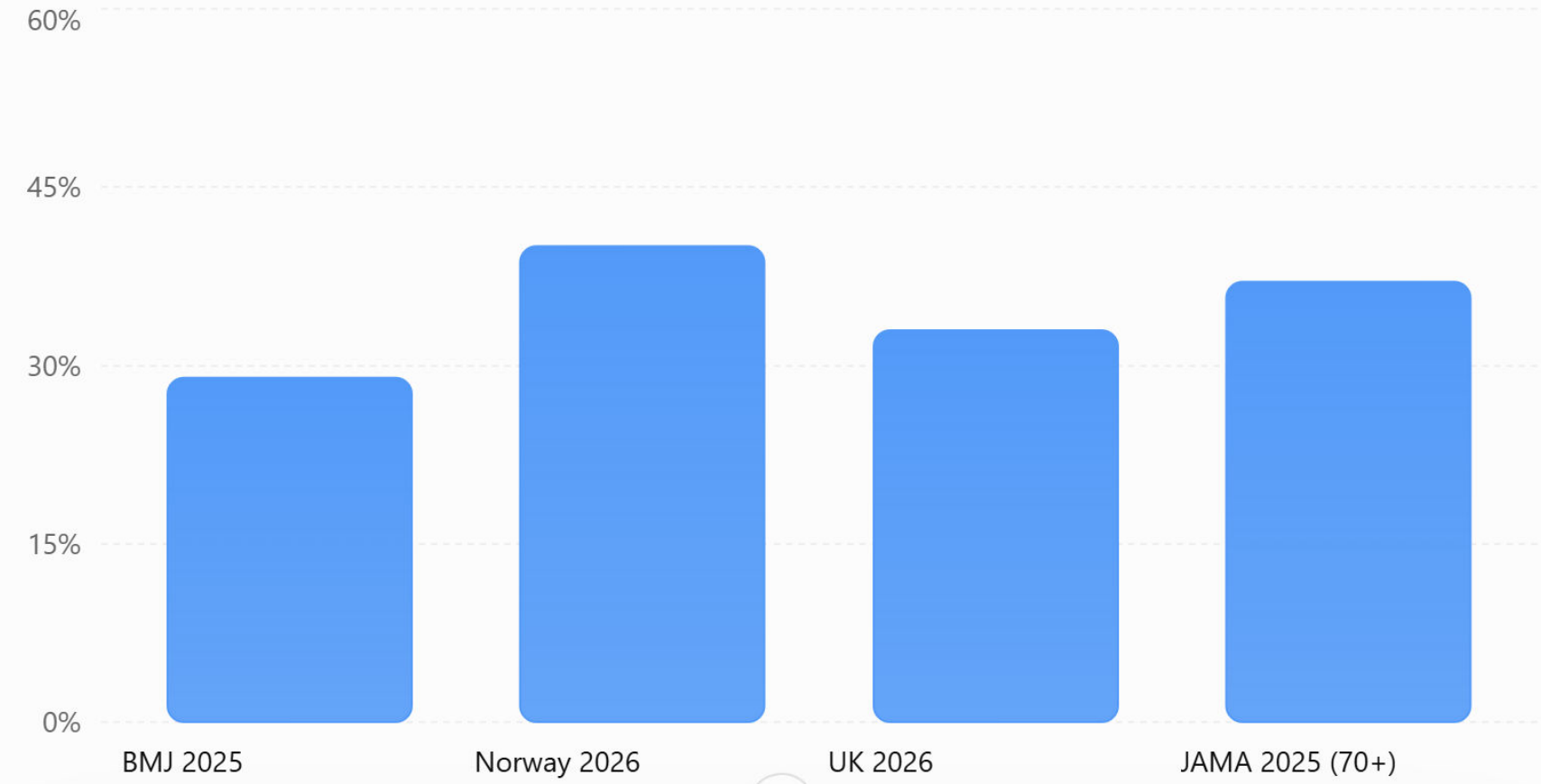
Canadian National Breast Screening Study

Cochrane Review (2013)

American Cancer Society (ACS)

Breast Cancer Mortality and Screening Mammography

Relative reduction in breast cancer mortality associated with mammography screening participation, based on the studies discussed above.



Observational associations, not necessarily causal effects. Estimates differ in adjustment methods and populations. The BMJ figure is approximately 29% lower mortality among participants relative to nonparticipants, derived from the reported 40% higher adjusted risk in...

1. Ma Z, et al. *BMJ*. 2025;390:bmj-2025-085029.
2. Moshina N, et al. *Breast Cancer Res*. 2026;28:75.
3. Dibden A, et al. *Br J Cancer*. 2026;135:964-971.
4. Huang S, et al. *JAMA Netw Open*. 2025;8(4):e255322.

Mammography Screening Guidelines in Average Risk Women

	Age (yrs) to Start Mammography	Age to Stop Mammography	Mammography Interval
ACR/SBI	40[a]	No age limit, tailor to individual health status	Annual
ACS	45, option to start at age 40	When life expectancy is < 10 years	Annual 45-54; Every 1 or 2 years 55+
ACOG	40	Age 75, then shared decision making	Every 1 or 2 years
AMA	40	Not Stated	Annual
ASBrS	40	When life expectancy is < 10 years	Annual
NCCN	40	Age 75, then shared decision making	Annual
USPSTF	40	74 years	Every 2 years

©DenseBreast-info.org Rev. Oct 2024

Age	AAFP recommendation
Under 40	No routine mammography for average-risk women
40–49	**Mammography every 2 years**
50–74	**Mammography every 2 years**
75 and older	Insufficient evidence; individualized decision
Dense breasts	Insufficient evidence to recommend for or against supplemental ultrasound or MRI after a negative mammogram

Recommendations

- Begin screening 5-10 years earlier than first degree relative with breast cancer
- Women with genetic mutations should begin screening with MRI at 25 and mammography at 30

Consequences of Numerous Recommendations



CONFUSING



FRUSTRATING



DIFFICULT

- Although so many different recommendations critical to remember
- **THE MOST LIVES WILL BE SAVED IF WOMEN AGED 40 AND ABOVE *(with average risk)* OBTAIN MAMMOGRAMS ANNUALLY**
- Approximately 20% of breast cancer occur in women 40-49

Why differences in screening mammography recommendations

- EVERYONE AGREES THAT STARTING AT $) WITH ANNUAL MAMMOGRAPHY OPTIMIZING MORTALITY REDUCTION
- Harms of mammography
- Data
  - Women over 74
- When do you stop screening

Screening Mammography

- Detects 2-7 cancers / 1000 screening mammograms

Diagnostic Mammogram

- evaluate an abnormality detected on a screening mammogram
- investigate specific breast symptoms such as lumps, pain, or nipple discharge
- Unlike screening mammograms, which are routine and performed on women without symptoms, diagnostic mammograms are more detailed and focused to diagnose or rule out breast cancer or other breast conditions
- Patient receives results following examination (and will perform ultrasound at time of the examination if needed) unless requires MRI

Personal history of breast cancer

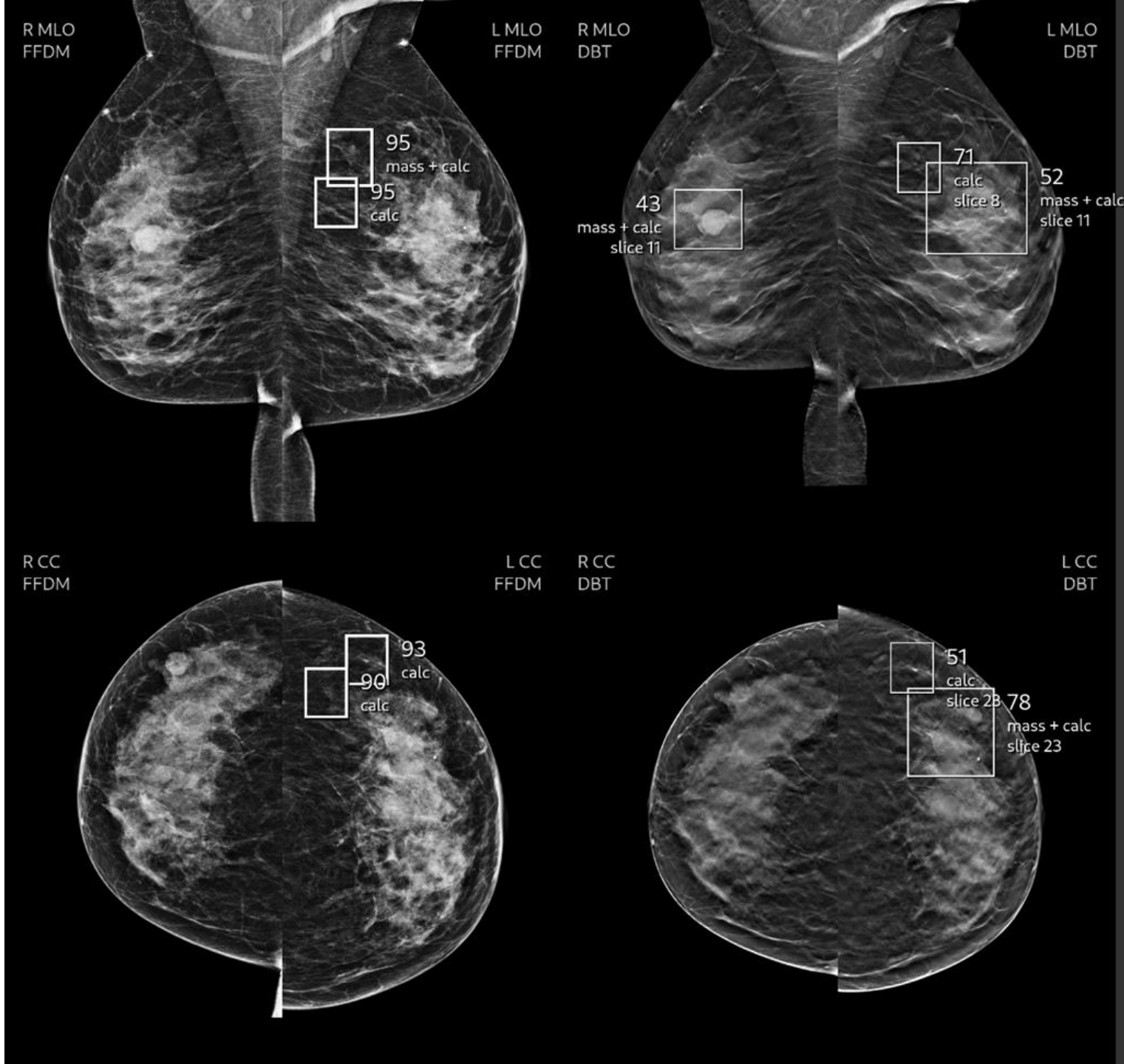
- CAN HAVE SCREENING EXAMINATION

Diagnostic Mammogram

- Covered by insurance
- WITH CO-PAY and DEDUCTIBLE

AI

- Marked decrease in interval cancers
- Detection of Cancer up to five years earlier
- Equally effective in women with dense and non-dense breasts
- Fairly widely available in our area



10

Elevated

Risk based on presence of abnormalities

transpara® report

By ScreenPoint Medical

Not intended for primary reading

Version 1.7.1

THE LANCET
Oncology

COMMENT | VOLUME 24, ISSUE 8, P830-832, AUGUST 2023

Download Full Issue

Artificial intelligence for breast cancer screening: breathtaking results and a word of caution

Nereo Segnan • Antonio Ponti

NATURE MEDICINE

Notable advances 2023

This year brought wins for artificial intelligence, genomics and gene editing, and breakthroughs in understanding diseases whose underpinnings have long eluded scientists. Here is our selection of critical developments that moved medicine forward in 2023.

Machine learning

Raising the bar for AI in cancer screening

Artificial intelligence (AI) algorithms applied to mammography images could potentially aid breast cancer diagnosis, but until recently, this had only been evaluated retrospectively. August saw the first data (a pre-specified safety analysis) from an ongoing randomized, controlled study evaluating AI-supported mammography screening versus standard double reading by two radiologists. The cancer-detection rate and false-positive rate were similar between the two groups, and the AI-supported approach reduced radiologists' workload by almost half. This prospective study suggests that AI-supported mammography screening is safe – which will pave the way for additional planned outcomes of this trial (including interval cancer rate), as well as further studies to evaluate the long-term impact on patient outcomes.

Original reference: *Lancet* **24**, 936–944 (2023)

Genomics

Diversifying the 'reference' genome

The first draft of the human genome, created over 20 years ago, was a turning point in human genetics, but each version was based on the DNA of a single person or a very small number of people. In May, the Human Pangenome Reference Consortium completed the mammoth task of compiling the first human 'pangenome' reference – which combines diploid assemblies of 47 diverse people into a single resource, with plans to extend this to 350 people. In parallel, the Telomere-to-Telomere Consortium harnessed advances in sequencing technology to fully sequence the human Y chromosome – previously incomplete owing to its challenging repetitive structure. This allowed them to assemble Y chromosome sequences from 43 diverse people from the 1000 Genomes Project, to provide information on the extent of genetic variation. These new, increasingly diverse reference assemblies have the potential to improve clinical genetics research and are now available for use by investigators.

Original references: *Nature* **617**, 312–324 (2023); *Nature* **621**, 344–354 (2023); *Nature* **621**, 355–364 (2023)

Nutrition

WHO cautions against non-sugar sweeteners

Non-sugar sweeteners are widely used globally to help reduce sugar intake without compromising the flavor of foods and beverages. Recently, however, studies have shown associations between non-sugar sweeteners and negative clinical outcomes – such as increased cardiovascular risk. The World Health Organization carried out a systematic review of available data to generate evidence-informed guidance for policymakers, health professionals and other stakeholders. The guidance states that non-sugar sweeteners should not be used for weight control or to reduce the risk of noncommunicable diseases, and it applies to everyone except those with diabetes. Given that some associations are weak, and outcomes may differ according to usage patterns and population characteristics, the guideline is conditional – and will be re-evaluated as further evidence emerges.

Original references: *World Health Organization* (2023); *Nat. Med.* **29**, 539–540 (2023)

Gene editing

Base editors in the clinic

Base editing enables the precise introduction of single-nucleotide changes into DNA and – unlike nuclease-based CRISPR–Cas systems – it does so without creating double-stranded DNA breaks. This latest advance in gene editing has already reached clinical development, and this year saw promising results from a phase 1 study in which base-edited 'off-the-shelf' CAR T cells were used to treat three children with refractory T cell acute lymphoblastic leukemia. Although one patient died from infection-related complications (a known risk of CAR T cell treatment protocols), potent anti-leukemic effects were observed in all three patients. This ongoing study and others will further evaluate the safety and efficacy of the approach. Meanwhile, at the time of this writing, the UK medicines regulator has granted the first approval of a CRISPR-based therapy (exagamglogene autotemcel, for sickle-cell disease and β-thalassemia), with other regulators expected to follow suit – which makes 2023 a big year for therapeutic gene editing.



CREDIT: YVON MARSH / ALAMY STOCK PHOTO

Original reference: *N. Engl. J. Med.* **389**, 899–910 (2023); *GOV.UK* (2023)

Society

Misinformation, mistrust and science

Widespread misinformation and public mistrust in science are interconnected phenomena that pose a substantial threat to public health; understanding these processes is therefore an urgent and complex endeavor. Social media has been touted as a contributor to the spread of misinformation and polarizing ideas, both within and outside the health sector. A recent study of Facebook users in the USA found high levels of ideological segregation in terms of exposure to political news, but found that 'echo chambers' – whereby users are exposed mostly to like-minded sources – were not politically polarizing. In the context of scientific ideologies, a recent study showed that people with intermediate levels of scientific knowledge had the highest levels of overconfidence and the most negative attitudes toward science. Further research to elucidate how misinformation spreads and how this and other factors influence public opinion could help inform public health messaging.

Original references: *Nat. Hum. Behav.* **7**, 1490–1501 (2023); *Science* **381**, 392–398 (2023); *Nature* **620**, 137–144 (2023)

NATURE MEDICINE

Year in review

Notable advances 2023

This year brought wins for artificial intelligence, genomics and gene editing, and breakthroughs in understanding diseases whose underpinnings have long eluded scientists. Here is our selection of critical developments that moved medicine forward in 2023.

Machine learning

Raising the bar for AI in cancer screening

Artificial intelligence (AI) algorithms applied to mammography images could potentially aid breast cancer diagnosis, but until recently, this had only been evaluated retrospectively. August saw the first data (a pre-specified safety analysis) from an ongoing randomized, controlled study evaluating AI-supported mammography screening versus standard double reading by two radiologists. The cancer-detection rate and false-positive rate were similar between the two groups, and the AI-supported approach reduced radiologists' workload by almost half. This prospective study suggests that AI-supported mammography screening is safe – which will pave the way for additional planned outcomes of this trial (including interval cancer rate), as well as further studies to evaluate the long-term impact on patient outcomes.

Original reference: *Lancet* **24**, 936–944 (2023)

Genomics

Diversifying the 'reference' genome

The first draft of the human genome, created over 20 years ago, was a turning point in human genetics, but each version was based on the DNA of a single person or a very small number of people. In May, the Human Pangenome Reference Consortium completed the mammoth task of compiling the first human 'pangenome' reference – which combines diploid assemblies of 47 diverse people into a single resource, with plans to extend this to 350 people. In parallel, the Telomere-to-Telomere Consortium harnessed advances in sequencing technology to fully sequence the human Y chromosome – previously incomplete owing to its challenging repetitive structure. This allowed them to assemble Y chromosome sequences from 43 diverse people from the 1000 Genomes Project, to provide information on the extent of genetic variation. These new, increasingly diverse reference assemblies have the potential to improve clinical genetics research and are now available for use by investigators.

Original references: *Nature* **617**, 312–324 (2023); *Nature* **621**, 344–354 (2023); *Nature* **621**, 355–364 (2023)

Nutrition

WHO cautions against non-sugar sweeteners

Non-sugar sweeteners are widely used globally to help reduce sugar intake without compromising the flavor of foods and beverages. Recently, however, studies have shown associations between non-sugar sweeteners and negative clinical outcomes – such as increased cardiovascular risk. The World Health Organization carried out a systematic review of available data to generate evidence-informed guidance for policymakers, health professionals and other stakeholders. The guidance states that non-sugar sweeteners should not be used for weight control or to reduce the risk of noncommunicable diseases, and it applies to everyone except those with diabetes. Given that some associations are weak, and outcomes may differ according to usage patterns and population characteristics, the guideline is conditional – and will be re-evaluated as further evidence emerges.

Original references: *World Health Organization* (2023); *Nat. Med.* **29**, 539–540 (2023)

Gene editing

Base editors in the clinic

Base editing enables the precise introduction of single-nucleotide changes into DNA and – unlike nuclease-based CRISPR–Cas systems – it does so without creating double-stranded DNA breaks. This latest advance in gene editing has already reached clinical development, and this year saw promising results from a phase 1 study in which base-edited 'off-the-shelf' CAR T cells were used to treat three children with refractory T cell acute lymphoblastic leukemia. Although one patient died from infection-related complications (a known risk of CAR T cell treatment protocols), potent anti-leukemic effects were observed in all three patients. This ongoing study and others will further evaluate the safety and efficacy of the approach. Meanwhile, at the time of this writing, the UK medicines regulator has granted the first approval of a CRISPR-based therapy (exagamglogene autotemcel, for sickle-cell disease and β-thalassemia), with other regulators expected to follow suit – which makes 2023 a big year for therapeutic gene editing.



CREDIT: YON MARSH / ALAMY STOCK PHOTO

Original reference: *N. Engl. J. Med.* **389**, 899–910 (2023); *GOV.UK* (2023)

Society

Misinformation, mistrust and science

Widespread misinformation and public mistrust in science are interconnected phenomena that pose a substantial threat to public health; understanding these processes is therefore an urgent and complex endeavor. Social media has been touted as a contributor to the spread of misinformation and polarizing ideas, both within and outside the health sector. A recent study of Facebook users in the USA found high levels of ideological segregation in terms of exposure to political news, but found that 'echo chambers' – whereby users are exposed mostly to like-minded sources – were not politically polarizing. In the context of scientific ideologies, a recent study showed that people with intermediate levels of scientific knowledge had the highest levels of overconfidence and the most negative attitudes toward science. Further research to elucidate how misinformation spreads and how this and other factors influence public opinion could help inform public health messaging.

Original references: *Nat. Hum. Behav.* **7**, 1490–1501 (2023); *Science* **381**, 392–398 (2023); *Nature* **620**, 137–144 (2023)

Opportunities for AI in Mammography

- Improving accuracy and decrease variability of interpretations:
  - Variability in interpretation accuracy with different years of experience, geographic differences, gender, sub-specialization
  - False negative and false positive rates
- Improve efficiency:
  - To serve as a 2nd reader in Europe
  - Decrease interpretation time
- Standalone AI
  - Complex in the US
  - Enormous opportunity in emerging countries
- Decrease Interval Cancers
- Risk assessment– “Precision Screening”
  - Harness enormous genomic/proteomic data available in mammograms for individualized risk assessment
  - Short term and long term individual risk profile

MASAI TRIAL:

Randomized Controlled Trial > Lancet Oncol. 2023 Aug;24(8):936-944.
doi: 10.1016/S1470-2045(23)00298-X.

Artificial intelligence-supported screen reading versus standard double reading in the Mammography Screening with Artificial Intelligence trial (MASAI): a clinical safety analysis of a randomised, controlled, non-inferiority, single-blinded, screening accuracy study

Kristina Lång [1], Viktoria Josefsson [2], Anna-Maria Larsson [3], Stefan Larsson [4], Charlotte Högberg [4], Hanna Sartor [2], Solveig Hofvind [5], Ingvar Andersson [2], Aldana Rosso [6]

MASAI trial was the first randomized controlled trial to investigate the use of AI in breast cancer screening

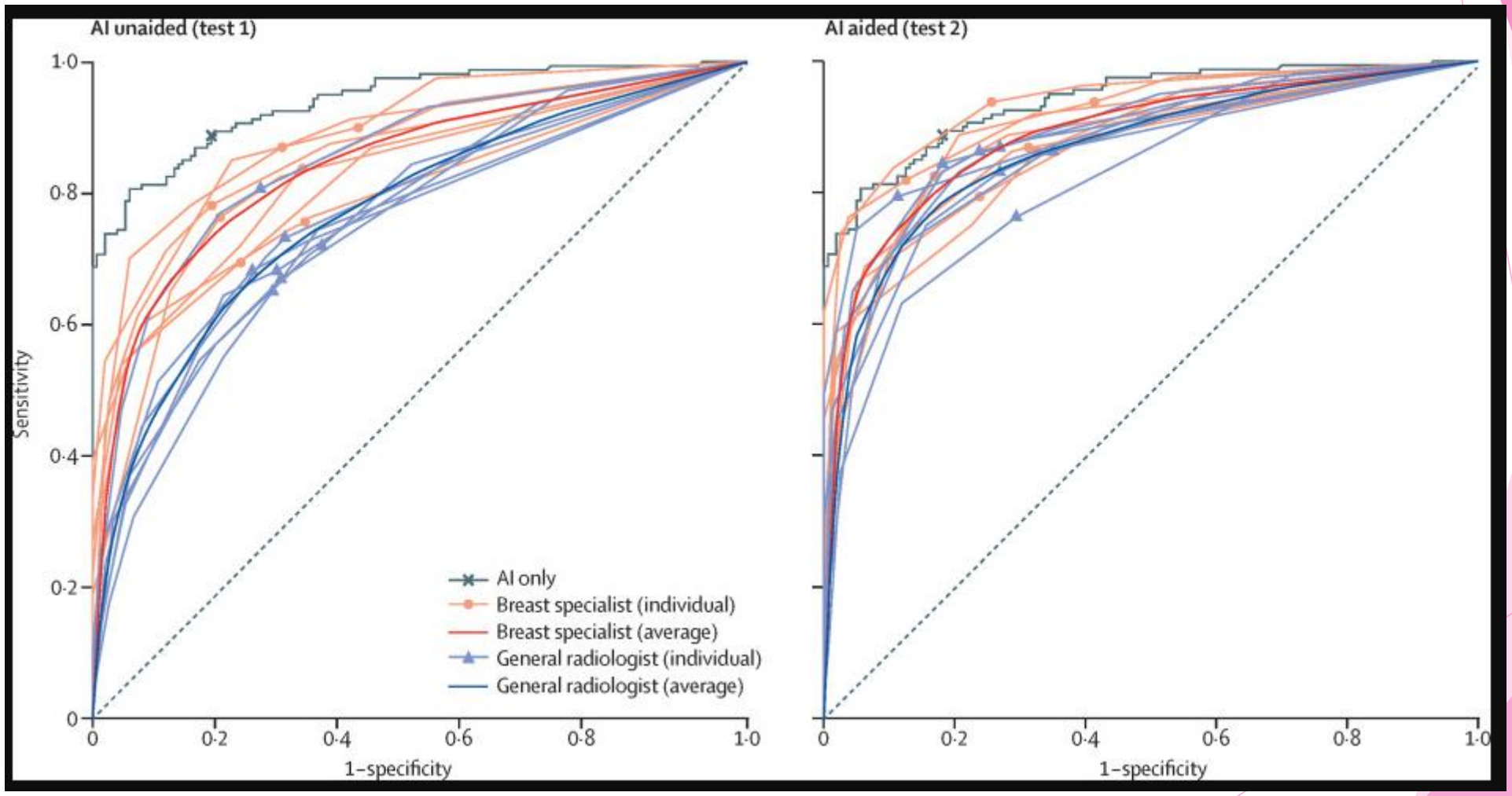
- A total of 105,934 women were enrolled, with 53,043 in the AI-supported group and 52,872 in the control group.
- 6.4 per 1000 participants vs 5.0 per 1000
- 29% increase in detection.
- higher detection of invasive cancers (270 vs. 217)
- in situ cancers (68 vs. 45)
- small, lymph-node negative cancers.
- Recall rates were similar between groups, with a non-significant increase in the AI group (2.1% vs. 1.9%).
- The positive predictive value of recall was significantly higher in the AI group (30.5% vs. 25.5%).
- 44.2% reduction in workload

Change in Sensitivity (DBT): Breast Specialists and General Radiologists

Performance Measure		Without AI (95% CI)	With AI (95% CI)	Difference	95% CI
Sensitivity	Breast Subspecialists	81.7% (74.1%, 89.3%)	85.9% (79.8%, 92.1%)	+4.2%	(-1.0%, 9.4%)
	General Radiologists	71.5% (59.7%, 83.2%)	84.0% (76.0%, 92.0%)	+12.5%	(4.7%, 20.4%)

Conant et al. doi: 10.1148/ryai.2019180096

Impact of AI on interpretation of Breast Specialist and General Radiologist



McKinney, S.M., Sieniek, M., Godbole, V. *et al*. https://doi.org/10.1038/s41586-019-1799-6

Artificial Intelligence in Mammography: Can it level the playing field in Breast Cancer Disparities

- What about other diseases?
- Opportunistic screening

Cardiovascular Disease

- **1 in 3 female deaths globally**—approximately **8.5 million women every year** (WHO)
- **Heart disease is the leading cause of death among women in the US**
  - **20% of all female deaths**
- Many women underestimate their risk—more women die from heart disease than from all forms of cancer combined
- Vascular calcifications on mammograms strong cardiovascular biomarker

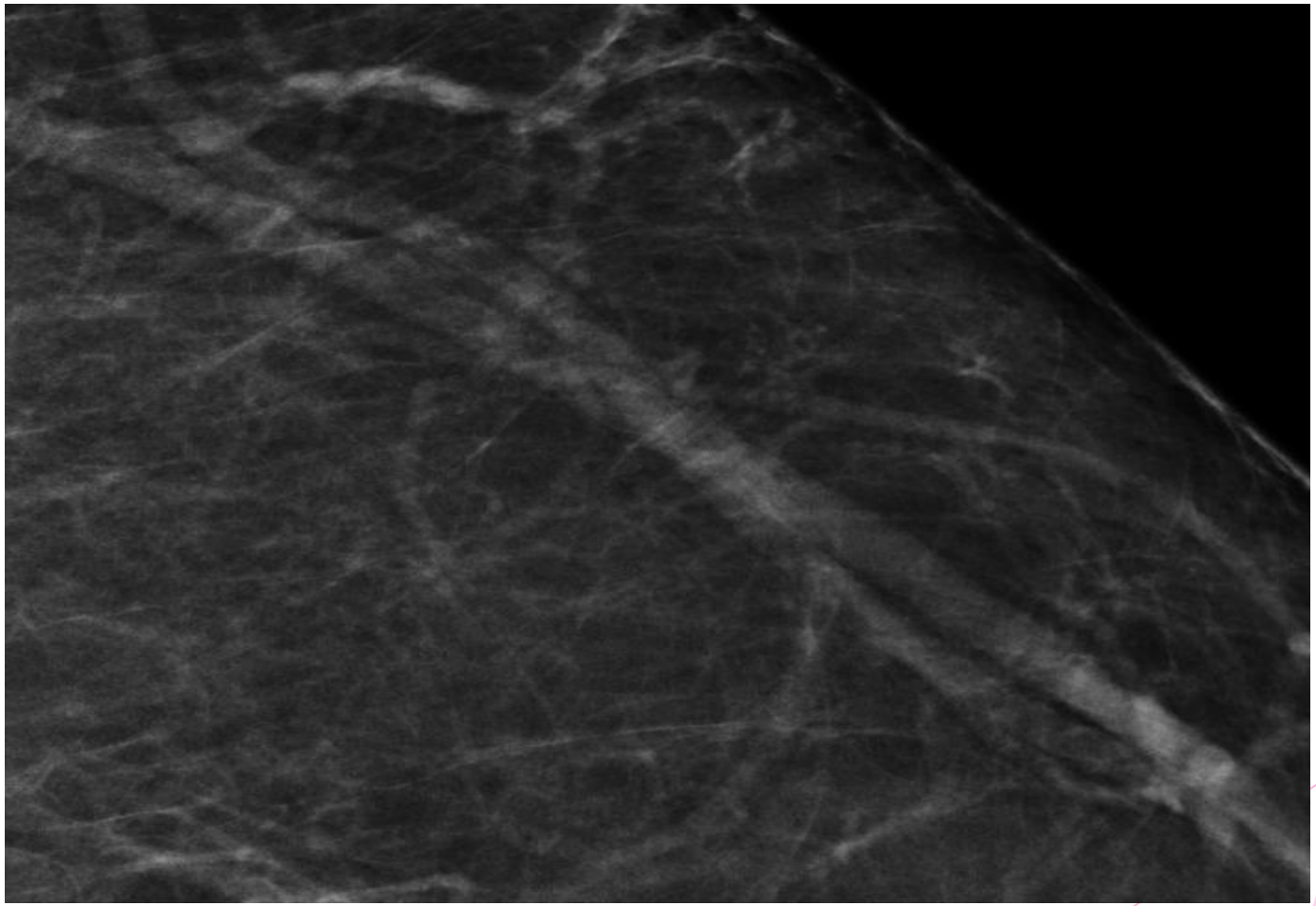
Early Detection of CVD Disease

- If CVD is detected prior to symptoms, major adverse events can be prevented
  - Statin
  - Lifestyle changes
  - CAC CT
  - GLP-1

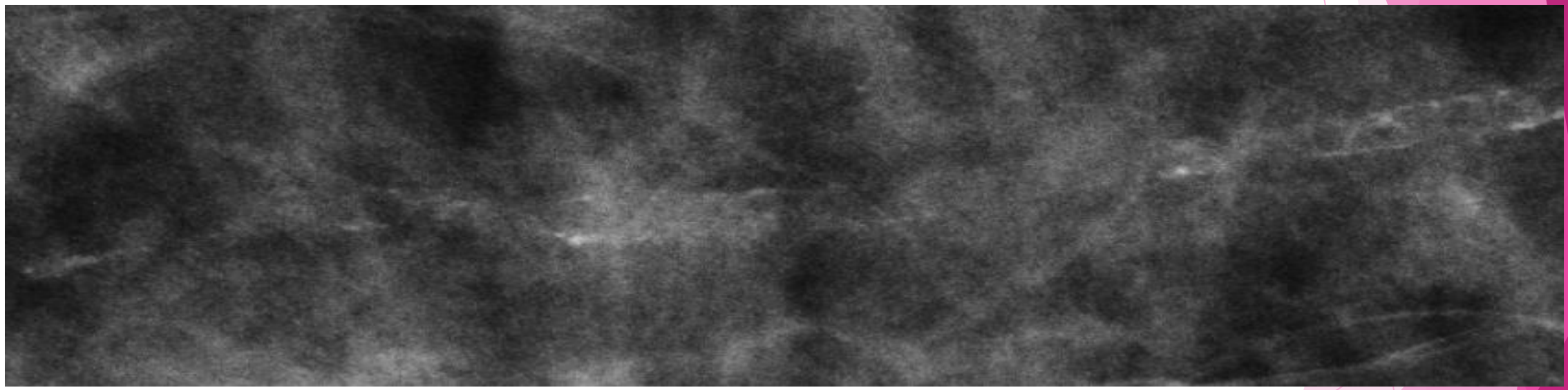
BAC Classic Appearance: Easy For Breast Radiologists to Recognize on Mammograms

- Historically, the vessels have NOT been reported on mammography.
- But we can see breast arterial calcifications very well and very quickly on mammography.

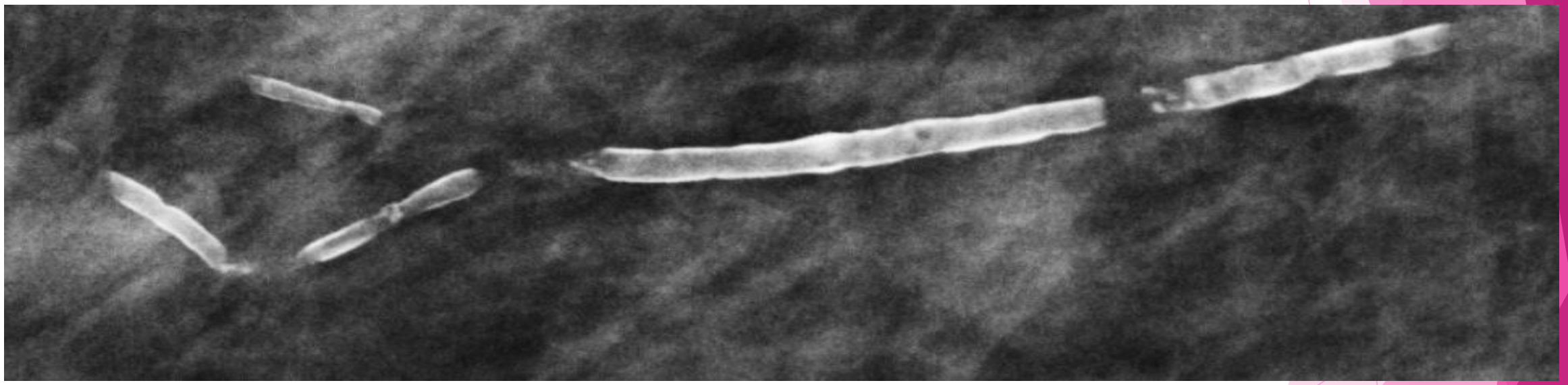
Normal with no vascular calcification:48 year old



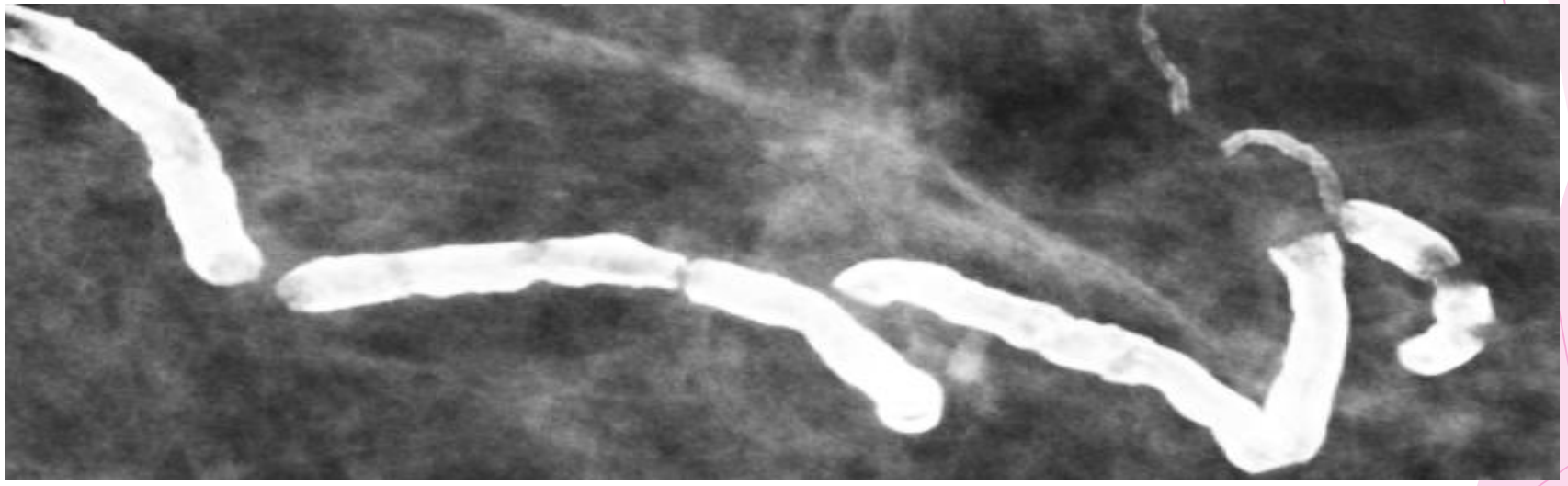
Mild vascular calcification in a 58 year old



Moderate Vascular Calcification in a 54 year old



Dense breast calcification in a 61 year old



Results: Additional adverse outcomes in women with BAC

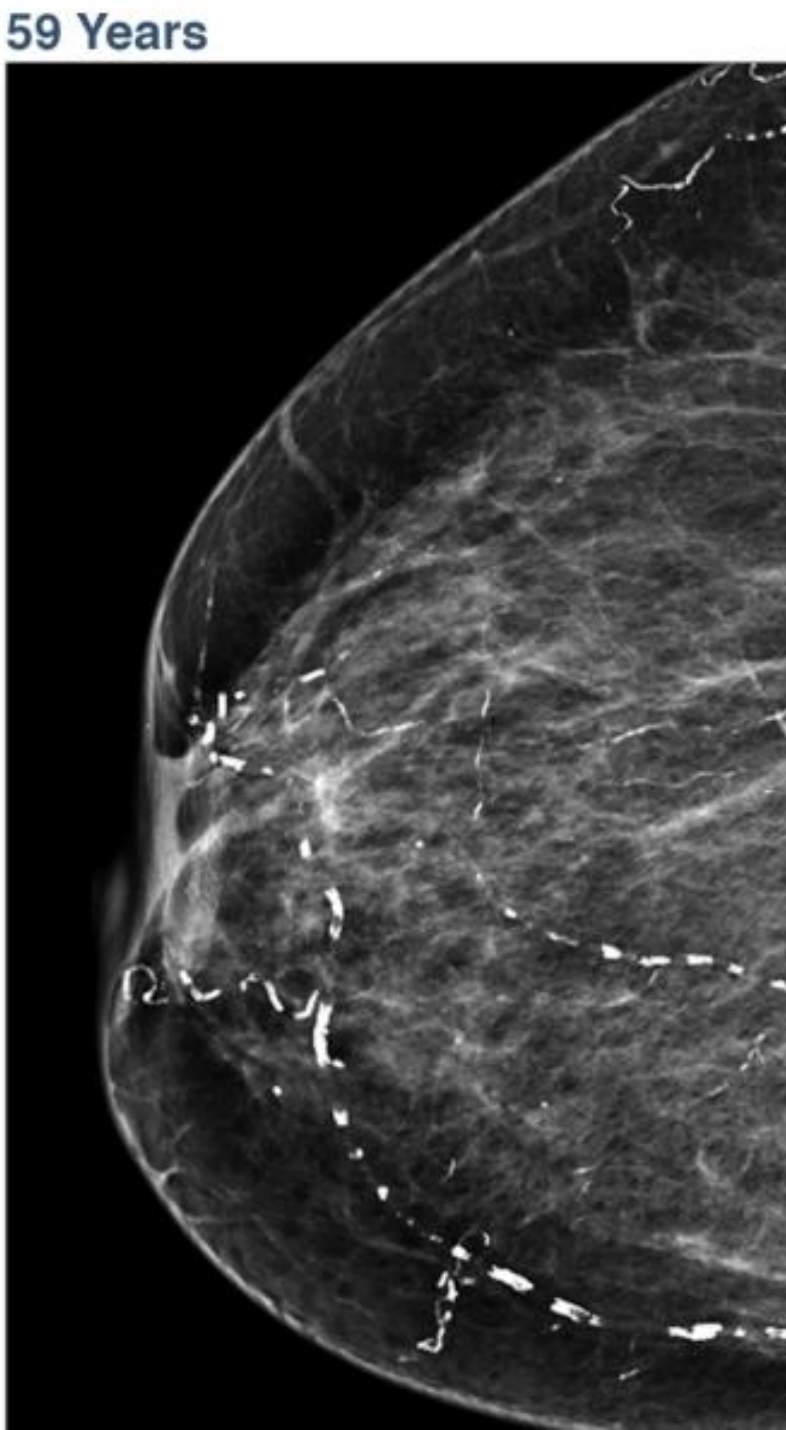
Clinical Outcomes	Total (n = 18,092)	BAC Present (n = 4,223)	BAC Absent (n = 13,869)	p-value
Myocardial infarction, No. (%)	83 (0.5)	36 (0.9)	47 (0.3)	<0.001
Heart failure, No. (%)	298 (1.7)	154 (3.7)	144 (1.0)	<0.001
Stroke, No. (%)	259 (1.4)	110 (2.6)	149 (1.1)	<0.001
All-cause mortality, No. (%)	642 (3.6)	329 (7.8)	313 (2.3)	<0.001
Composite Outcome*, No. (%)	1,082 (6.0)	500 (11.8)	582 (4.2)	<0.001

*Composite outcome = myocardial infarction, heart failure, stroke, and all-cause mortality.

RSNA® 2022
NOVEMBER 27–DECEMBER 1




55 Years


59 Years

Breast Arterial Calcifications

- Present in 12-23% of all screening mammograms
- Associated
  - Diabetes
  - CAC
  - CAD
  - PVD
  - CVA
  - CV mortality

Media interest turns into legislative interest after the speaker watches TV!















Legislative History

Bill was introduced in February 2026 by a bi-partisan group of House Delegates

Passed both the Maryland House and Senate UNANIMOUSLY.

Some Maryland radiologists thought bill was inappropriate

- same as some radiologists in Connecticut when the first breast density bill was passed


HB 1364
May 26, 2026

HOUSE BILL 1364 “THIS NOTICE CONTAINS THE RESULTS OF YOUR RECENT MAMMOGRAM, INCLUDING INFORMATION ABOUT BREAST ARTERIAL CALCIFICATION.

IF YOUR MAMMOGRAM SHOWS BREAST ARTERIAL CALCIFICATION, YOU SHOULD KNOW THAT BREAST ARTERIAL CALCIFICATION IS A COMMON FINDING.

HOWEVER, BREAST ARTERIAL CALCIFICATION MAY BE AN INDICATOR OF AN INCREASED RISK OF CARDIOVASCULAR DISEASE.

IF YOU HAVE BREAST ARTERIAL CALCIFICATIONS, PLEASE DISCUSS THIS WITH YOUR PHYSICIAN TO ASSESS YOUR CARDIOVASCULAR RISKS AND DETERMINE IF ADDITIONAL TESTING MAY BE APPROPRIATE FOR YOU.

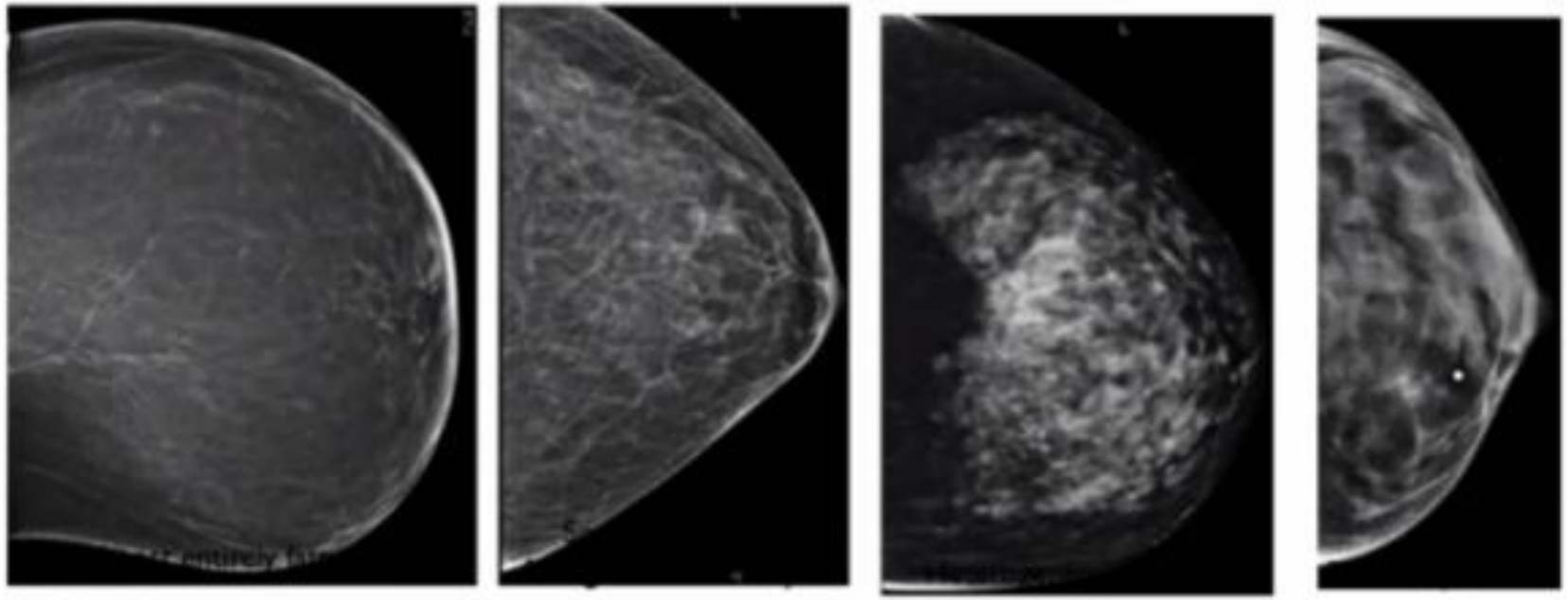
2026 Regular Session - House Bill 1364 Third Reader

Not all mammograms are equally effective in all women

- Sensitivity of mammography: 85%
- Sensitivity of mammography in women with dense breasts :40-50%

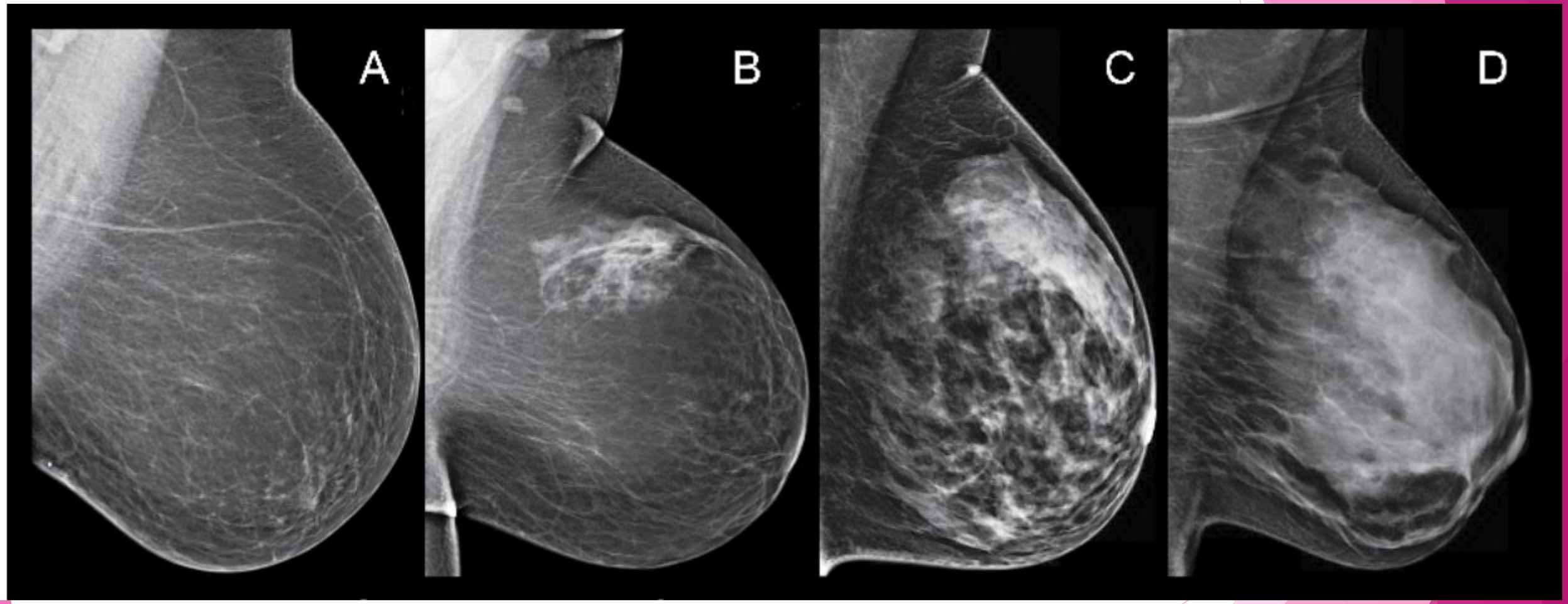
Breast Density

-Dense breasts are defined as those having heterogeneously dense or extremely dense breast composition as defined by the ACR BI-RADS Atlas Fifth Edition
-Approximately 50% of the female population over the age of 40 have dense breasts

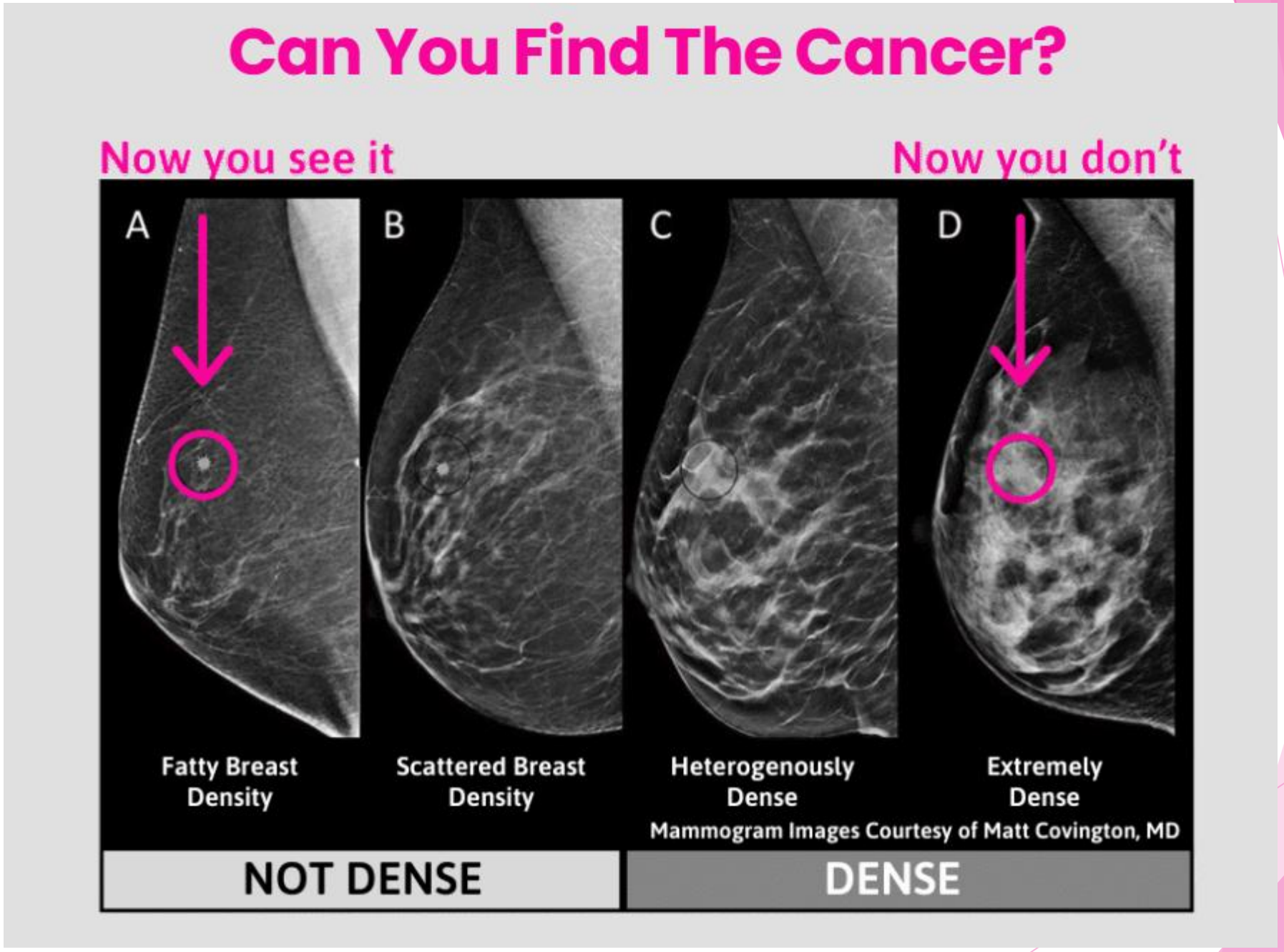


9% of population | 44% | 38% | 9%

NOT DENSE → DENSE



70% of women in their 40’s have dense tissue:
30% of women in their 70’s have dense tissue



My Density Matters

Breast Density

- The ONLY currently accepted way to determine breast density is mammography
- PHYSICAL EXAMINATION CANNOT DETERMINE BREAST DENSITY

Breast Density

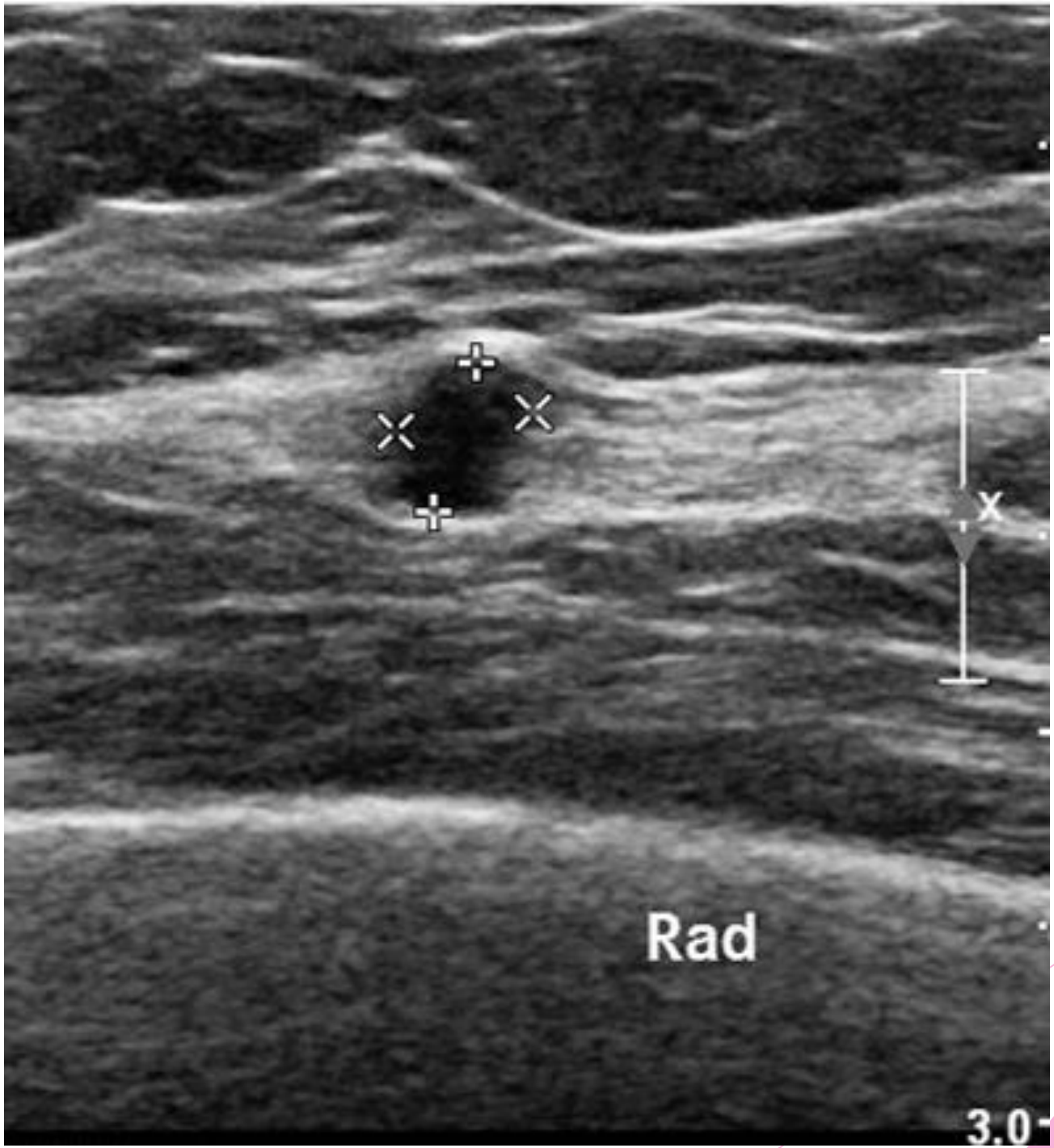
- Masking effect of Cancer
- Independent risk factor for developing breast cancer
  - 2-4 fold increased risk

Mammography, Breast Cancer and Breast Density

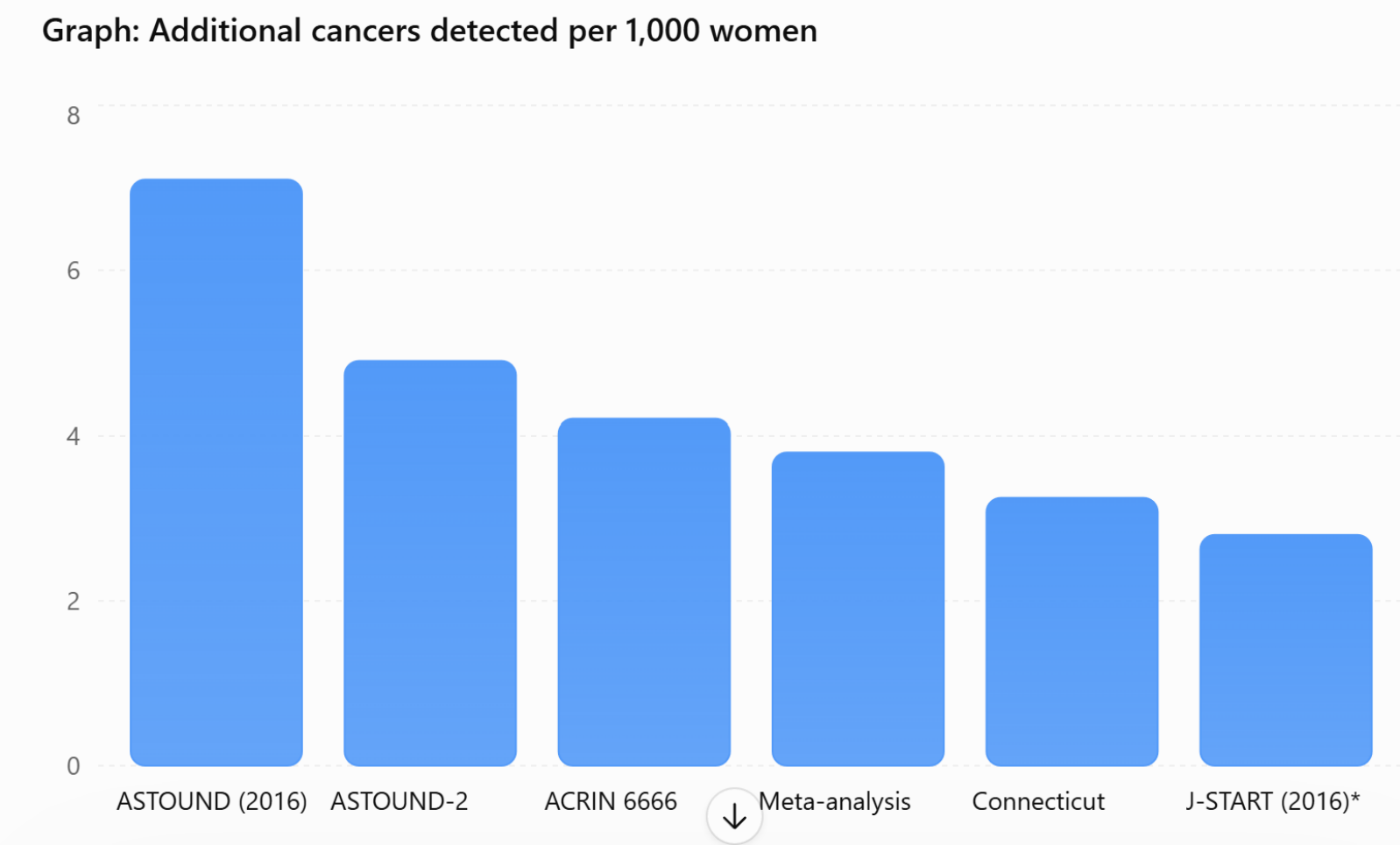
- Up to 60% of breast cancers are “masked” in women with dense breast tissue
- 50% of women have dense breast tissue
- 4-6 fold increased risk of breast cancer
- As you age, the density decreases, and as the incidence of breast cancer increases in younger women, finding these cancers in mammograms are harder

How Do We Find the “Masked” Cancers in women with dense breast tissue

- Ultrasound
- MRI
- Contrast Enhanced Mammography
- MBI


Rad
3.0

- **Supplemental Ultrasound Screening in Women With Dense Breasts**
- **Supplemental screening ultrasound detects approximately 2–5 additional breast cancers per 1,000 women screened**, with higher yields in some prospective studies.
- A 2018 meta-analysis of 29 studies found that supplemental ultrasound identified approximately **40% more cancers than mammography alone**,
  - equivalent to 3.8 additional cancers per 1,000 mammography-negative women.


Graph: Additional cancers detected per 1,000 women
8
6
4
2
0
ASTOUND (2016)
ASTOUND-2
ACRIN 6666
Meta-analysis
Connecticut
J-START (2016)*

Automated Breast US

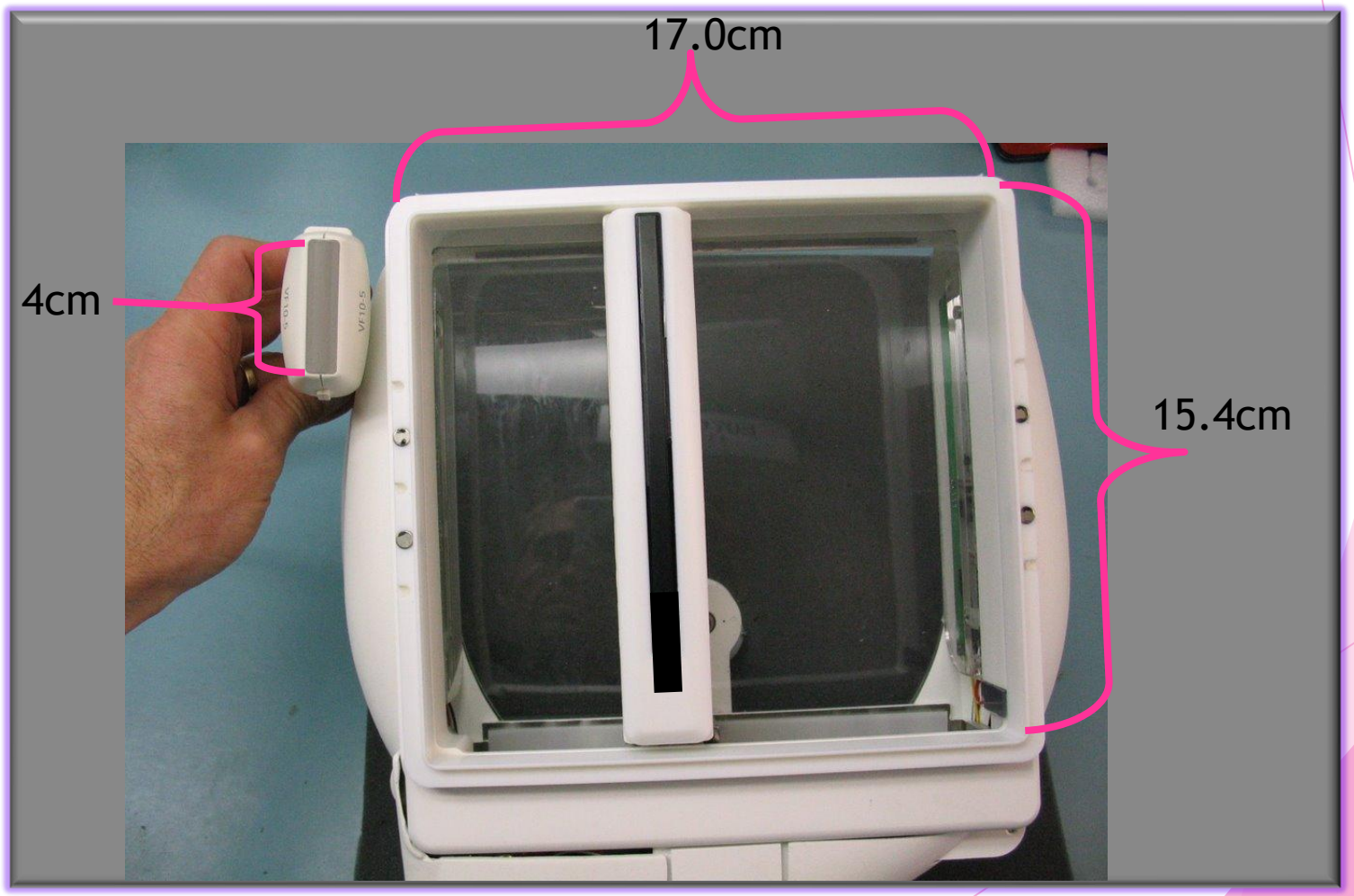
- Consistency
- Reproducibility
- Alleviates operator dependence
- Assures inclusion of entire breast

Automated Breast Ultrasound System (ABUS-GE)





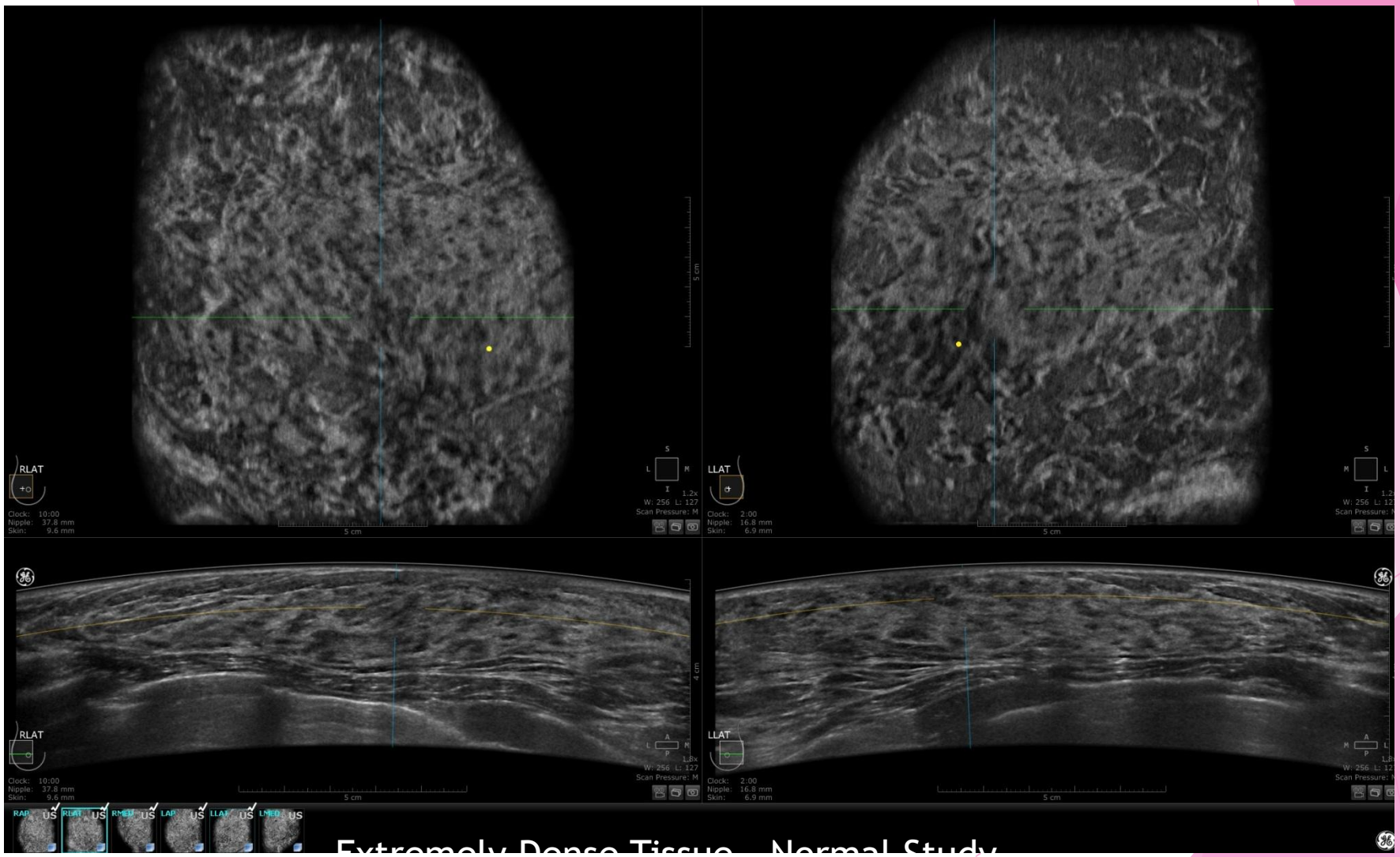
Automated Breast Ultrasound System



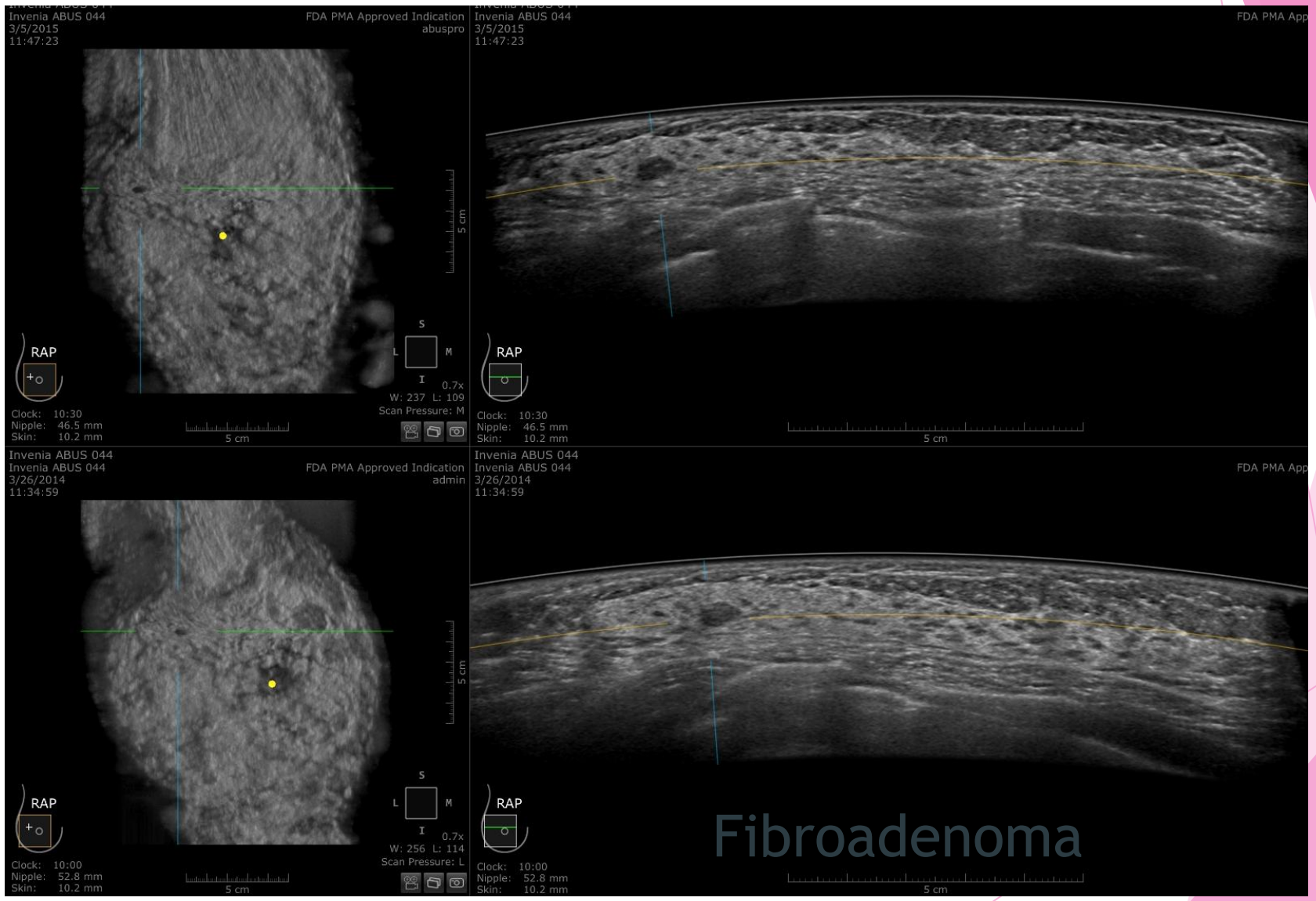
Automated Breast Ultrasound(ABUS)

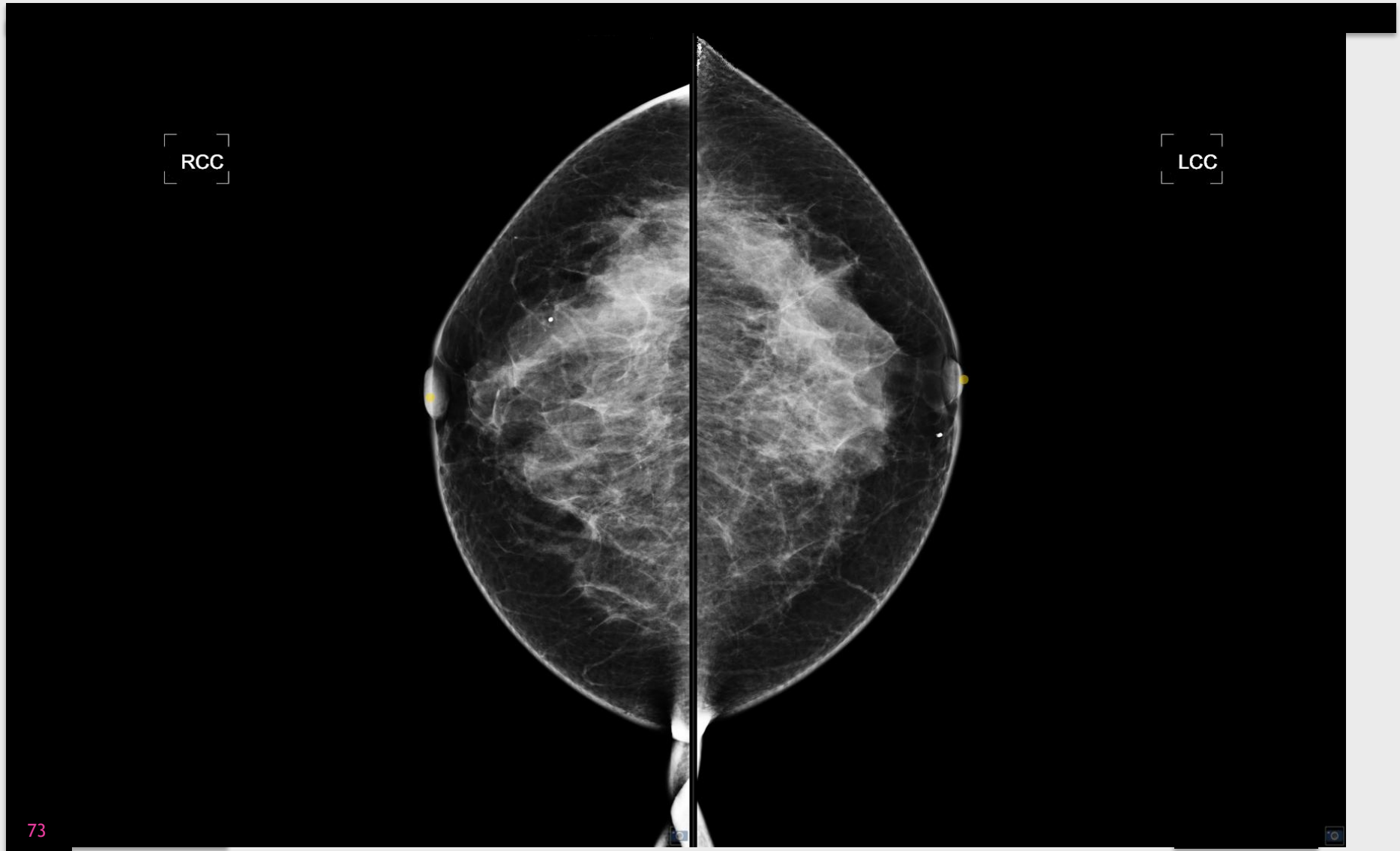
- Images the entirety of the breast in the transverse plane
- Reconstructed in the coronal plane
  - Optimize visualization of lesions

Normal Dense Breast Tissue

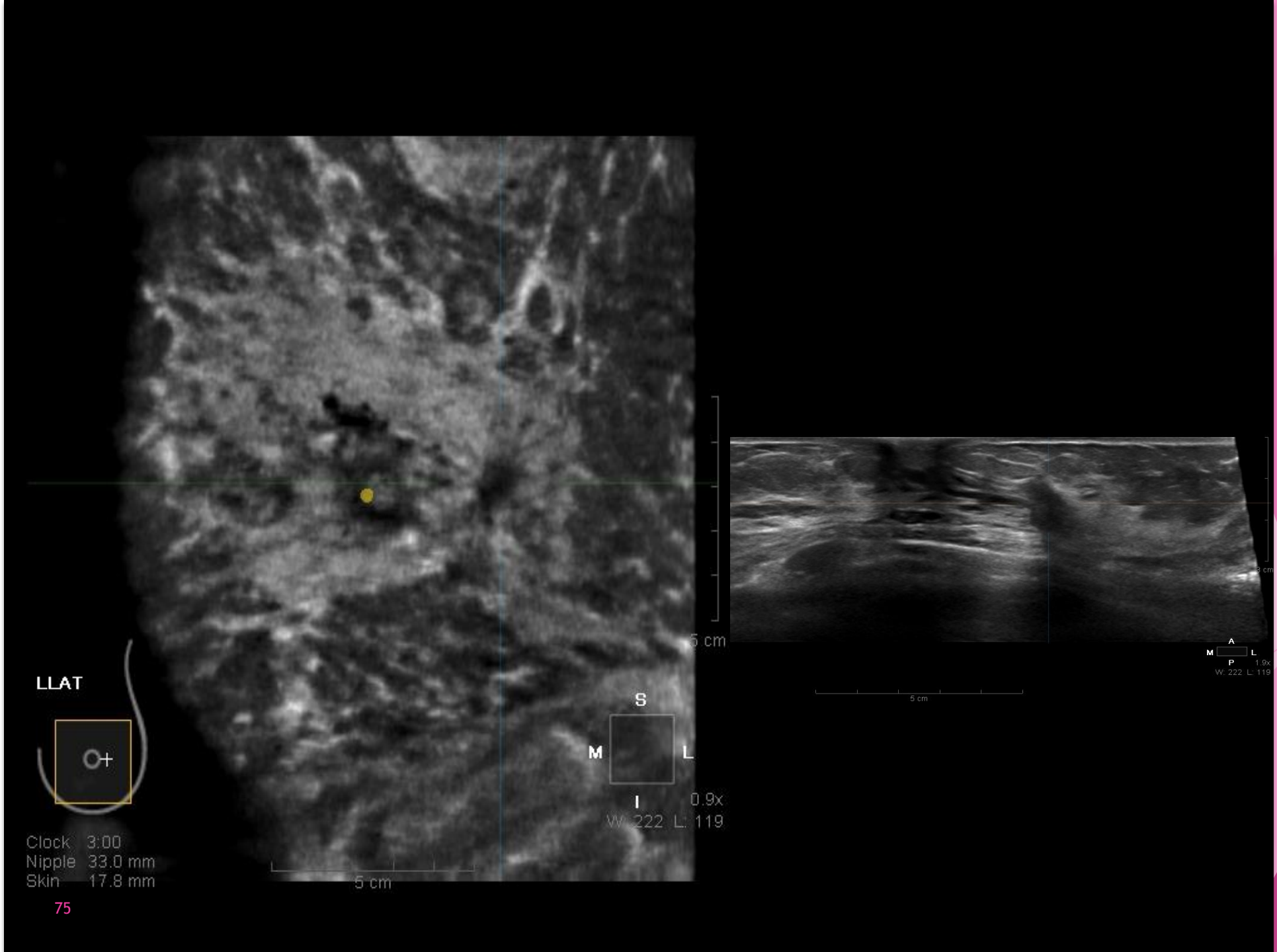


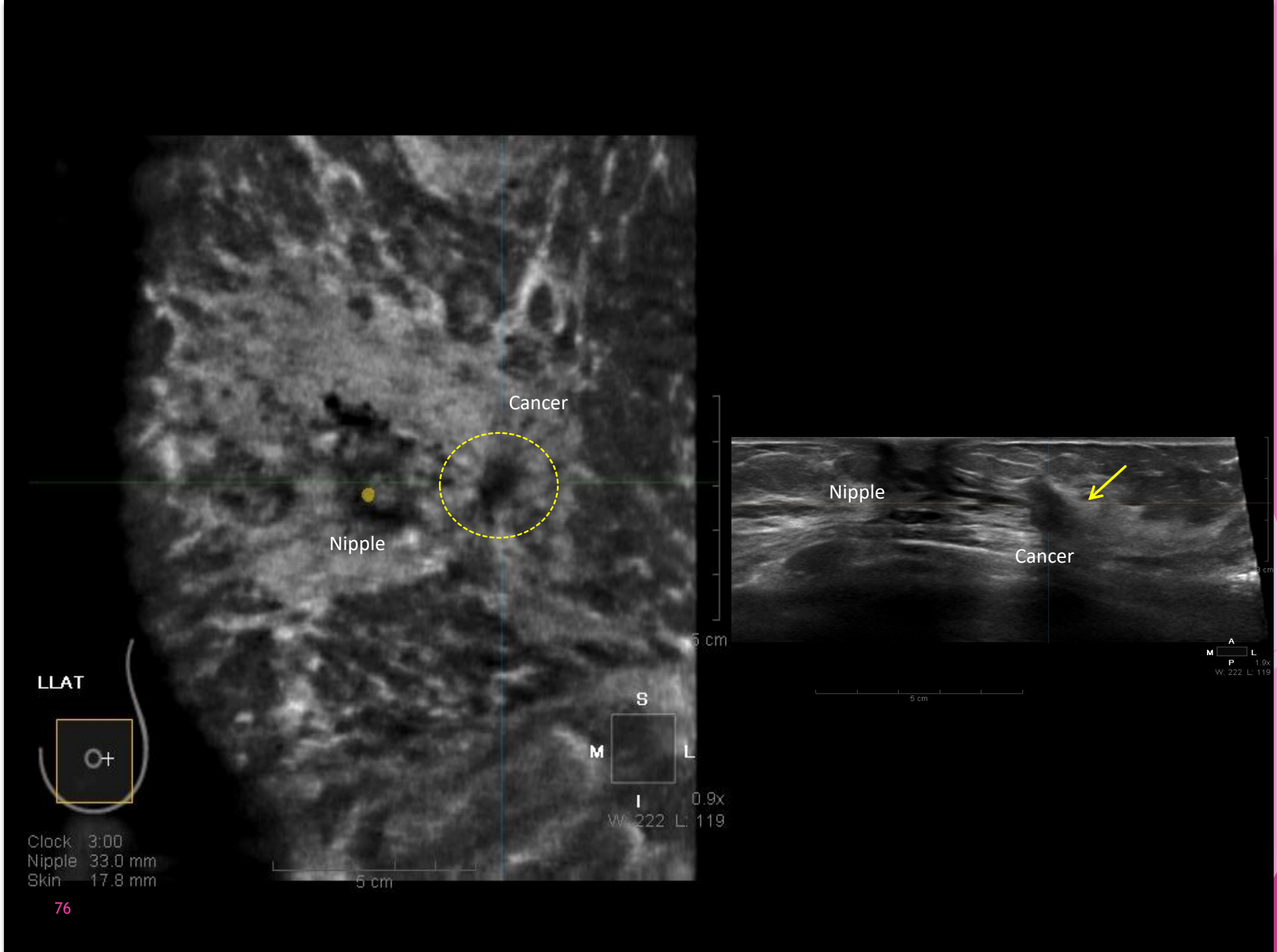
Benign Findings




RCC
LCC


RMLO
LMLO


LLAT
Clock 3:00
Nipple 33.0 mm
Skin 17.8 mm
5 cm
S
M
L
I
0.9x
W: 222 L: 119
5 cm
A
M
L
P
1.9x
W: 222 L: 119
5 cm


Cancer
Nipple
5 cm
LLAT
S
M
L
I
0.9x
W: 222 L: 119
Clock 3:00
Nipple 33.0 mm
Skin 17.8 mm
5 cm
Nipple
Cancer
A
M
L
P
1.9x
W: 222 L: 119
5 cm

Breast Cancer Screening with MRI

- ACS recommends annual screening mammography in women with a 20% lifetime risk of breast cancer or greater
- **Highest Sensitivity:** MRI is the most sensitive screening test for breast cancer

- Women with a **known BRCA1 or BRCA2 mutation** or other hereditary gene mutations associated with a high risk of breast cancer
- Women with a **history of prior chest radiation therapy** between ages 10-30.
- Women with **lifetime breast cancer risk ≥20%** based on risk assessment models (e.g., the Tyrer-Cuzick or Gail model).
- Women with **strong family histories** of breast cancer, especially in multiple close relatives, who haven't been diagnosed with cancer themselves

MRI Screening

- Personal history of breast cancer
- Aypia
  - Hartmann (NEJM): Younger and more sites the higher the risk
  - Up to 50% lifetime risk with detection under 50 and 3 or more sites

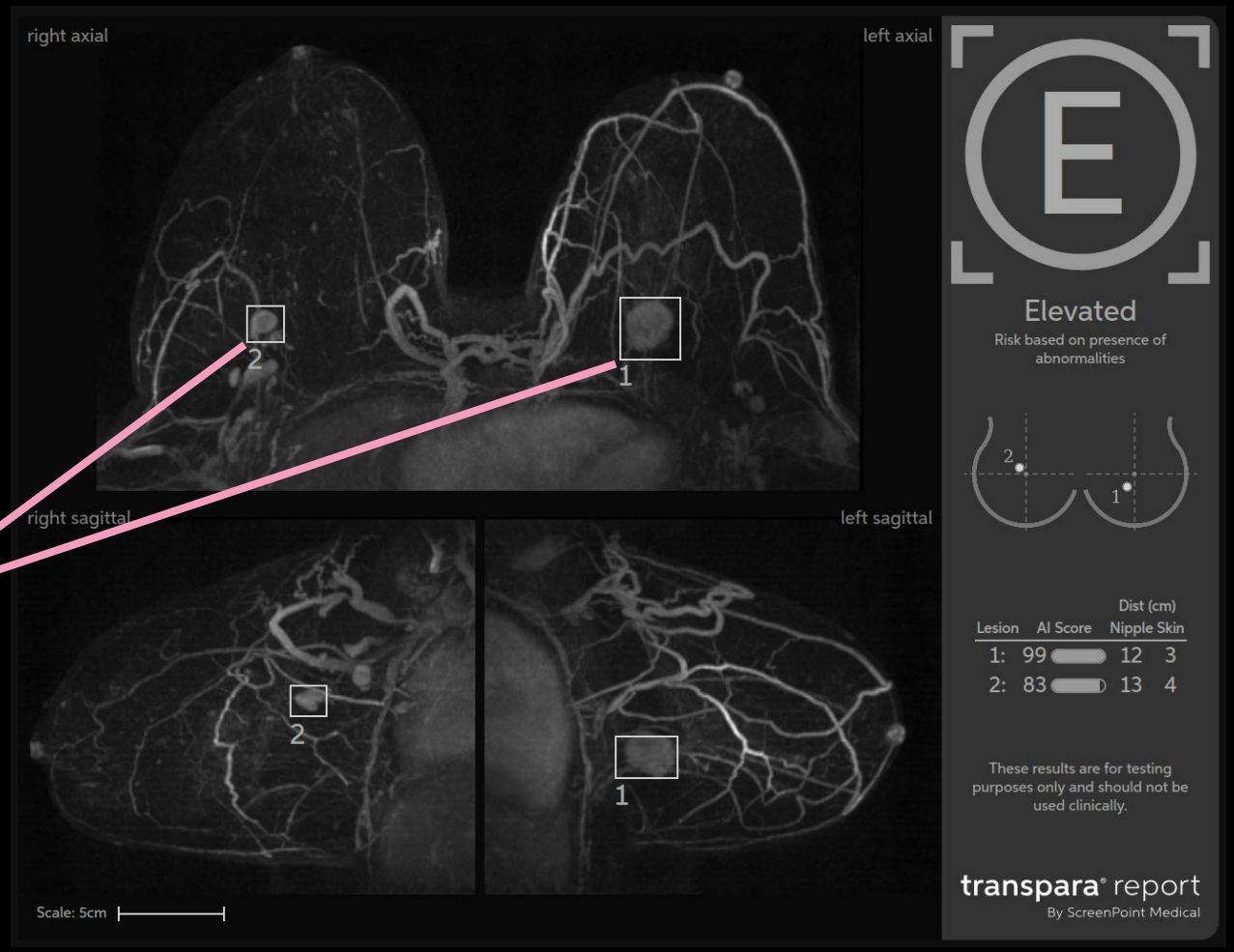
MRI Screening

- **Higher cancer detection rate:** MRI is more sensitive than mammography, especially in women with dense breasts, which can hide small cancers.
- **Earlier stage diagnosis:** Studies show that MRI screening shifts the diagnosis to an earlier stage of disease, meaning cancers are smaller and more easily treated.
- **Fewer interval cancers:** Supplemental MRI screening reduces the number of "interval cancers," which are cancers that develop between routine screening exams.
- **Improved survival rates:** Detecting cancer earlier is associated with better treatment outcomes and higher survival rates.

- **Detection of Occult Cancers:** MRI can reveal cancers not visible on other imaging tests, with studies showing an average of 10 to 16 additional cancers detected per thousand high-risk women screened.
- **Earlier Detection and Favorable Stage:** Cancers detected by MRI screening are often smaller (e.g., mean tumor size of 0.7 cm in one study) and more likely to be compared to those found by mammography alone.
- **Reduced Interval Cancers:** The use of annual MRI significantly reduces the incidence of "interval cancers" – aggressive cancers that appear between scheduled mammogram screenings.



Breast MRI AI Score Card



AI-detected lesions projected on motion-corrected MIPs

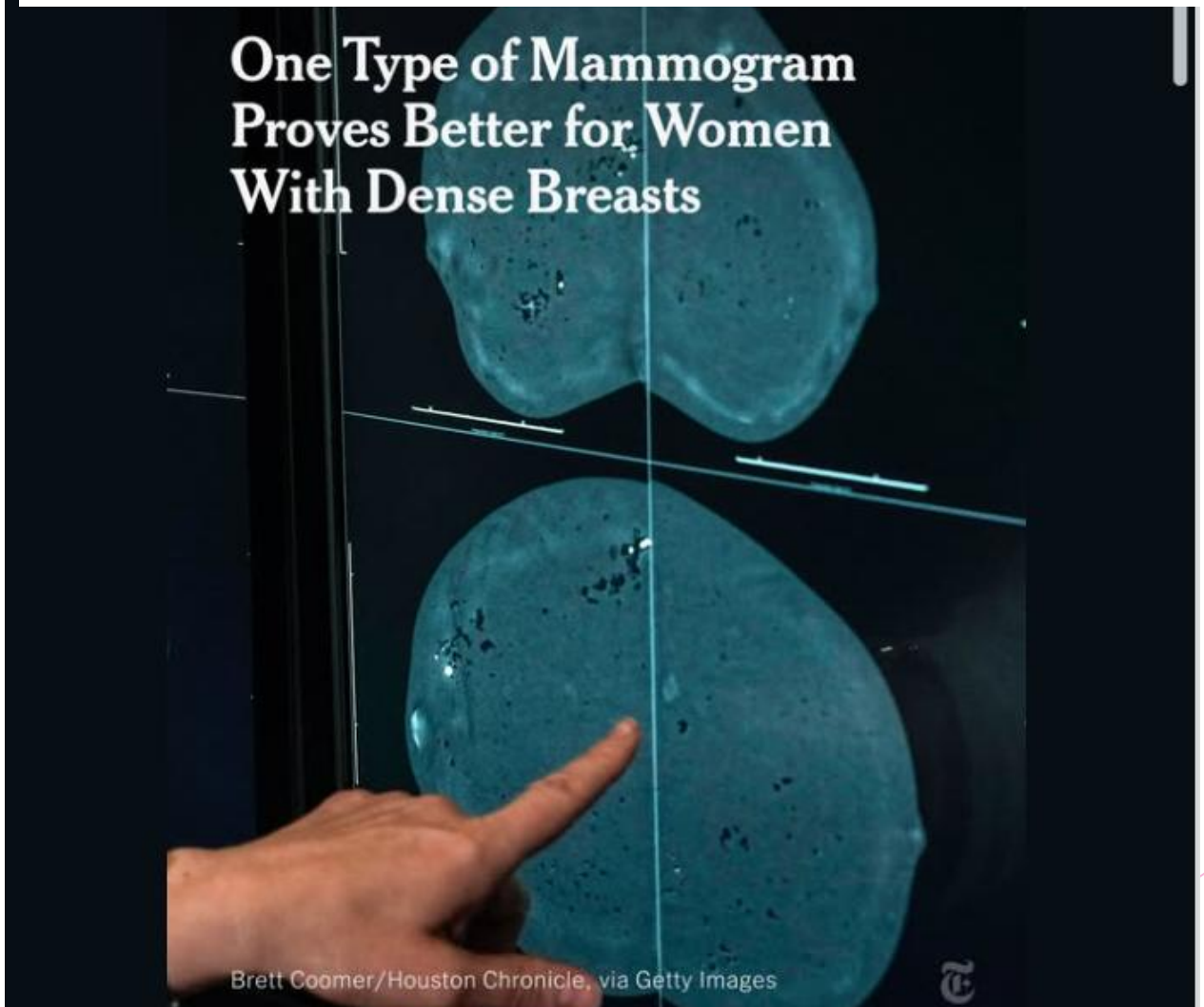
Exam score (Elevated, Intermediate, or Low risk)

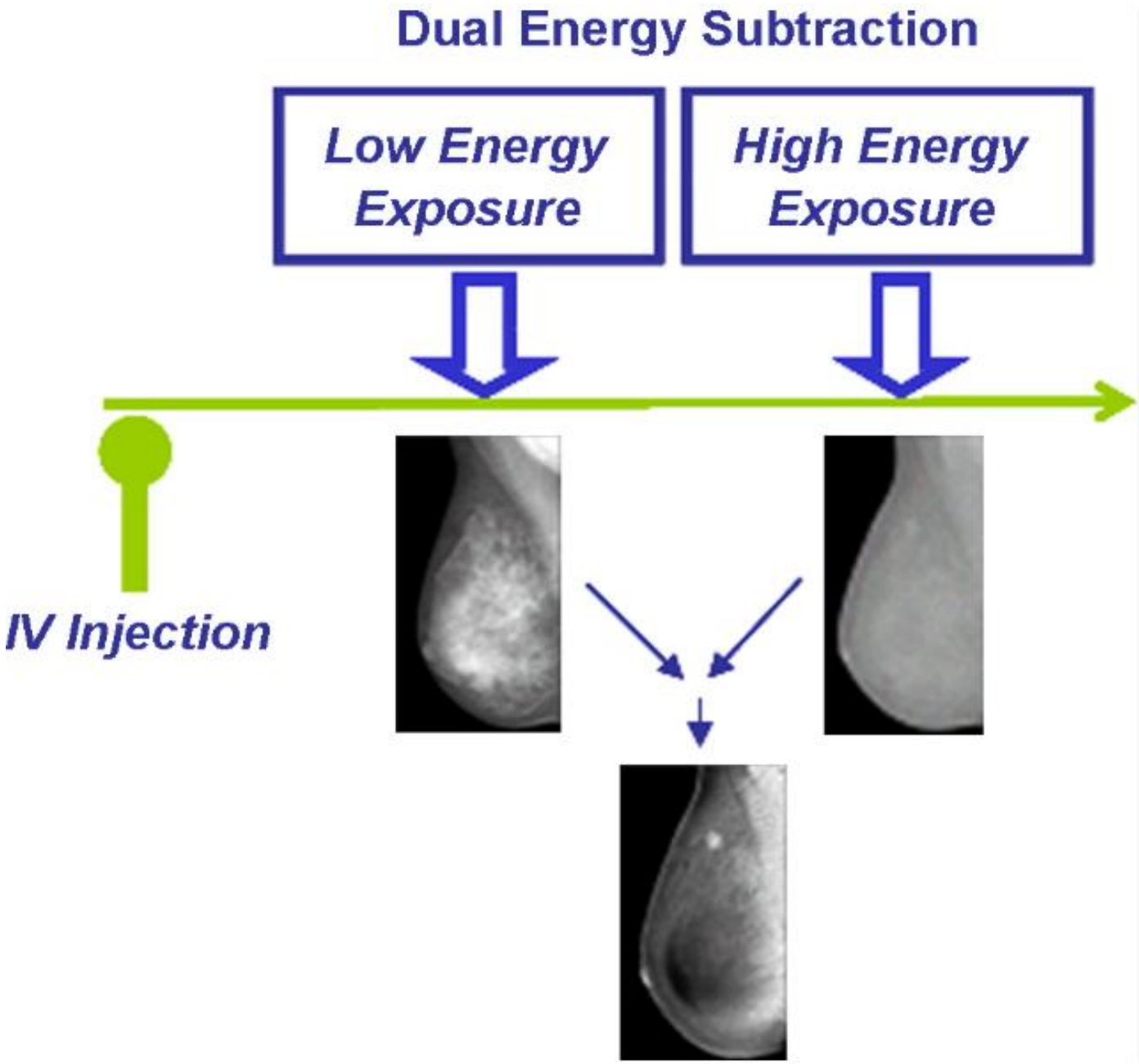
Coronal projection with breast quadrants

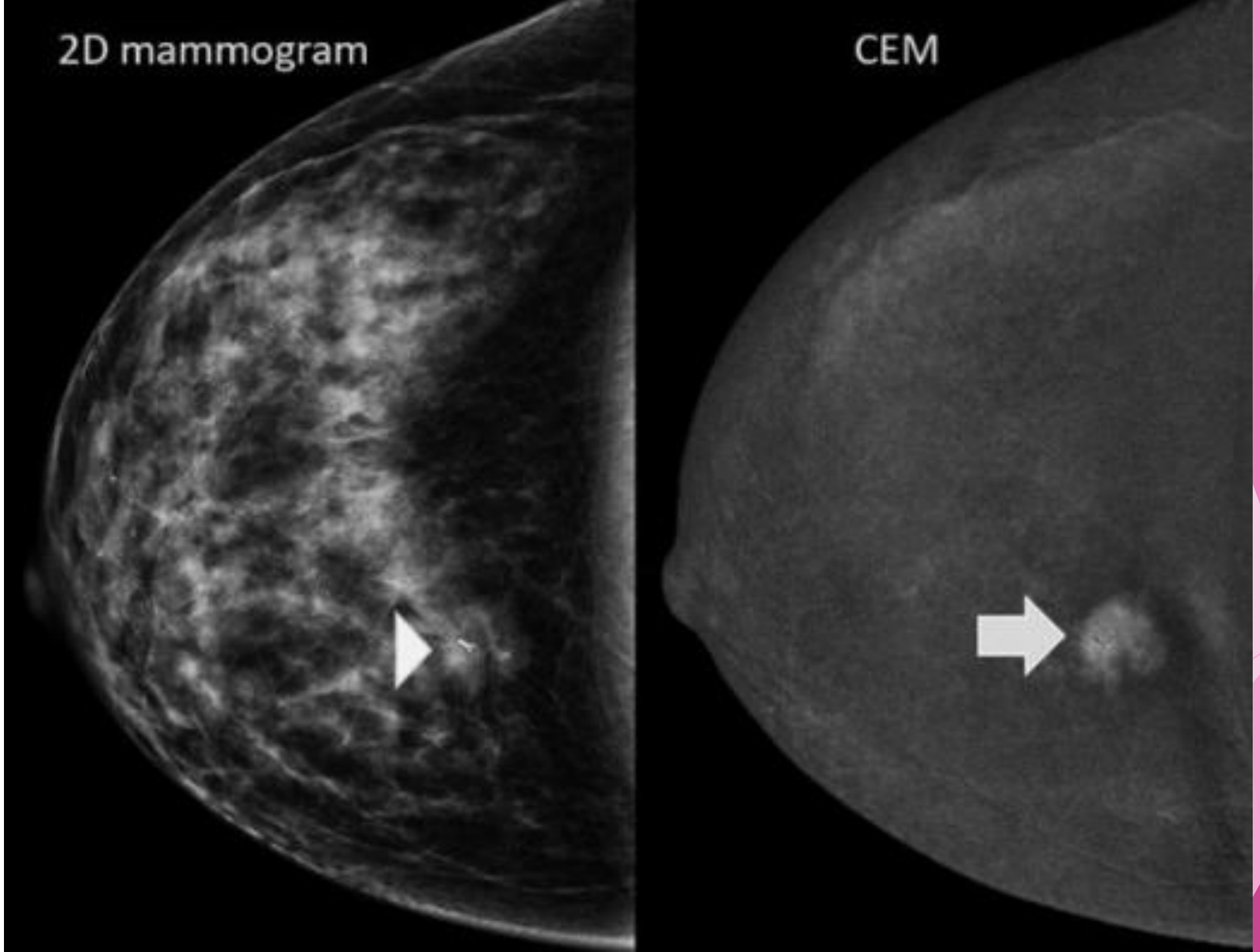
Table with AI scores and distances to nipple/skin

One Type of Mammogram Proves Better for Women With Dense Breasts

Contrast-enhanced mammography identified three times as many tumors as ultrasound scans. But it is not widely used for screening in the United States.

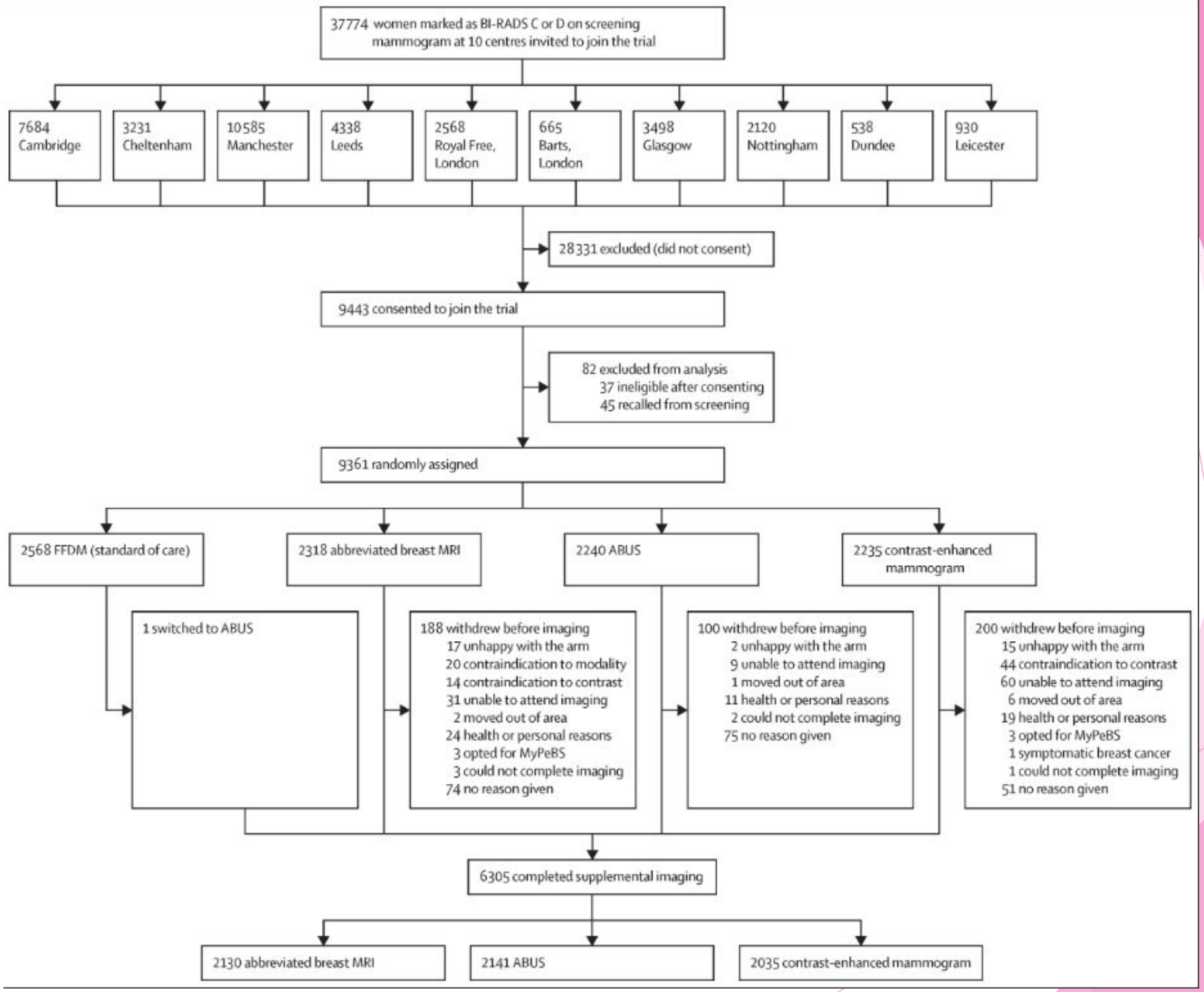



Dual Energy Subtraction
Low Energy Exposure
High Energy Exposure
IV Injection


2D mammogram
CEM

BRAID STUDY

- **Study Design:**
- **Randomized Controlled Trial:** Women aged 50-70 with dense breasts and negative mammograms were randomly assigned to abbreviated MRI, ABUS, contrast-enhanced mammography, or standard of care (full-field digital mammography).
- **Multi-Center:** Conducted at ten breast screening sites in the UK.
- **Intention-to-Treat Analysis:** Analysis was based on imaging received, treating each site as a study in the meta-analysis.
- **Primary Outcome:** Difference in cancer detection rate between arms, defined as the percentage of women with a positive supplemental imaging result leading to histologically confirmed breast cancer.


37774 women marked as BI-RADS C or D on screening mammogram at 10 centres invited to join the trial
7684 Cambridge
3231 Cheltenham
10585 Manchester
4338 Leeds
2568 Royal Free, London
665 Barts, London
3498 Glasgow
2120 Nottingham
538 Dundee
930 Leicester
28331 excluded (did not consent)
9443 consented to join the trial
82 excluded from analysis
37 ineligible after consenting
45 recalled from screening
9361 randomly assigned
2568 FFDM (standard of care)
2318 abbreviated breast MRI
2240 ABUS
2235 contrast-enhanced mammogram
1 switched to ABUS
188 withdrew before imaging
17 unhappy with the arm
20 contraindication to modality
14 contraindication to contrast
31 unable to attend imaging
2 moved out of area
24 health or personal reasons
3 opted for MyPeBS
3 could not complete imaging
74 no reason given
100 withdrew before imaging
2 unhappy with the arm
9 unable to attend imaging
1 moved out of area
11 health or personal reasons
2 could not complete imaging
75 no reason given
200 withdrew before imaging
15 unhappy with the arm
44 contraindication to contrast
60 unable to attend imaging
6 moved out of area
19 health or personal reasons
3 opted for MyPeBS
1 symptomatic breast cancer
1 could not complete imaging
51 no reason given
6305 completed supplemental imaging
2130 abbreviated breast MRI
2141 ABUS
2035 contrast-enhanced mammogram

- **Cancer Detection Rates:**
  - Abbreviated MRI: 17.4 per 1000 examinations
  - ABUS: 4.2 per 1000 examinations
  - Contrast-Enhanced Mammography: 19.2 per 1000 examinations
- **Invasive Cancer Detection Rates:** Similar to overall cancer detection rates
  - Abbreviated MRI: 15.0 per 1000 examinations
  - ABUS: 4.2 per 1000 examinations
  - Contrast-Enhanced Mammography: 15.7 per 1000 examinations

Results

- **Tumor Size:** Abbreviated MRI and contrast-enhanced mammography detected smaller invasive tumors (median size 10-11 mm) compared to ABUS (22 mm).
- **Recall Rates:** Higher for abbreviated MRI (9.7%) and contrast-enhanced mammography (9.7%) compared to ABUS (4.0%).
- **Adverse Events:** One extravasation in the abbreviated MRI arm, no adverse events in the ABUS arm, and 24 iodinated contrast reactions (including minor, moderate, and one severe event) and three extravasations in the contrast-enhanced mammography arm.

BRAID STUDY: CONCLUSIONS

- ABUS doubled the number of cancers detected as compared to mammography alone
- Abbreviated MRI and contrast-enhanced mammography detected three times as many invasive cancers compared with ABUS.
- Cancers detected by abbreviated MRI and contrast-enhanced mammography tended to be smaller.
- Supplemental imaging could lead to earlier detection of cancer in women with dense breasts

Contrast-Enhanced Mammography (CEM)

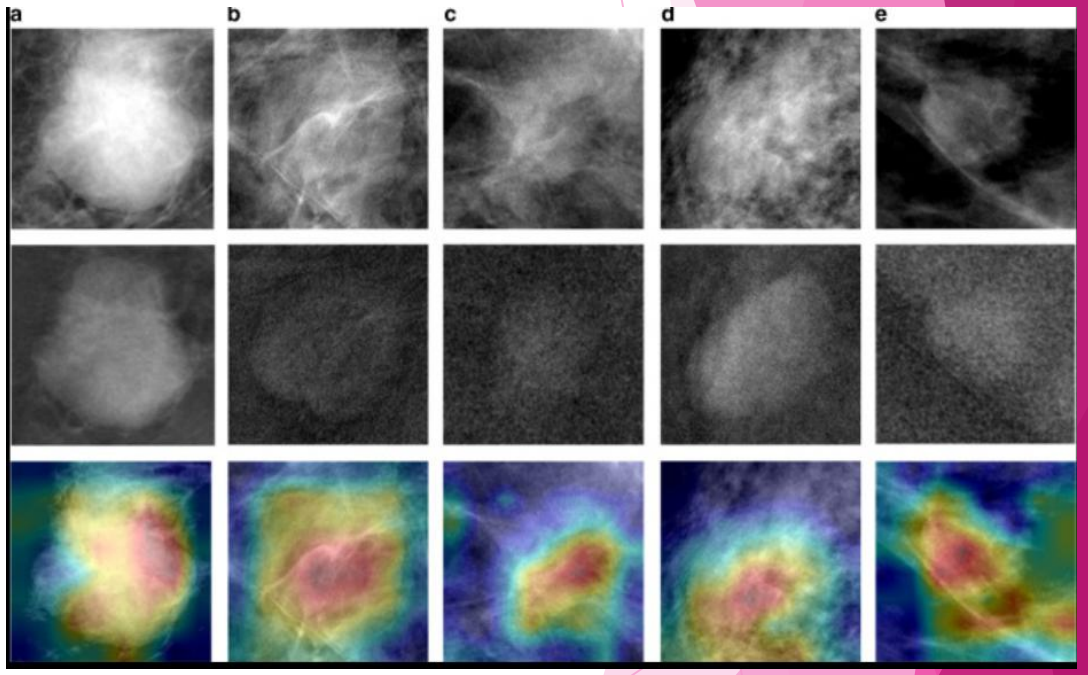
QUICK FACTS

- Contrast-enhanced mammography (CEM) uses IV injection of a dye containing iodine (as is used in CT) in combination with a standard digital mammogram.
- CEM is FDA-approved for diagnostic breast imaging, and is proven effective in looking at the extent of cancer in women with newly diagnosed breast cancer, to check a cancer's response to chemotherapy before surgery, and to assess breast symptoms, or abnormalities seen on standard mammograms.
- CEM is being evaluated for breast cancer screening, especially in women with dense breasts. After a "normal" mammogram, CEM detects about 10 cancers for every 1000 women screened, which is similar to MRI.
- Unlike standard mammography, dense breast tissue does not hide detection of cancers on CEM.

AI for Contrast Enhanced Mammography

Characterization of Benign from Malignant and BPE

- 1,239 CEM exams with
- 805 malignant lesions and
- 288 benign lesions
- sensitivity of 85%
- specificity of 100%



Covington MF, Salmon S, Weaver BD, Fajardo LL. State-of-the-art for contrast-enhanced mammography. Br J Radiol. 2024 Mar 28;97(1156):695-704

Conclusions

- Screening mammography
  - Start at 40 (or younger if indicated)
  - ANNUAL
- Diagnostic Mammogram: Signs or Sx or if patient highly motivated for “one stop” care
- Dense Breasts
  - MUST have US , MRI or CEM to optimize diagnosis
- High Risk
  - Annual mammogram and MRI Seperated by 6 months

JOURNAL ARTICLE

Deep Learning vs Traditional Breast Cancer Risk Models to Support Risk-Based Mammography Screening

Constance D Lehman, MD, PhD ✉, Sarah Mercaldo, PhD, Leslie R Lamb, MD, Tari A King, MD, Leif W Ellisen, MD, Michelle Specht, MD, Rulla M Tamimi, ScD

JNCI: Journal of the National Cancer Institute, Volume 114, Issue 10, October 2022, Pages 1355–1363, https://doi.org/10.1093/jnci/djac142

Published: 25 July 2022 **Article history** ▾

Results

- Key Results:
- • Cancers detected per 1,000 screened:
- – Deep Learning: 8.6 (95% CI 7.9–9.4)
- – Tyrer-Cuzick: 4.4 (3.9–4.9)
- – NCI BCRAT: 3.8 (3.3–4.3) (P < .001)

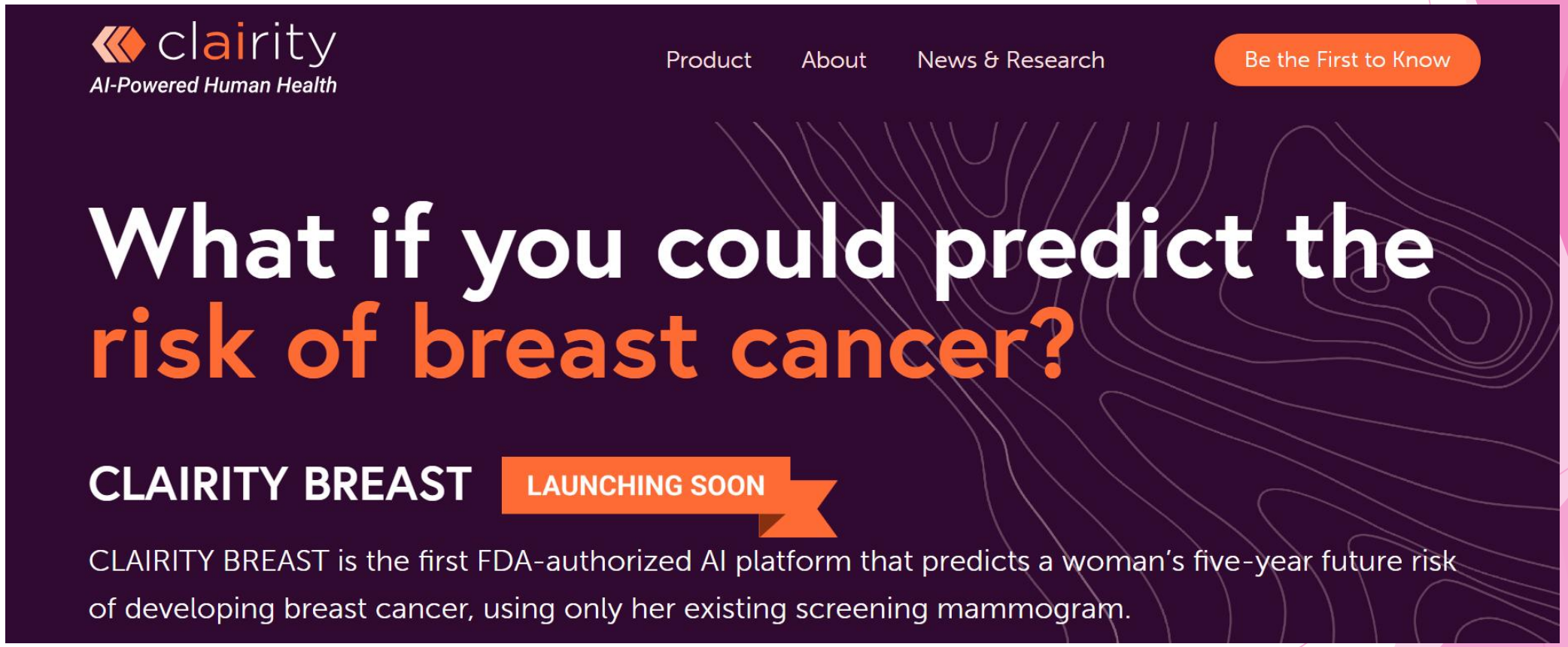
- • AUC Performance:
- – Deep Learning: 0.68 (95% CI 0.66–0.70)
- – Tyrer-Cuzick: 0.57 (0.54–0.60)
- – NCI BCRAT: 0.57 (0.54–0.60)

- • Top 50% risk group by Deep Learning captured significantly more cancers (P < .001)

Conclusions

- • Deep Learning model derived directly from mammograms was superior to traditional models.
- • Enables feasible, effective, risk-based screening.
- • Potential to identify women at near-term risk and personalize screening strategies

Short term (5 year) risk FDA Cleared



Risk Based Screening

- Not one size fits all
- Different algorithms for different densities and risk stratification
- Additional technologies on the horizon

Thank you

Rachel F. Brem, MD FACR FSBI

rbrem@bremfoundation.org