

# Extent of Disease/ Management Decisions – New Tools

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## Extent of Disease/ Management Decisions New Tools

### Equipment:

- 2 mammography devices (GE company one with CESM, one with CESM and tomosynthesis)
- 3 Ultrasounds (3 Hitachi with elastography)
- 1 MRI 1.5 T Siemens
- 2 Roentgen Siemens
- 1 CT GE with spectral option



# Extent of Disease/ Management Decisions New Tools

## The number of examinations performed in 2017

- Clinical mammography - 8050
- Breast US – 9600
- **CESM - 430**
- **Tomosynthesis – 110**
- Spot compression– 225
- Breast MRI – 450
- US/CB - 1300
- US/FNA - 450
- US/VABB – 670
- MG/VABB – 160
- MRI/VABB - 21



## Extent of Disease/ Management Decisions

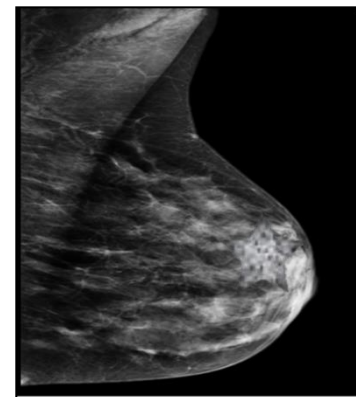
### New Tools

- Sensitivity of mammography in fatty breast is 88%, and in extremely dense breast is 62%,
- Specificity of mammography in fatty breast is 96,9%, while in dense glandular breast - 89,1%,
- About 50% of women presenting for mammography have dense glandular breast anatomy,
- Detection of cancer in dense breast is more difficult because cancerous tissue has the ability to absorb X-rays similar to glandular tissue.

*Carney PA, Miglioretti DL, Yankaskas BC, et al. Individual and combined effects of breast density, and hormone replacement therapy use on the accuracy of screening mammography. Ann Intern Med 2003;138:168-75,*

*Boyd NF, Guo H, Martin LJ, et al. Mammographic density and the risk and detection of cancer. N Engl J Med. 2007;356(3):227-236,*

*Harvey JA, Bovbjerg VE. Quantitative assessment of mammographic breast density: breast cancer risk. Radiology. 2004;230(1):29-41*

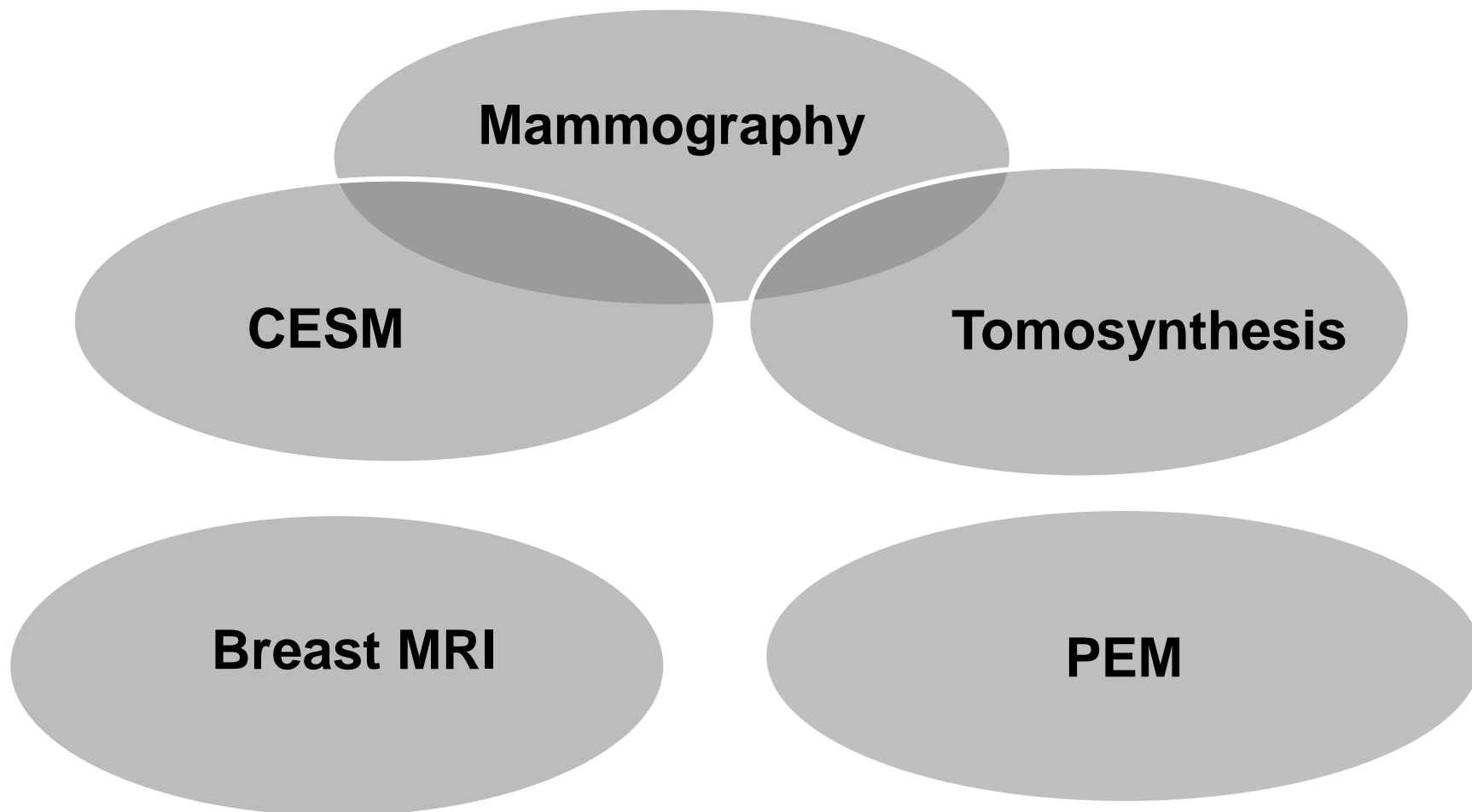




# Extent of Disease/ Management Decisions

## New Tools

New methods in breast cancer diagnostics:



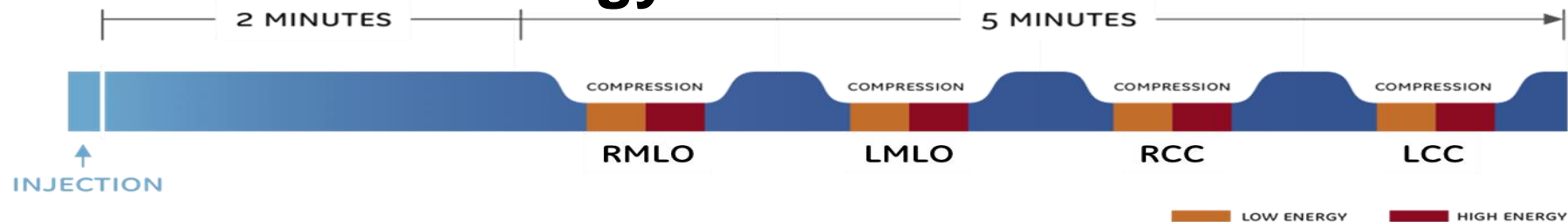
## CESM – methodology

- The amount of iodine contrast - 1,5 ml/kg of body mass,
- Contrast injector,
- Examination is begun with the healthy breast, and continued with the breast in which pathology is expected,
- The first image in oblique projection (MLO) is acquired 2 min after contrast administration.



# Extent of Disease/ Management Decisions New Tools

## CESM – methodology



- After contrast administration bilateral breast examination is performed in two projections,
- The first image in low-energy projection (26 to 32 keV), and the second in high-energy acquisition (45 to 49 keV),
- Energy range depends on a patient, mainly on breast thickness and glandular tissue content,
- Energy is set automatically by the device,
- Both images are performed within very short time interval,
- The whole radiation dose is about 20% higher than in classical mammography.





## Indications for CESM:

- Primary focus size assessment
- Evaluation of neoplastic recurrence
- Staging of neoplastic process
- Intraductal component evaluation

*Fallenberg EM, Schmitzberger FF, Amer H, Ingold-Heppner B, Balleyguier C, Diekmann F, Engelken F, Mann RM, Renz DM, Bick U, Hamm B, Dromain C. Contrast-enhanced spectral mammography vs. mammography and MRI – clinical performance in multi-center evaluation. Eur Radiol. 2016 Nov 28,*

*Sardanelli F, Fallenberg EM, Clauser P, Trimboli RM, Camps-Herrero J, Helbich TH, Forrai G; European Society of Breast Imaging (EUSOBI), with language review by Europa Donna–The European Breast Cancer Coalition. Mammography: an update of the EUSOBI recommendations on information for women. Insights Imaging. 2017 Feb;8(1):11-1,*

*Bhimani C, Matta D, Roth RG, Liao L, Tinney E, Brill K, Germaine P. Contrast-enhanced Spectral Mammography: Technique, Indications, and Clinical Łuczyńska E., Heinze - Paluchowska S., Hendrick E., Dyczek S., Ryś J., Herman K., Blecharz P., Jakubowicz J. Comparison between breast MRI and Contrast Enhanced Spectral Mammography (CESM). Med Sci Monit 2015;12(21):1358-67,*

*Łuczyńska E., Heinze-Paluchowska S., Dyczek S., Blecharz P., Ryś J., Reinfuss M. Contrast-Enhanced Spectral Mammography: comparison with Conventional Mammography and Histopathology in 152 women. Radiol, 2014; 15(6): 689-96 Applications. Acad Radiol. 2017 Jan;24(1):84—88,*





## CESM and extent of disease – CESM versus MG or US – reports from the publications

1. The value of CESM as a supplement to MG in determining tumor size was greater in patients with dense breasts. CESM may be a promising alternative preoperative measurement tool for breast cancer patients with dense breasts and/or limited access or contraindications to MRI.
2. CESM is accurate in size measurements of small breast tumors. On average CESM leads to a slight overestimation of tumor size, whereas US tends to underestimate tumor size.
3. CESM provides additional enhancement information for diagnosing breast microcalcifications and measuring cancer sizes with high correlation to histology.
4. CESM provides immediately available, clinically useful information in the symptomatic patients with suspicious palpable abnormalities. Sensitivity, specificity, and accuracy for breast cancer detection and staging are all improved using CESM as the primary mammographic investigation.

*Patel BK et al, Assessing tumor extent on contrast-enhanced spectral mammography versus full-field digital mammography and ultrasound. Clin Imaging 2017 Jul 12;46:78-84*

*Blum K. S., et al, Use of contrast-enhanced spectral mammography for intramammary cancer staging: preliminary results., Academic Radiology, 2014; 21(11): 1363-1369.*

*Cheung YC, et al. Clinical utility of dual-energy contrast-enhanced spectral mammography for breast microcalcifications without associated mass: a preliminary analysis. Eur Radiol. 2016 Apr;26(4):1082-9*

*Tennant SL, et al., Contrast-enhanced spectral mammography improves diagnostic accuracy in the symptomatic setting. Clin Radiol. 2016 Nov;71(11): 1148-55*



## CESM and extent of disease – CESM versus MRI - reports from the publications

1. Quality of tumor size measurement using CESM is good and matches the quality of these measurements assessed by breast MRI. Additional measurements using breast MRI did not improve the quality.
2. Initial results show a better sensitivity of CESM and MRI in breast cancer detection than MG and a good correlation with postoperative histology in size assessment.
3. CESM has similar sensitivity to MRI in breast cancer detection, with higher PPV and less background enhancement.
4. Contrast-enhanced spectral mammography is potentially as sensitive as MRI in the evaluation of extent of disease in newly diagnosed breast cancer, with a higher PPV.

*Lobbes M.B., et al., The quality of tumor size assessment by contrast-enhanced spectral mammography and the benefit of additional breast MRI. Journal of Cancer, 2015; 6(2):144-150.*

*Fallenberg E.M., et al, Contrast-enhanced spectral mammography versus MRI: Initial results in the detection of breast cancer and assessment of tumour size. European Radiology, 2014; 24(1): 256-264*

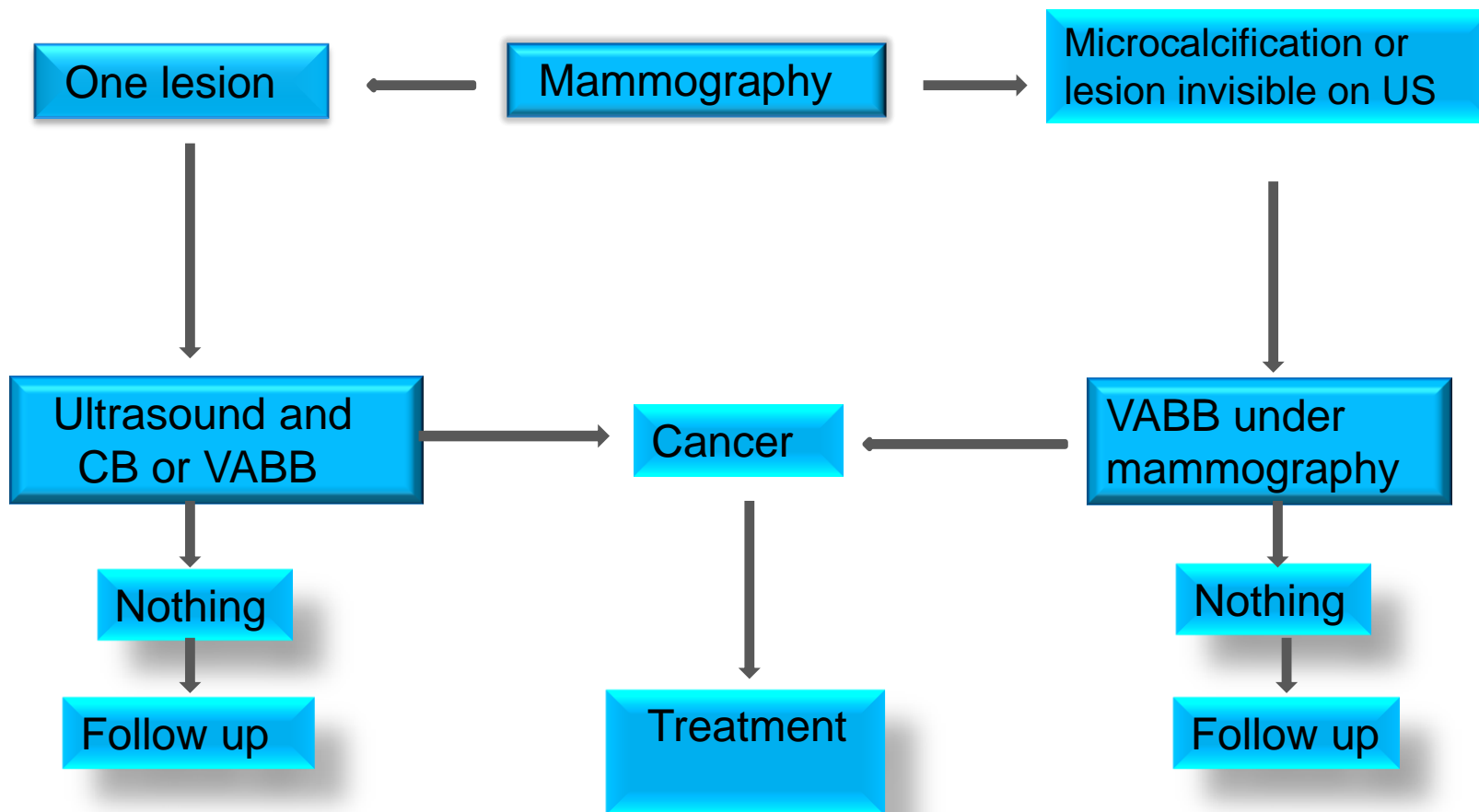
*Li L at al., Contrast-enhanced spectral mammography (CESM) versus breast magnetic resonance imaging (MRI): A retrospective comparison in 66 breast lesions . Diagn Interv Imaging. 2017 Feb;98(2):113-123*

*Stephanie A. Lee-Felker, et al., Newly Diagnosed Breast Cancer: Comparison of Contrast-enhanced Spectral Mammography and Breast MR Imaging in the Evaluation of Extent of Disease ,Radiology 2017*



# Extent of Disease/ Management Decisions New Tools

The imaging workflow and management before introduction of CESM





## Extent of Disease/ Management Decisions

### New Tools

**In our hospital: CESM is performed only in more in-depth diagnostics.**

**We don't have any problems with waiting time before performing CESM which is constantly available for the patients.**

### Indications:

1. Patients with suspicious focal lesions where mammography (MG) and additional ultrasound examinations (US) fail to make a definitive diagnosis.
2. In cases of dense breasts or heterogeneously dense breasts, where cancer detection is impeded due to the lower sensitivity of mammography.



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# Extent of Disease/ Management Decisions New Tools-Own Experience

**Original Article | Breast Imaging**

<http://dx.doi.org/10.3348/kjr.2014.15.6.689>

pISSN 1229-6929 · eISSN 2005-8330

Korean J Radiol 2014;15(6):689-696



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Korean Journal of Radiology

# KJR

## Contrast-Enhanced Spectral Mammography: Comparison with Conventional Mammography and Histopathology in 152 Women

Elzbieta Luczyńska, MD, PhD<sup>1</sup>, Sylwia Heinze-Paluchowska, PhD<sup>1</sup>, Sonia Dyczek, MD, PhD<sup>1</sup>,  
Pawel Blecharz, MD, PhD<sup>2</sup>, Janusz Rys, MD, PhD<sup>3</sup>, Marian Reinfuss, MD, PhD<sup>4</sup>

- Spectral mammography was performed in 152 women, 173 lesions were detected.
- Spectral mammography detected additional 16 lesions that were not visible in conventional mammography.

### Results and Conclusions:

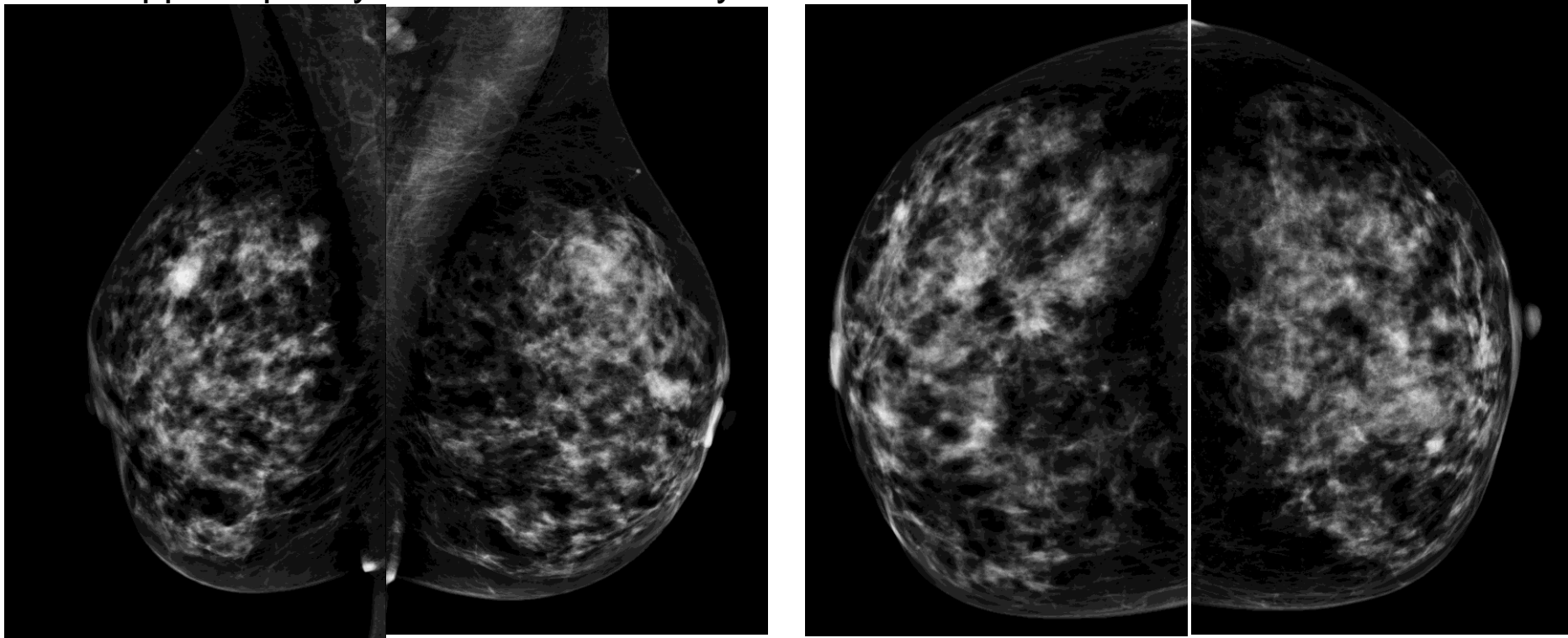
- Both MG and CESM overestimated lesion sizes compared to histology ( $p < 0.001$ ); the difference was smaller for CESM.
- CESM may provide higher sensitivity for breast cancer detection and greater diagnostic accuracy than conventional mammography.
- Our results indicated that CESM may have improved sensitivity and specificity of breast cancer detection.



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## Extent of Disease/ Management Decisions New Tools- Own Experience

- **Mammography:** Patient 62 y/o,
- Screening examination: in the upper outer quadrant of the right breast 7 cm to the nipple a poorly demarcated density 15 mm in diameter.



**Contrast-Enhanced Spectral Mammography: Comparison  
with Conventional Mammography and Histopathology in  
152 Women**

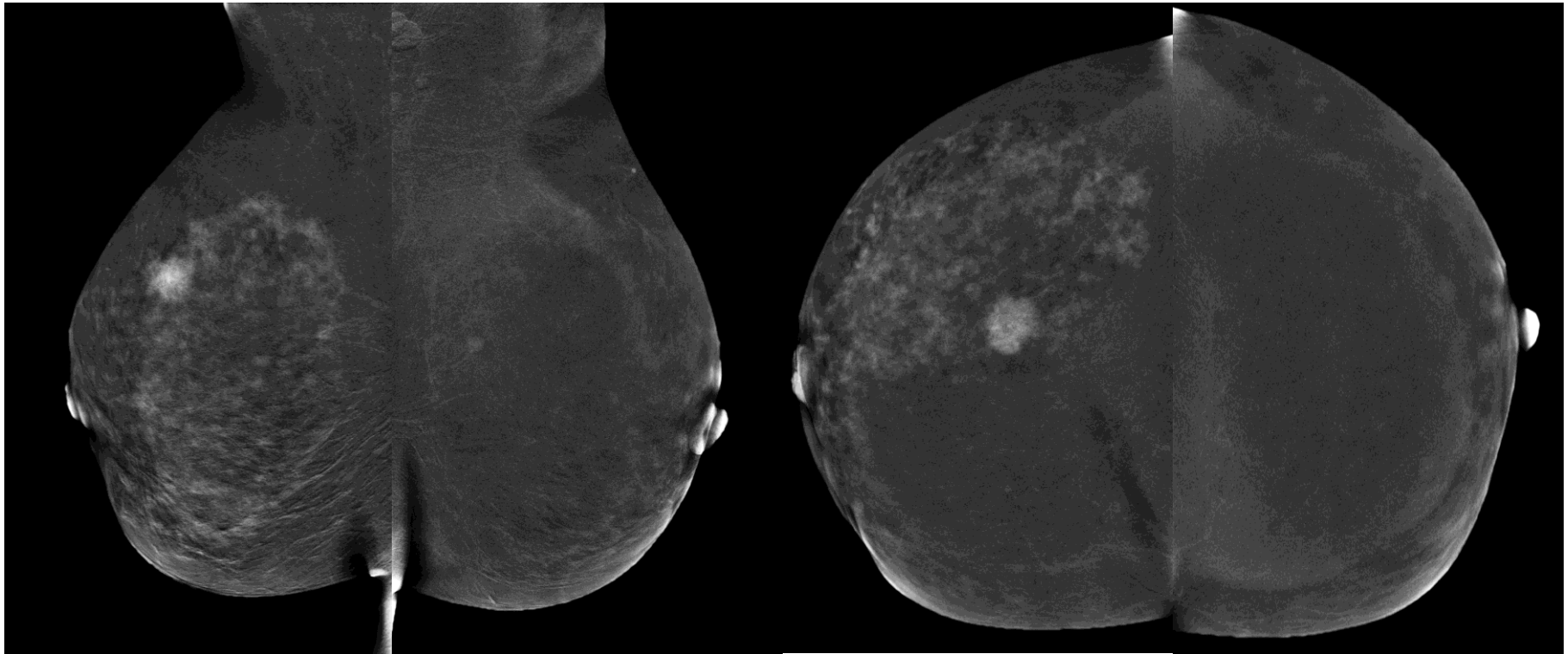
Elzbieta Luczyńska, MD, PhD<sup>1</sup>, Sylwia Heinze-Paluchowska, PhD<sup>1</sup>, Sonia Dyczek, MD, PhD<sup>1</sup>,  
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## Extent of Disease/ Management Decisions New Tools

**CESM:** in right breast - about 7 cm to the nipple strongly enhancing lesion 15 mm in diameter. Enhancement was also visible in the upper and lower outer quadrant.



**Contrast-Enhanced Spectral Mammography: Comparison with Conventional Mammography and Histopathology in 152 Women**

Elzbieta Luczyńska, MD, PhD<sup>1</sup>, Sylwia Heinze-Paluchowska, PhD<sup>1</sup>, Sonia Dyczek, MD, PhD<sup>1</sup>,  
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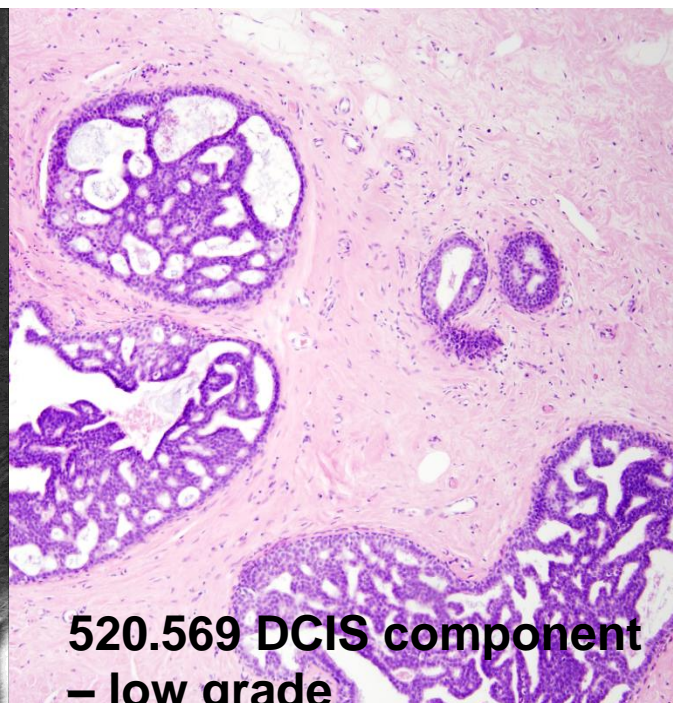
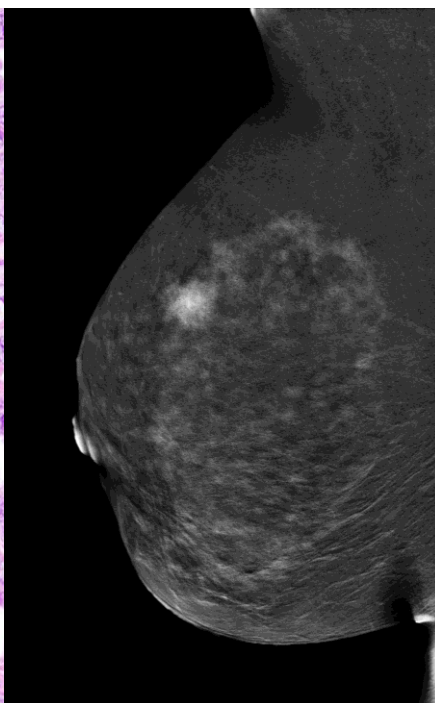
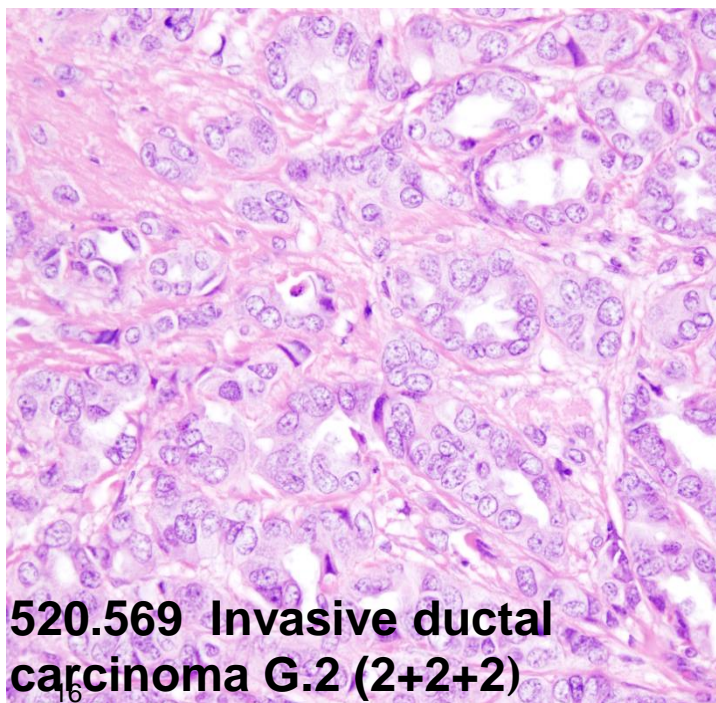


# Extent of Disease/ Management Decisions

## New Tools

### Histology:

- Invasive ductal carcinoma G2.
- The pattern characteristic for DCIS was visible in a specimen randomly taken from macroscopically unchanged breast parenchyma.





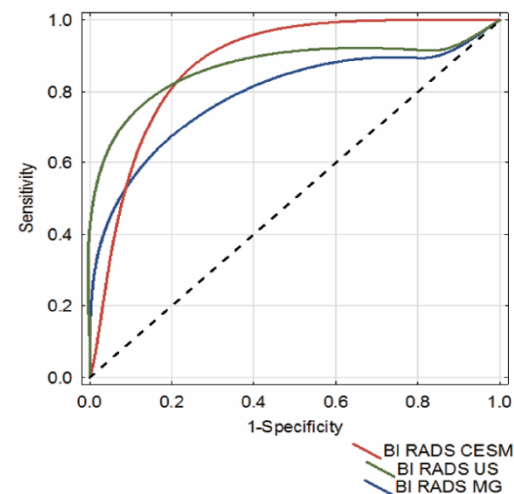
## Extent of Disease/ Management Decisions New Tools – Own experience

### Comparison of the Mammography, Contrast-Enhanced Spectral Mammography and Ultrasonography in a Group of 116 patients.

Łuczyńska E. , Heinze S., Adamczyk A., Ryś J., Mituś JW., Hendrick E.,  
Anticancer res. 2016 Aug;36(8):4359-66.

- MG, CESM and US were compared among 116 patients with 137 lesions encountered.

Examination	Sensitivity	Specificity	Accuracy
MG	90% [82%; 95%]	22% [11%; 38%]	69% [61%; 77%]
US	92% [84%; 96%]	20% [9%; 35%]	70% [62%; 78%]
CESM	100% [96%; 100%]	27% [14%; 43%]	78% [70%; 85%]
<i>p</i> -value: MG vs. US	0.77	0.99	0.99
<i>p</i> -value: MG vs. CESM	0.004	0.81	0.04
<i>p</i> -value: US vs. CESM	0.01	0.57	0.03



- Conclusions:** CESM permitted better detection of malignant lesions than both MG and US individually.



# Extent of Disease/ Management Decisions New Tools-Own Experience

**MEDICAL  
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MONITOR**

**CLINICAL RESEARCH**

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## Comparison between Breast MRI and Contrast-Enhanced Spectral Mammography

Authors' Contribution:  
Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

ABDEF 1 **Elżbieta Łuczyńska**  
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There were 102 patients entered into CESM/MRI studies and 118 lesions were identified by the combination of CESM and breast MRI. Histopathology confirmed that 81 of 118 lesions were malignant and 37 were benign. Of the 81 malignant lesions, 72 were invasive cancers and 9 were *in situ* cancers. Sensitivity was 100% with CESM and 93% with breast MRI. Accuracy was 79% with CESM and 73% with breast MRI. ROC curve areas based on BI-RADS were 0.83 for CESM and 0.84 for breast MRI. Lesion size estimates on CESM and breast MRI were similar, both slightly larger than those from histopathology.

## Conclusions

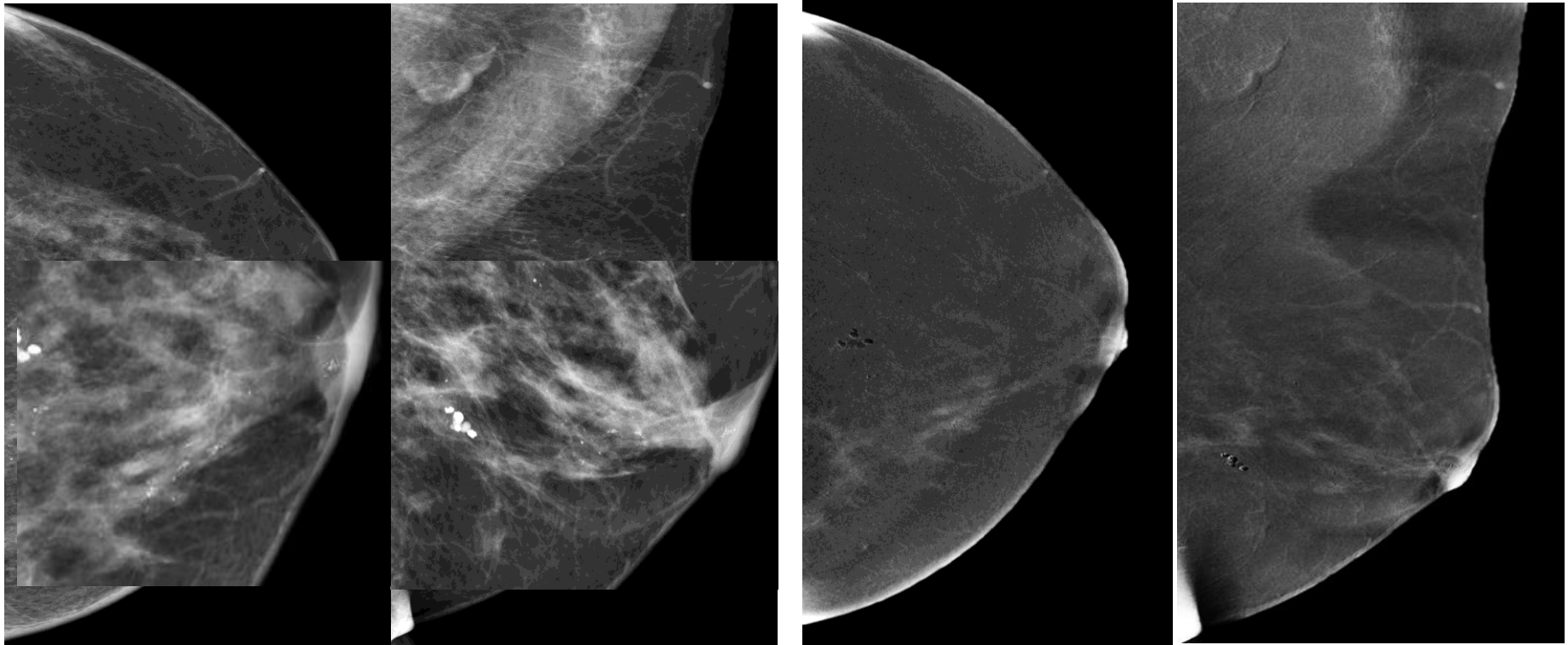
CESM is a new diagnostic method that enables accurate detection of malignant breast lesions, high negative predictive value, and a false-positive rate similar to that of breast MRI.



## Extent of Disease/ Management Decisions New Tools-Own Experience

### Mammography:

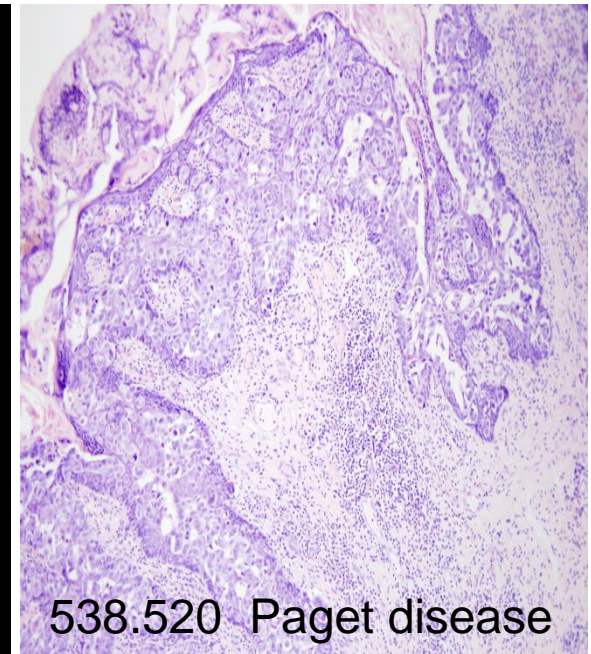
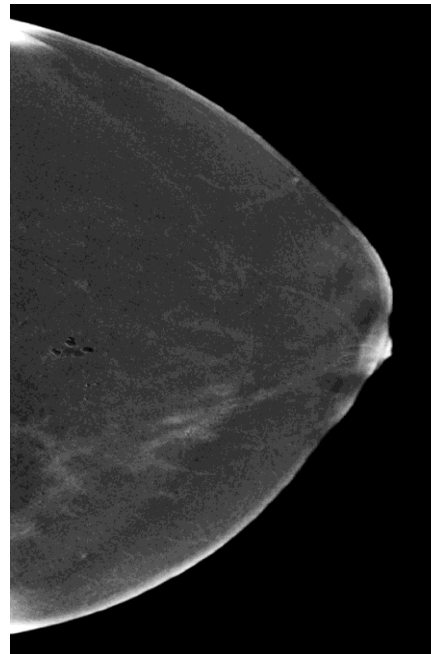
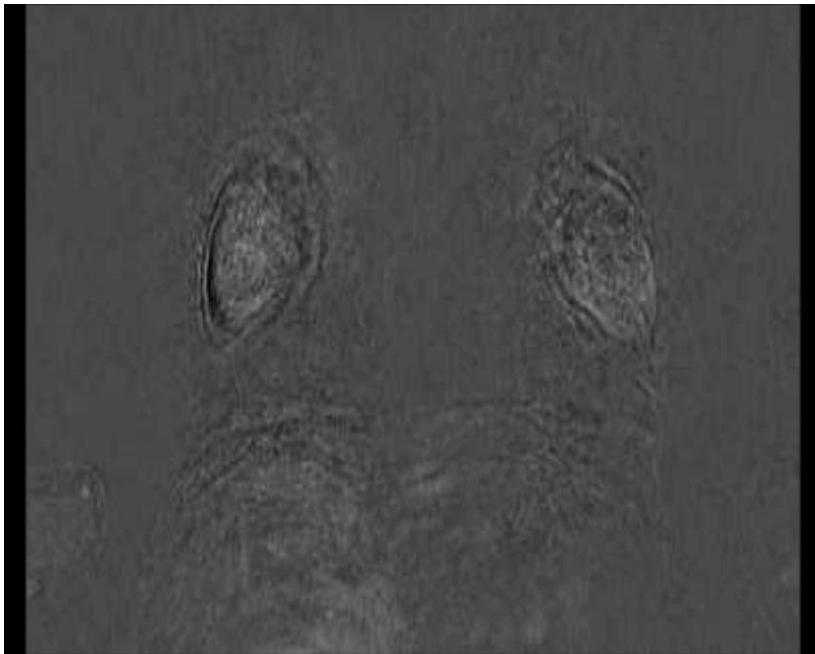
- Patient 60 y/o,
- Left breast - lower inner quadrant: microcalcifications, which form a duct 3 cm long,
- On CESM extended contrast enhancement, segmentally arranged.



## Extent of Disease/ Management Decisions New Tools– Own Experience

Patient 60 y/o,

A linear focus of contrast enhancement visible posteriorly to the nipple, weaker than enhancement visible on CESM.





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# Extent of Disease/ Management Decisions New Tools – Own Experience



Elżbieta Łuczyńska  
Joanna Niemiec  
Edward Hendrick  
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Jerzy Jakubowicz  
Beata Sas-Korczyńska  
Janusz Rys

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## **Degree of Enhancement on Contrast Enhanced Spectral Mammography (CESM) and Lesion Type on Mammography (MG): Comparison Based on Histological Results**

- The aim of this study was to compare the degree of enhancement on CESM to lesion characteristics on MG and histology results to compare the sensitivity of the two modalities and to establish correlations that might improve diagnostic accuracy.
- The study cohort included 193 patients, with a mean age of  $55 \pm 0.8$  years.
- In addition, lesion diameters measured on MG and CESM were compared to lesion sizes on histological examinations.

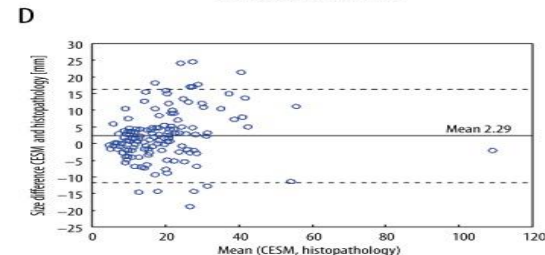
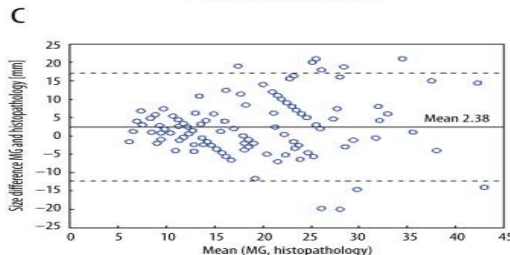
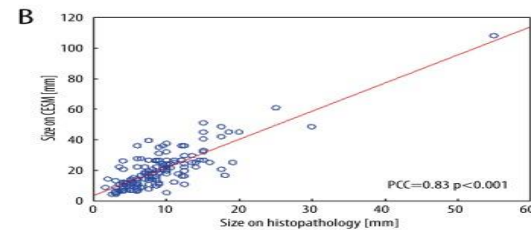
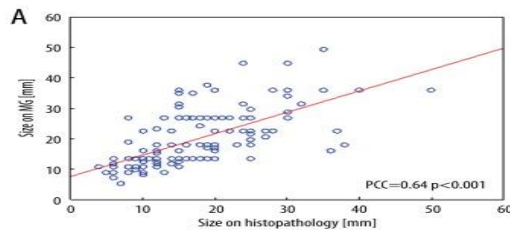


# Extent of Disease/ Management Decisions

## New Tools – Own Experience

### Results:

- The sensitivity of CESM was 100%, and was higher than that of MG, which was 90%.
- Invasive carcinomas were more frequently characterized by both: strong or medium enhancements on CESM, and mass or mass plus microcalcifications on MG.
- Correlations between the lesion diameters measured on MG and histology or CESM and histology were highly significant ( $p < 0.001$ ). Mean lesion diameter on MG was  $20.6 \pm 0.9$  mm, on CESM it was  $19.5 \pm 0.9$  mm, and on histology it was  $18.3 \pm 0.8$  mm. The difference was smaller for CESM.





## SHORT REPORT

### THE TUMOUR BORDER ON CONTRAST-ENHANCED SPECTRAL MAMMOGRAPHY AND ITS RELATION TO HISTOLOGICAL CHARACTERISTICS OF INVASIVE BREAST CANCER

ALEKSANDRA AMBICKA<sup>1</sup>, ELZBIETA LUCZYNSKA<sup>2</sup>, AGNIESZKA ADAMCZYK<sup>3</sup>,  
AGNIESZKA HARAZIN-LECHOWSKA<sup>4</sup>, BEATA SAS-KORCZYNSKA<sup>4</sup>, JOANNA NIEMIEC<sup>3</sup>

- The study included 82 breast cancer patients (with 92 lesions).
- Based on CESM, according to the BIRADS classification the lesion margin was defined as sharp, indistinct, or spiculated.
- On pathological examination tumor macroscopic borders were classified as invasive or pushing.

# Extent of Disease/ Management Decisions New Tools - Own Experience

DOI: 10.5114/pjp.2016.63783

POL J PATHOL 2016; 67 (3): 295-299

## SHORT REPORT

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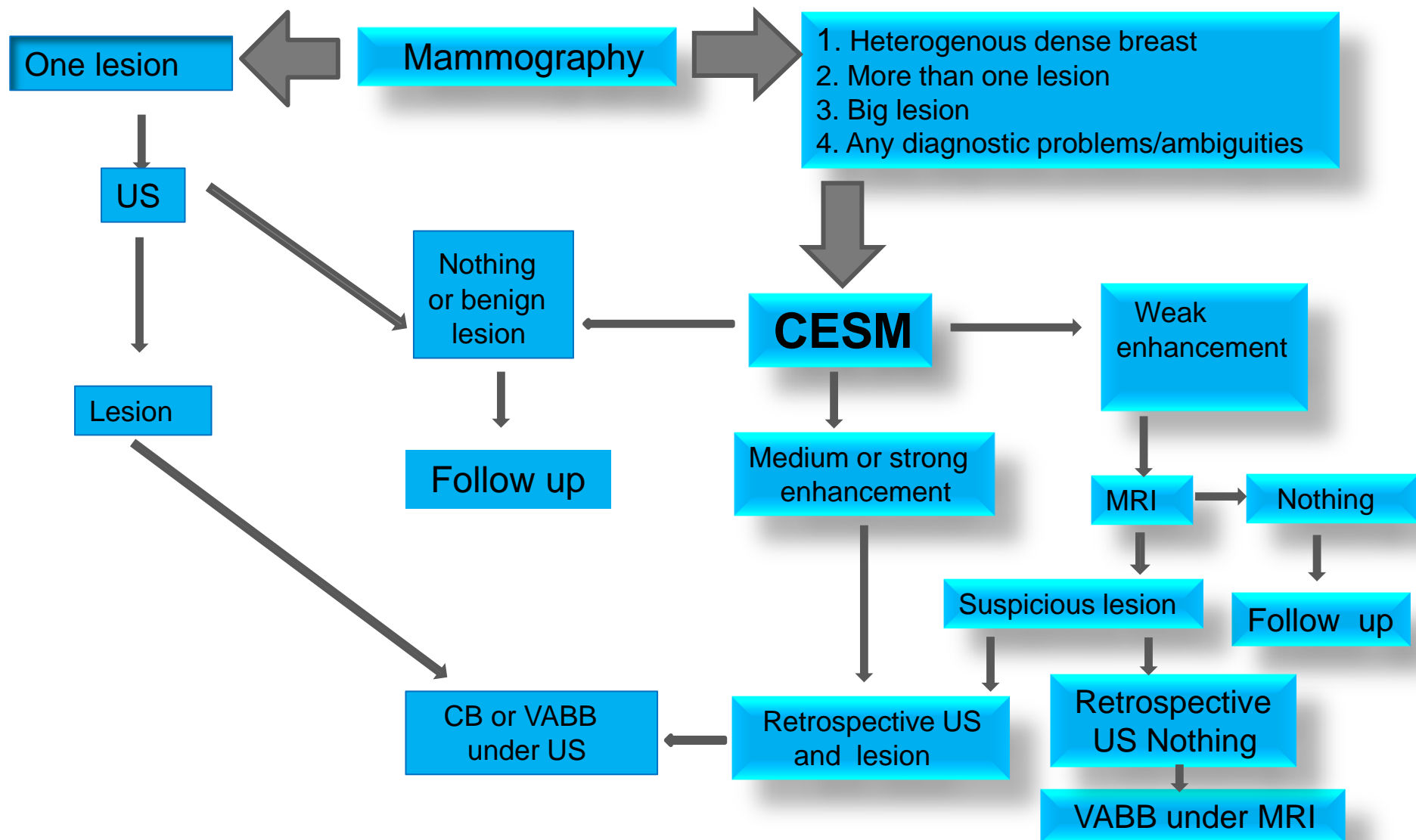
**Conclusions:** The results of our preliminary study suggest that it is possible to assess macroscopic borders of examined lesions on the basis of CESM imaging. This might be useful in planning the extent of surgical excision. However, the assessment of the tumor margin on CESM might not be precise in cases showing weak enhancement.



# Extent of Disease/ Management Decisions

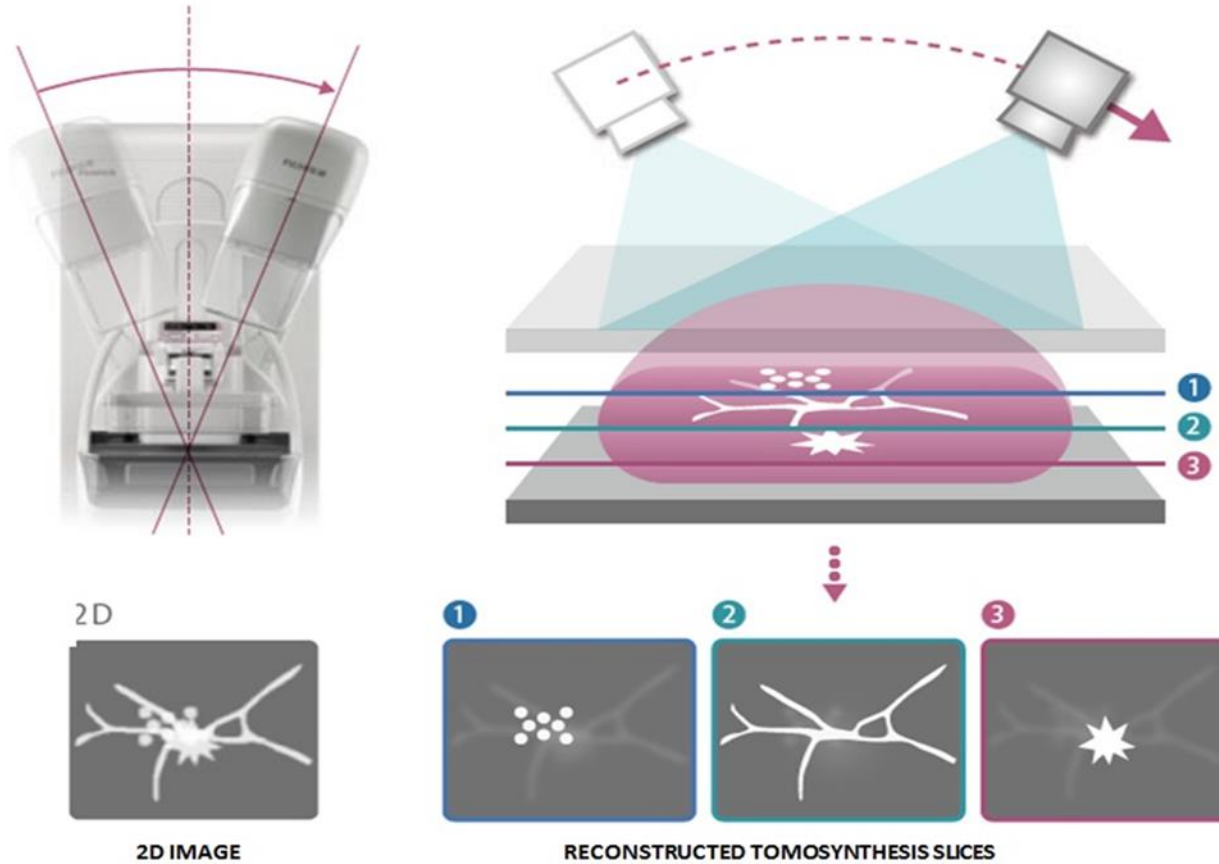
## New Tools

### Imaging workflow after introduction of CESM



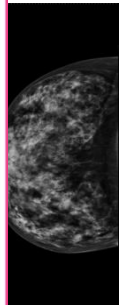
# 3D image reconstruction produces a series of tomosynthesis planes

Step-and-shoot



Slabs = 1 cm

V-Preview





## Extent of Disease/ Management Decisions New Tools

### **Tomosynthesis and extent of disease- reports from the publications:**

1. DBT was significantly superior to MG for the evaluation of lesion size overall, and specifically for small lesions and for lesions in dense breasts. Superiority of DBT versus MG increased with parenchymal density.
2. DBT may be superior to MG for determining the preoperative size measurement of breast lesions regardless of their parenchymal density.
3. DBT provided lower diagnostic performance than MRI as an additional imaging to mammography. However, DBT had higher diagnostic performance than mammography and higher PPV than MRI.

*Han Song Mun, et al, Assessment of Extent of Breast Cancer: Comparison between Digital Breast Tomosynthesis and Full-field Digital Mammography, RSNA 2011*

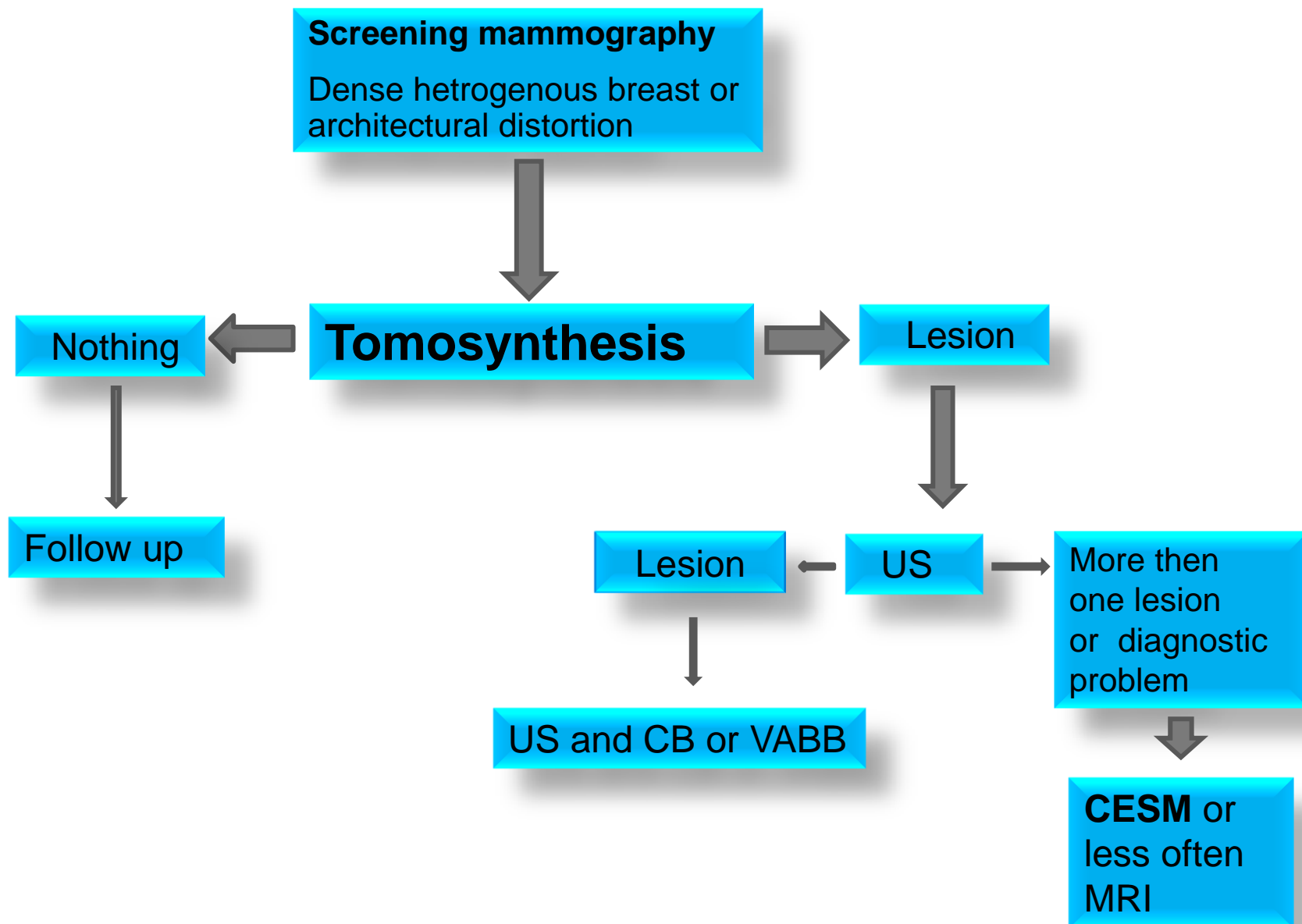
*Nieun Seo, et al, DBT vs. FFDM: comparison of the accuracy of lesion measurement and characterization using specimens Acta Radiologica 2014, Vol. 55(6) 661–667*

*Won Hwa Kim, et al., Comparison of the diagnostic performance of digital breast tomosynthesis and magnetic resonance imaging added to digital mammography in women with known breast cancers .Eur Radiol (2016) 26:1556–1564*



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## New Tools - Own Experience

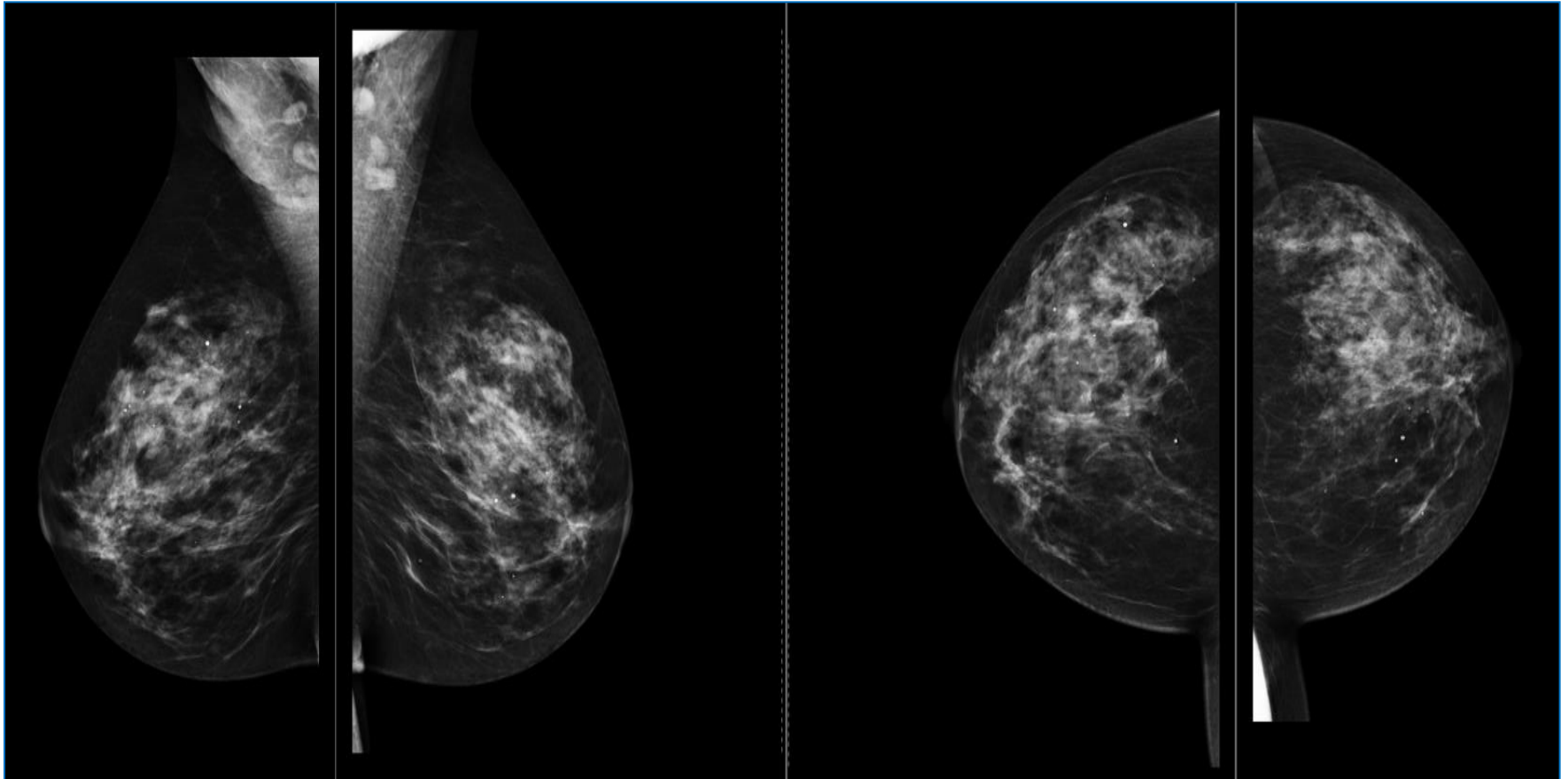




## Extent of Disease/ Management Decisions

### New Tools – own

53 y/o patient. Family history: mother's breast cancer. Screening mammography revealed slightly visible density in upper quadrants of the left breast, not visible in previous study.



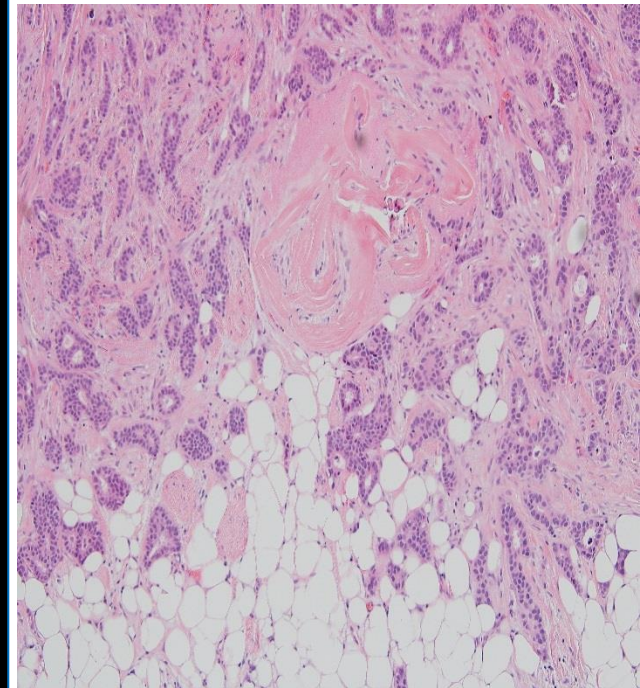
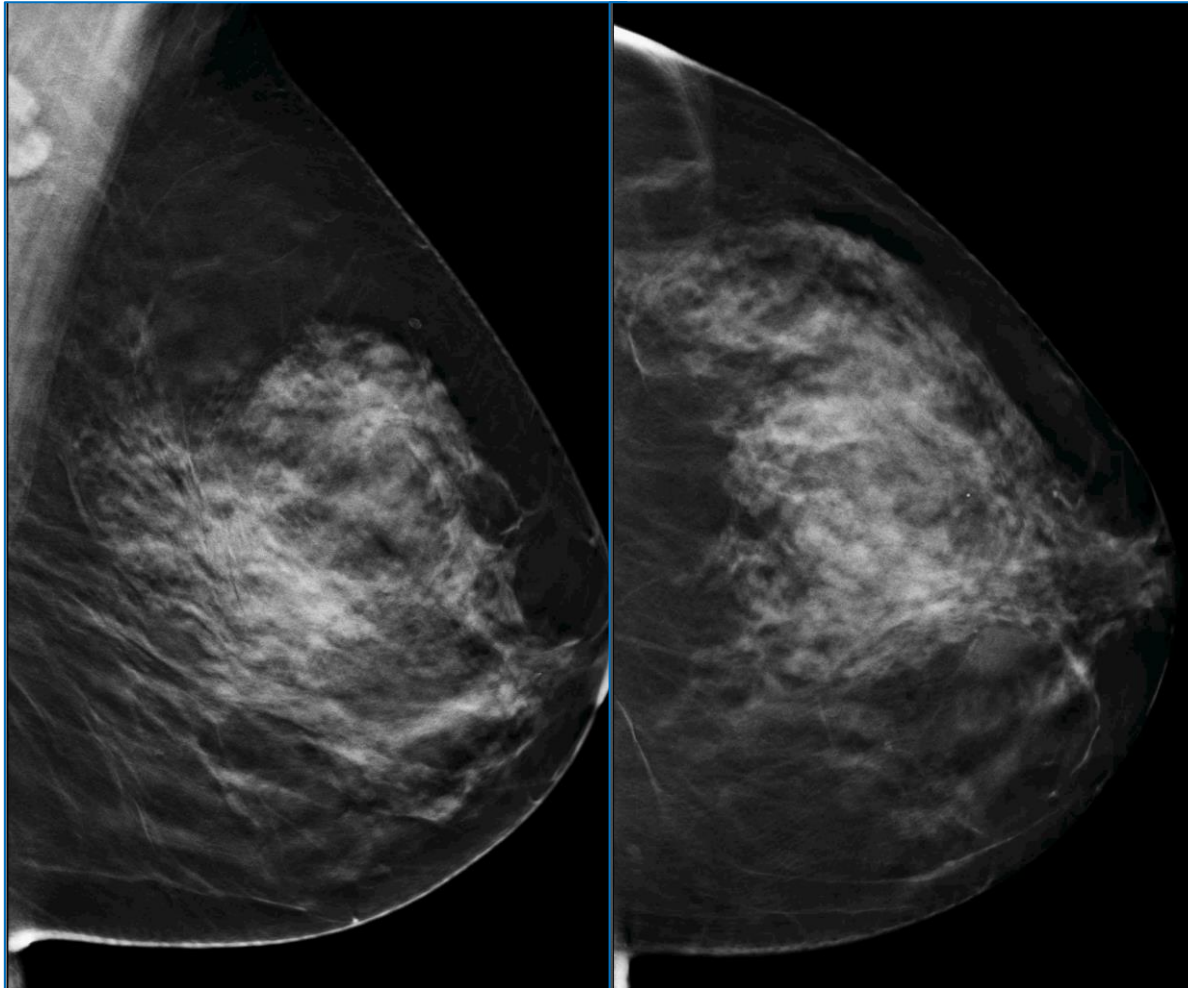




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## Tomosynthesis

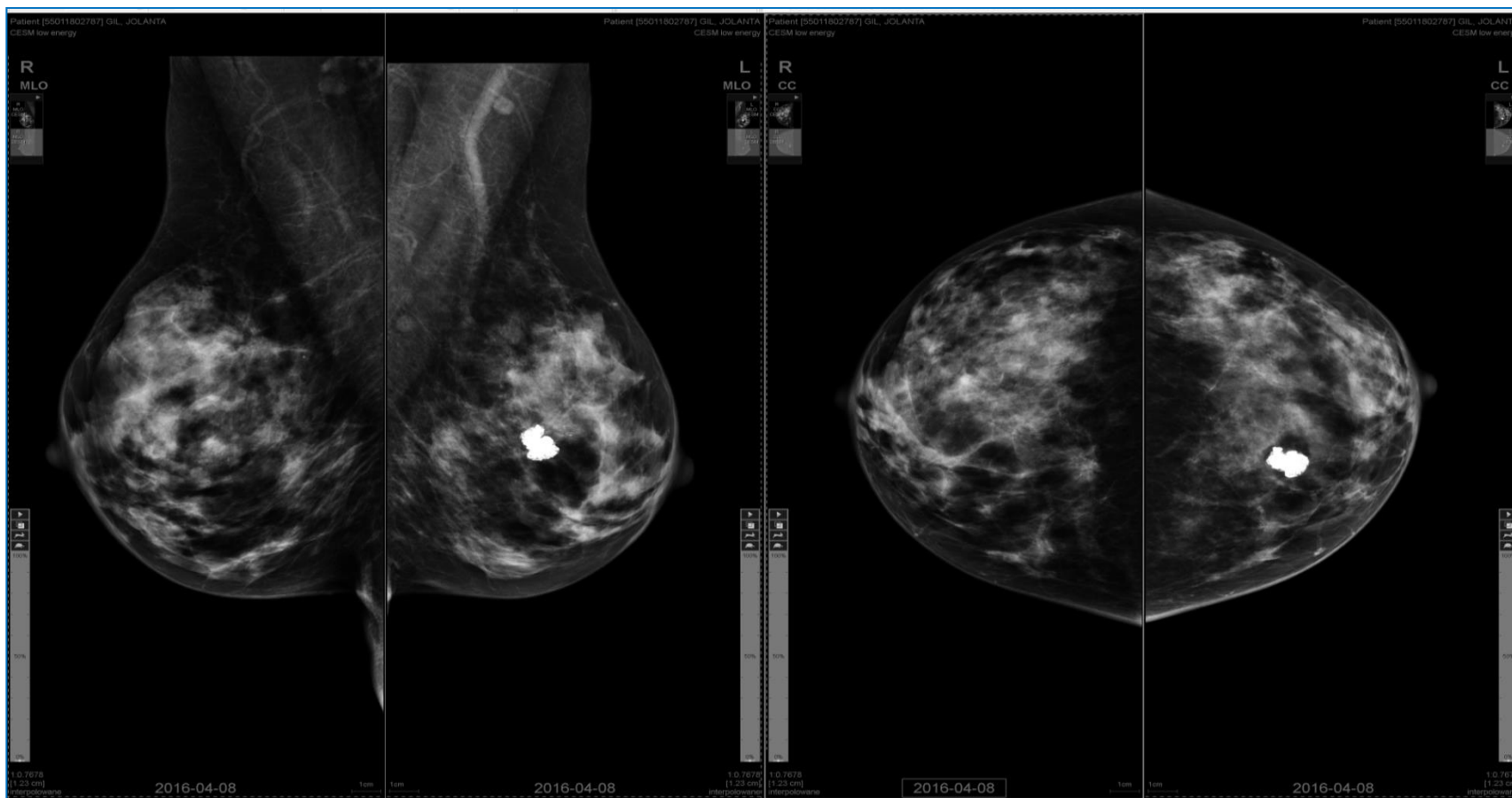


Invasive carcinoma NST G1



# Extent of Disease/ Management Decisions New Tools

61-y/o patient presented due to palpable breast lesion in the right breast.  
Family history: mother – breast cancer.

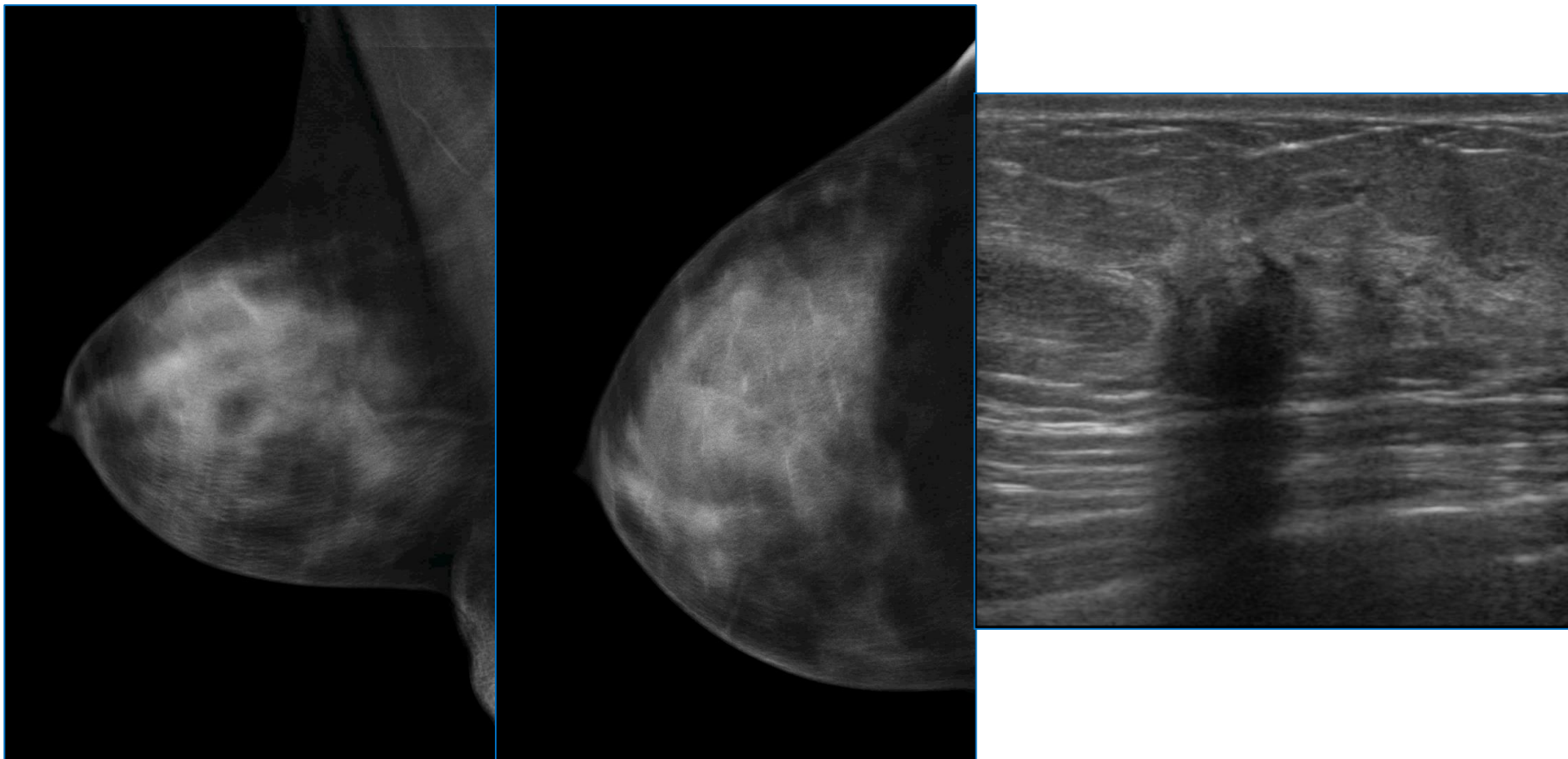




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## Extent of Disease/ Management Decisions New Tools

Tomosynthesis examination confirmed focus in the upper inner quadrant of the right breast. Apart from that, no other focal changes were detected.

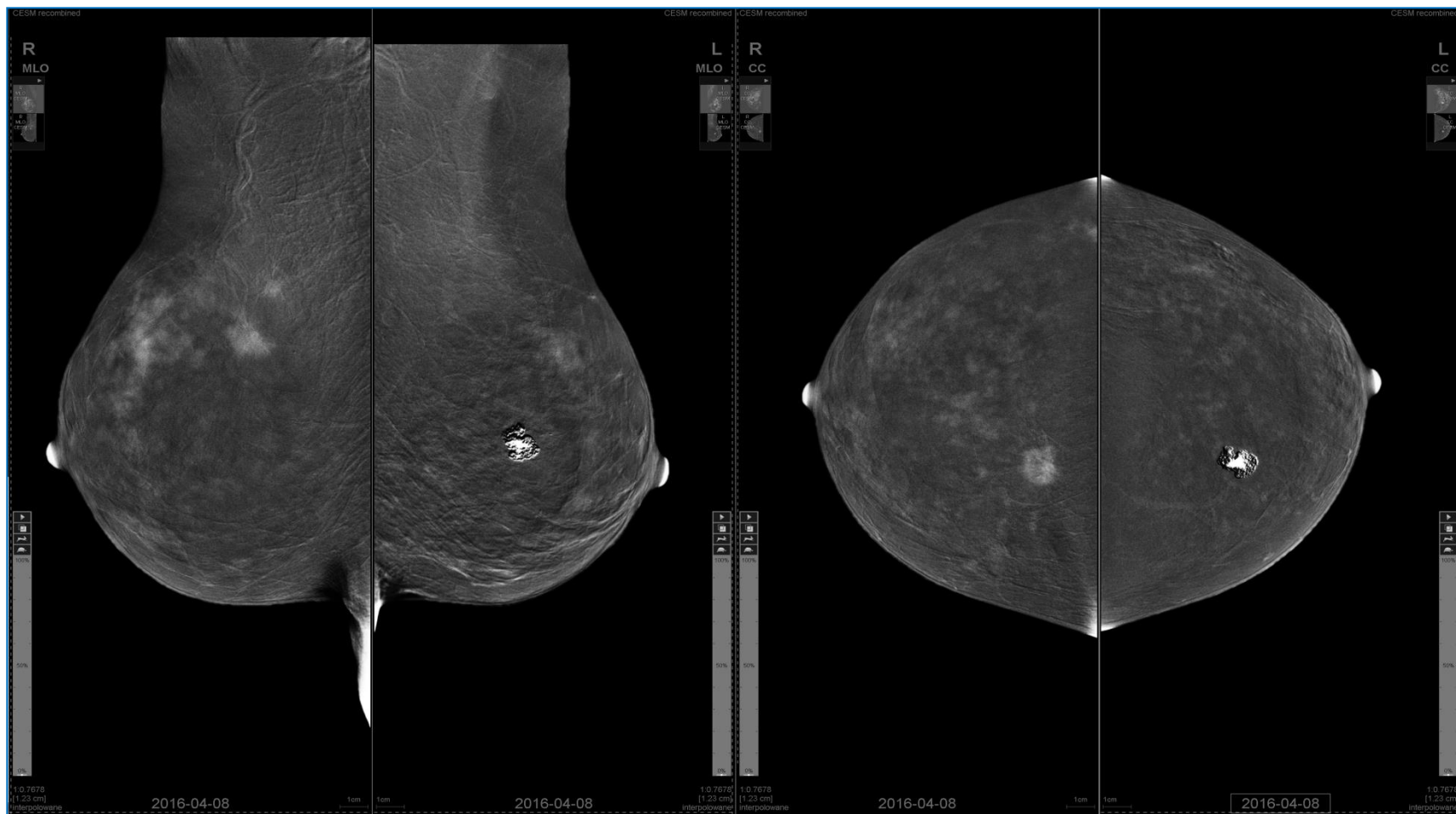




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## CESM

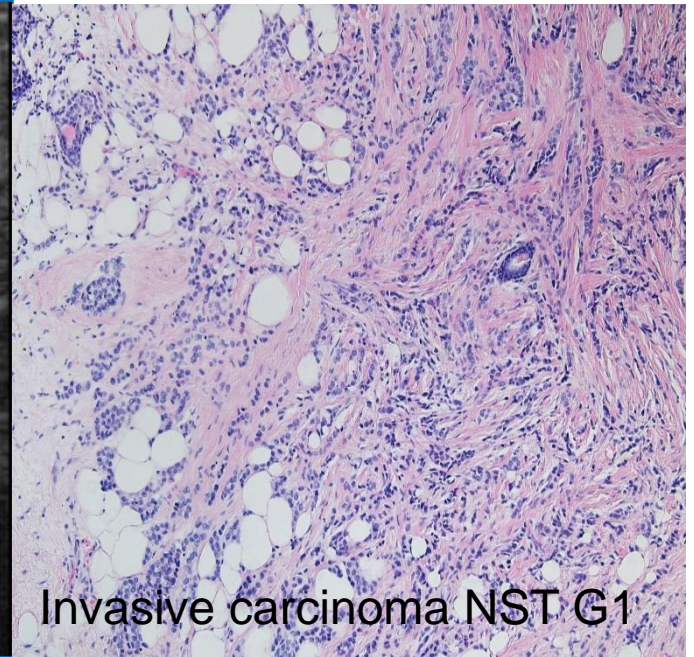
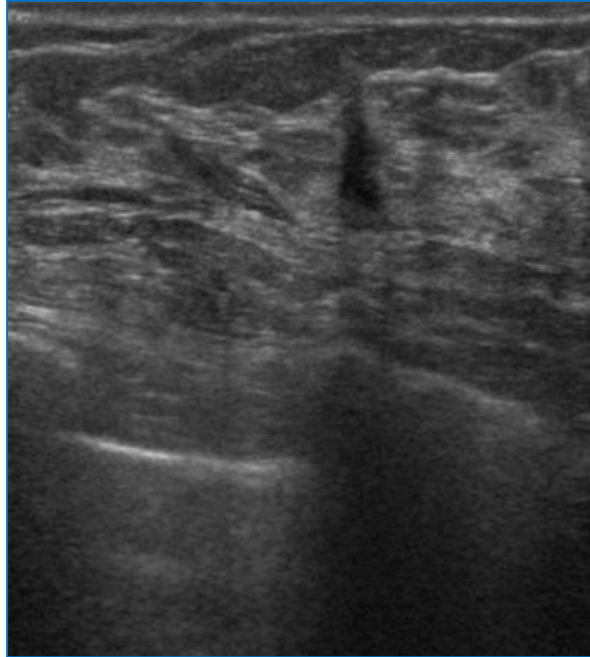
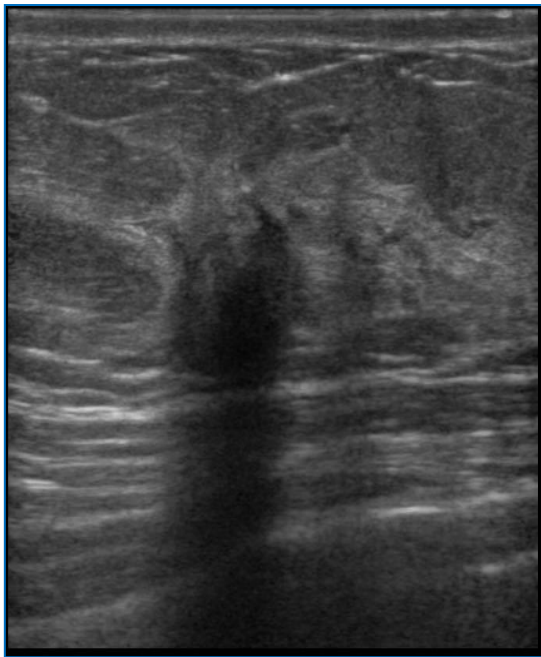






# Extent of Disease/ Management Decisions New Tools

## Second look ultrasound after CESM and histopathology



Invasive carcinoma NST G1



## Extent of Disease/ Management Decisions New Tools

- 1.5 T – 3 T MRI and a dedicated 4-channel or 16-channel (NORAS) breast coils

### Protocol:

- T1-weighted TSE sequence,
- T2-weighted TSE,
- T2-weighted TSE with fat saturation (SPAIR),
- DWI/ADC in transversal plane,
- transverse 3D FLASH T1-weighted gradient-echo dynamic sequence performed before and after the administration of contrast agent, followed by 7 repetitions of the same sequence.





# Extent of Disease/ Management Decisions

## New Tools

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### Breast MRI- main indications:

- Looking for primary foci in patients with enlarged axillary lymph nodes without focal lesions visible on mammography
- Assessing lesion size and its extent in case of lobular cancer
- Differentiating between scar and neoplastic recurrence
- Monitoring of neoadjuvant chemotherapy
- Implants evaluation
- Screening examination among high-risk women

*Malur S, Wurdinger S, Moritz A, Michels W, Schneider A. Comparison of written reports of mammography, sonography and magnetic resonance mammography for preoperative evaluation of breast lesions, with special emphasis on magnetic resonance mammography. Breast Cancer Res 2001;3:55-60*

*Buchanan CL, Morris EA, Doru PL et al. Utility of breast magnetic imaging in patients with occult primary breast cancer. Amer Surg Oncol 2005;12:1045-1053*  
*Argus A, Mahoney M.C, Indications for Breast MRI: Case-Based Review AJR:196, 2011*

*Berg WA, Gutierrez L, Ness Aiver MS, et al. Diagnostic accuracy of mammography, clinical examination, US, and MR imaging in preoperative assessment of breast cancer. Radiology 2004; 233:830-849*

*Juanpere s., Perez E., Huc o., Motos N., Pont J, Pedraza S, Imaging of breast implantsa pictorial review. Insights Imaging 2011, 2:653-70*

*Sardanelli F, Podo F Breast MR imaging in women at high-risk of breast cancer. Is something changing in early breast cancer detection? Eur Radiol 2007,17:873–887.*





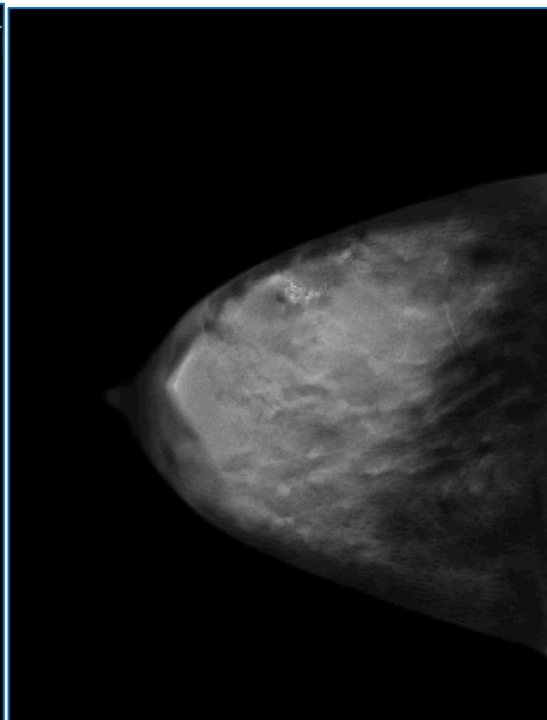
## Extent of Disease/ Management Decisions New Tools

Contraindications to MRI include:

- pacemakers
- a metallic foreign body in the orbit
- some aneurysm clips
- claustrophobia
- other factors, such as orthopedic spinal hardware, which can degrade the image quality and interpretation

## Extent of Disease/ Management Decisions New Tools

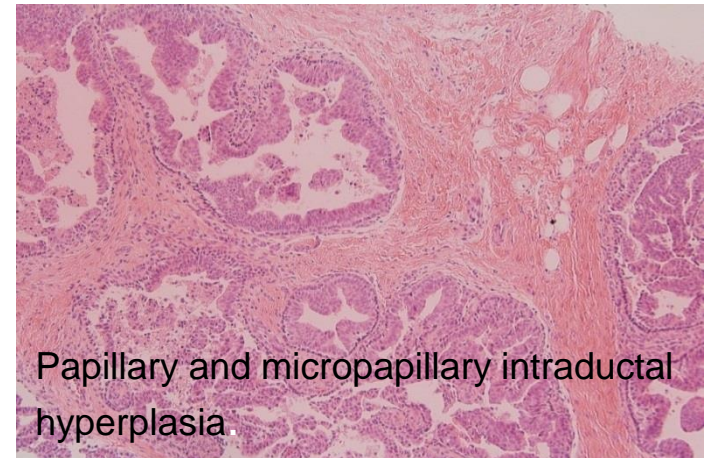
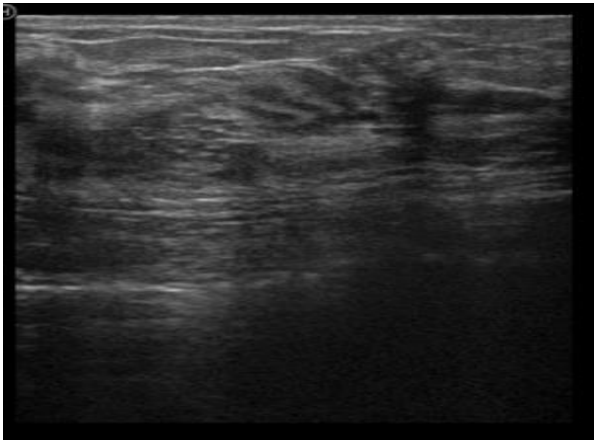
34-y/o patient. Palpable lesion in the right breast on the border of outer quadrants present for 1.5 year. Visible cysts on US examination. Pregnancy, follow-up. US 4 months after delivery revealed hypoechogenic, heterogenous lesion, 45 mm in diameter.





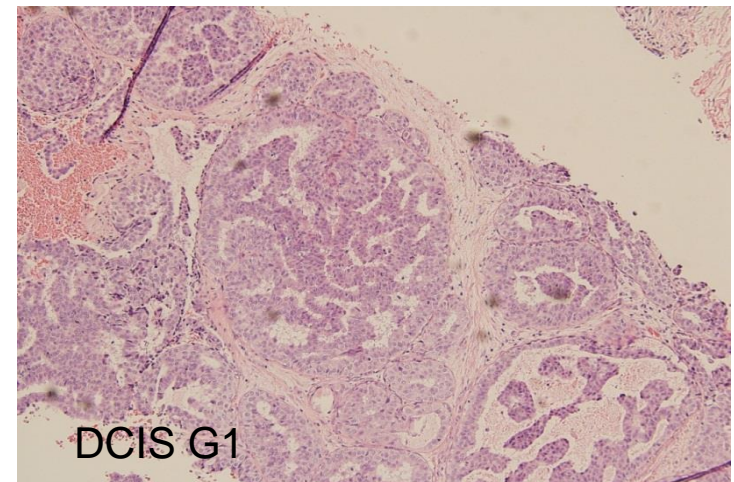
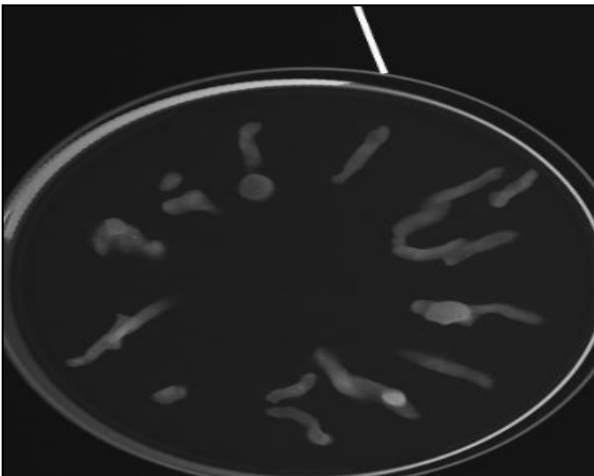
# Extent of Disease/ Management Decisions New Tools

## 1. Core biopsy under ultrasound



Papillary and micropapillary intraductal hyperplasia

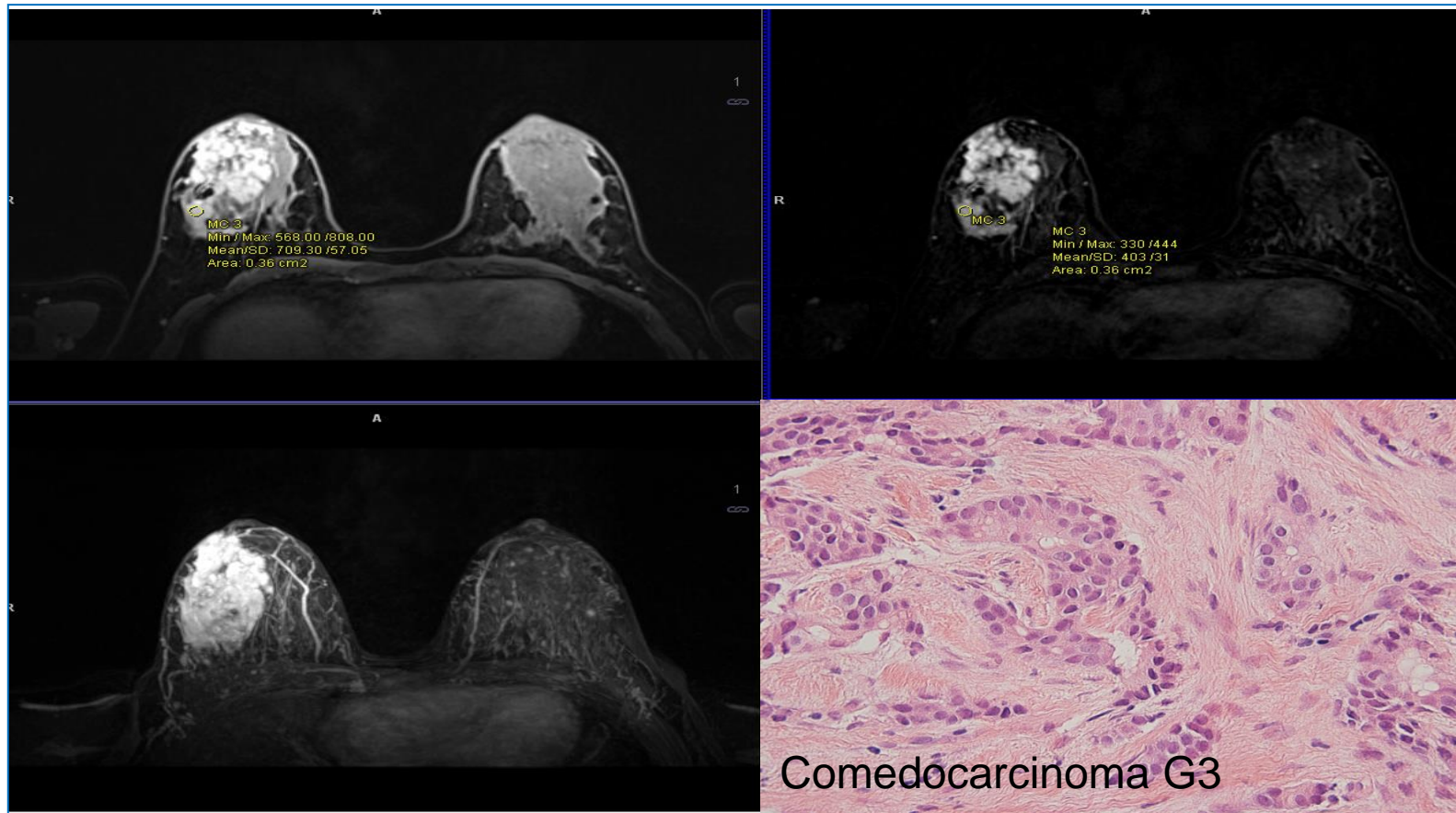
## 2. VABB under mammography



DCIS G1

# Extent of Disease/ Management Decisions New Tools

## MRI examination and histopathology after operation





# Extent of Disease/ Management Decisions

## New Tools

- Positron emission mammography (PEM) is a new imaging modality that has higher resolution than PET-CT and can be performed on patients unable to have an MRI scan
- PEM uses a pair of dedicated gamma radiation detectors placed above and below the breast and mild breast compression to detect coincident gamma rays after administration of fluorine-18 fluorodeoxyglucose ( $^{18}\text{F}$ -FDG)
- PEM is optimized for small body parts and utilizes gentle immobilization of the breast to attain higher spatial resolution (1–2 mm for PEM vs 4–6 mm for PET), as well as minimize the radiation dose by reducing breast thickness





# Extent of Disease/ Management Decisions New Tools

## MAMMO PET



- FDG (activity 185-370 MBq) – administered intravenously
- Mild breast immobilization
- Image acquisition in CC and MLO views
- Time: 4-10 min/screening

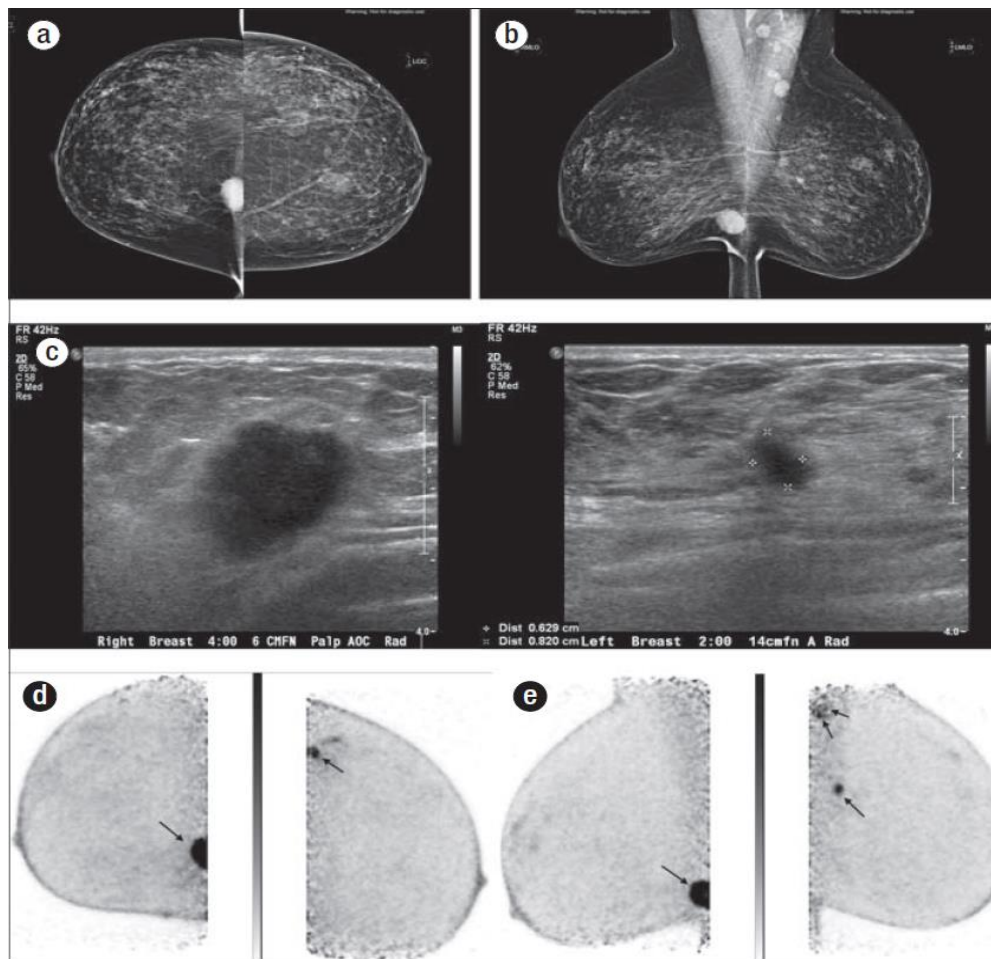




# Extent of Disease/ Management Decisions

## New Tools

Bilateral infiltrating grade 1 carcinoma with mixed lobular and ductal features in a 56-year-old woman



## Extent of Disease/ Management Decisions New Tools

### Take home:

- Breast cancer diagnostics is a complex process
- CESM permitted better detection of malignant lesions than both MG and US individually
- More lesions are visible on tomosynthesis than on mammography and also the extent of disease is bigger
- The role of MRI in breast cancer diagnostics has already been established as a method characterized by high sensitivity, slightly less specificity and independent from breast anatomy
- PEM may be considered as a method improving breast cancer diagnostics.



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**Thank you for your attention**