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Breast MRI

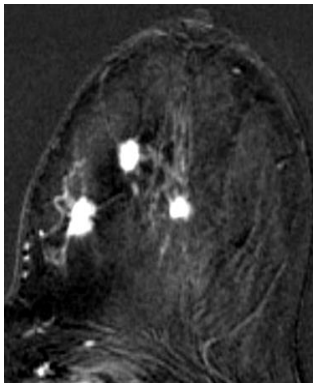
Dr M Telesca
Consultant Radiologist
Worcestershire Acute Hospitals NHS Trust

2010

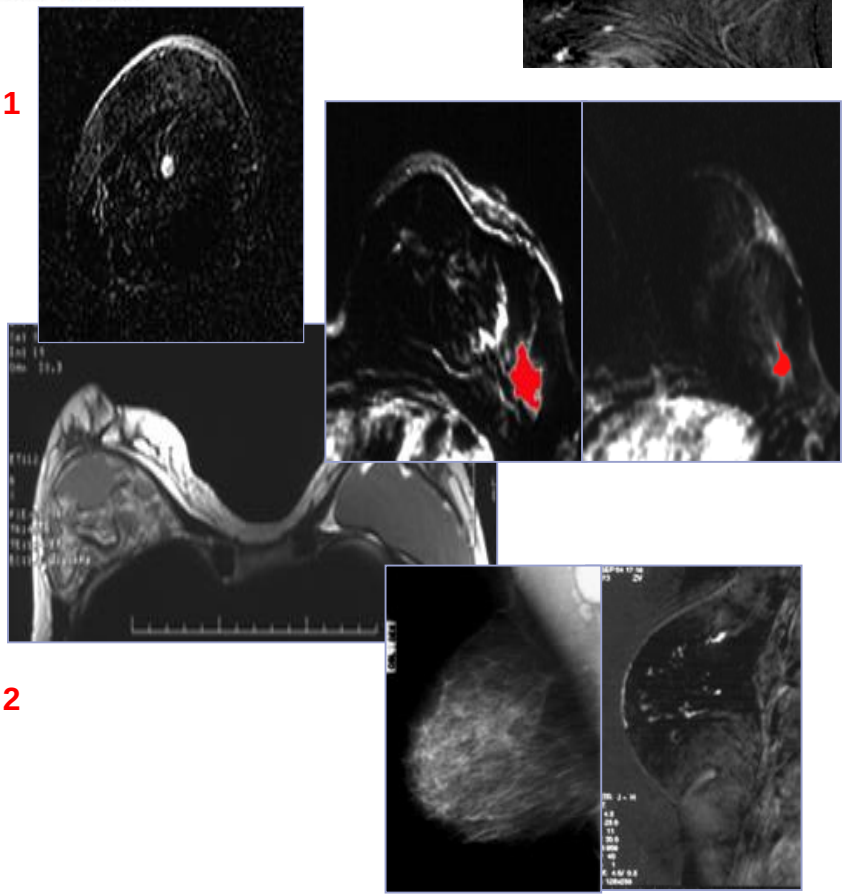
Position Paper

Magnetic resonance imaging of the breast: Recommendations from the EUSOMA working group

Francesco Sardanelli [a,], Carla Boetes [b], Bettina Borisch [c], Thomas Decker [d], Massimo Federico [e], Fiona J. Gilbert [f], Thomas Helbich [g], Sylvia H. Heywang-Köbrunner [h], Werner A. Kaiser [i], Michael J. Kerin [j], Robert E. Mansel [k], Lorenza Marotti [l], Laura Martincich [m], Louis Mauriac [n], Hanne Meijers-Heijboer [o], Roberto Orecchia [p], Pietro Panizza [q], Antonio Ponti [r], Arnie D. Purushotham [s], Peter Regitnig [t], Marco Rosselli Del Turco [l], Fabienne Thibault [u], Robin Wilson [v]*



1.	**Staging (preop MRI)**	**Limited[1]**
2.	**Screening high-risk women**	**YES**
3.	**Evaluation of response to NAC**	**YES**
4.	**Augmentation or reconstruction** (*suspected implant rupture*)	**YES**
5.	**Occult primary breast cancer**	**YES**
6.	**Suspected local recurrence**	**YES**
7.	**Equivocal findings at mammo/US**	**Limited[2]**



[1] ILC, high-risk, Mx/US size discrepancy, PBI

[2] When CNB/VAB cannot be performed

Local staging

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Recommended

- Invasive lobular carcinoma
- High risk patients
- Discordance in tumour size assessment (>1cm)
- ?Eligible for PBI

Evidence needed – creeping practice

- Dense breasts
- Involved/close margins
- Unilateral, unifocal pure DCIS (?synchronous invasive)
- Paget's disease

(*Ann Surg* 2013;257: 249–255)

META-ANALYSIS

Preoperative Magnetic Resonance Imaging in Breast Cancer

Meta-Analysis of Surgical Outcomes

Nehmat Houssami, MBBS, PhD, Robin Turner, PhD,* and Monica Morrow, MD†*

Background and Objective: The role of breast magnetic resonance imaging (MRI) in women newly diagnosed with breast cancer (BC) is controversial. This meta-analysis examines the effect of preoperative MRI compared with standard preoperative assessment on surgical outcomes, focusing on studies that used a controlled design.

Methods: Using random-effects logistic meta-regression modeling, we estimated the proportion of women with each outcome in the MRI versus no-MRI groups, and calculated the odds ratio (OR) and adjusted OR (adjusted for study-level median age, and, where appropriate, for temporal effect) for each model.

Results: There were 9 eligible studies (2 randomized trials; 7 comparative cohorts). Outcomes in 3112 patients with BC (any histological tumor type) for MRI versus no-MRI (referent) were as follows: initial mastectomy 16.4% versus 8.1% [OR, 2.22 ($P < 0.001$); adjusted OR, 3.06 ($P < 0.001$)]; re-excision after initial breast conservation 11.6% versus 11.4% [OR, 1.02 ($P = 0.87$); adjusted OR, 0.95 ($P = 0.71$)]; overall mastectomy 25.5% versus 18.2% [OR, 1.54 ($P < 0.001$); adjusted OR, 1.51 ($P < 0.001$)]. In 766 patients with invasive lobular cancer (ILC), outcomes were as follows: initial mastectomy 31.1% versus 24.9% [OR, 1.36 ($P = 0.056$); adjusted OR, 2.12 ($P = 0.008$)]; re-excision after initial breast conservation 10.9% versus 18.0% [OR, 0.56 ($P = 0.031$); adjusted OR, 0.56 ($P = 0.09$)]; overall mastectomy 43.0% versus 40.2% [OR, 1.12 ($P = 0.45$); adjusted OR, 1.64 ($P = 0.034$)].

Conclusions: Our summary of the evidence showed that MRI significantly increased mastectomy rates and suggests an unfavorable harm-benefit ratio for routine use of preoperative MRI in BC. We found weak evidence that MRI reduced re-excision surgery in patients with ILC —although this was at the expense of increased mastectomies—and overall patient benefit from MRI in ILC is not clear from this study.

9 studies (2 randomized, 7 comparative) all using a controlled study design

3112 patients with BC

MRI impact on short term surgical outcomes only

- Contralateral preop-MRI depicted 25 (1.4%) additional cancers

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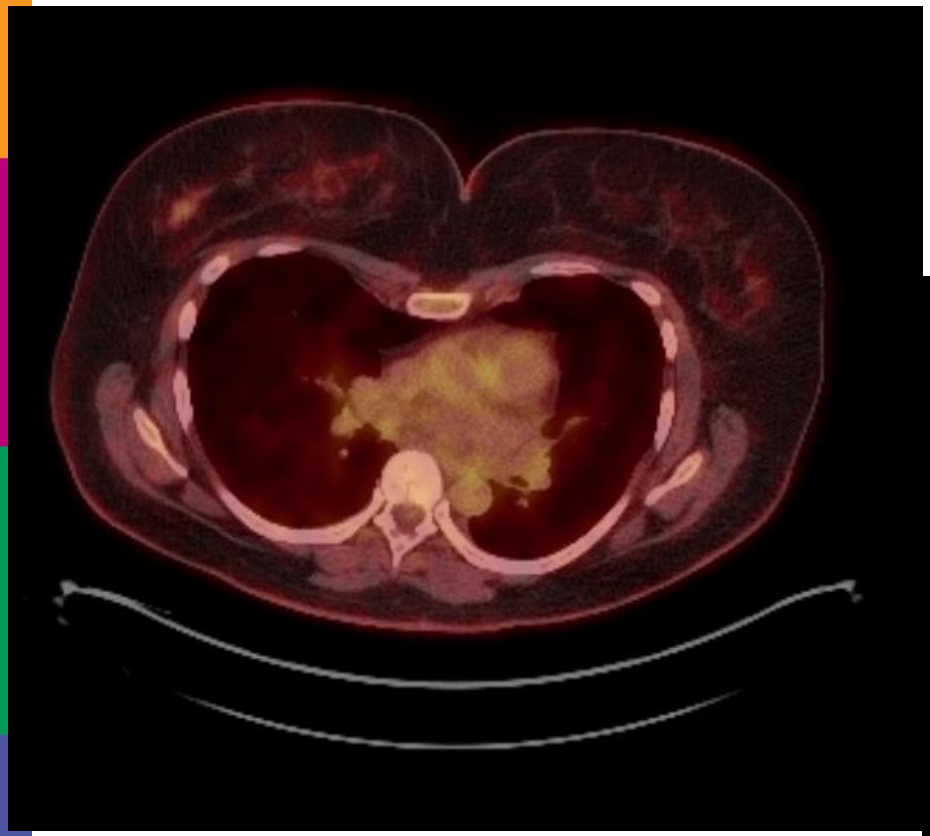

Suspected right lower lobe carcinoid with obstructive atelectasis

Two avid nodules in the R breast. Patient referred for triple assessemnt in the breast clinic

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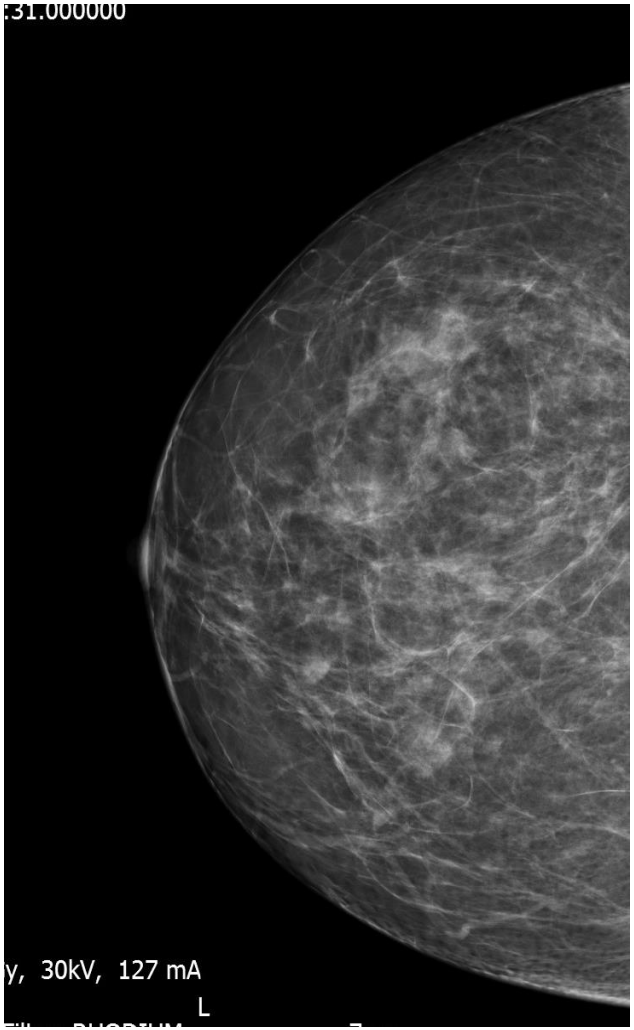

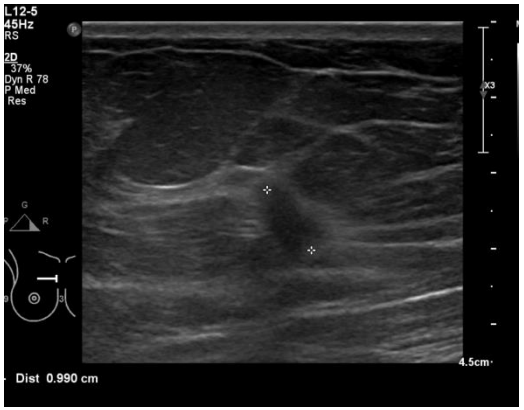

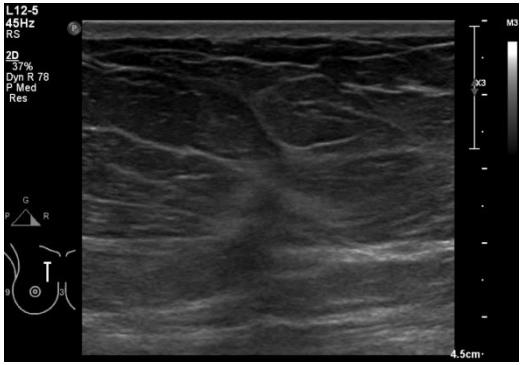


Maps
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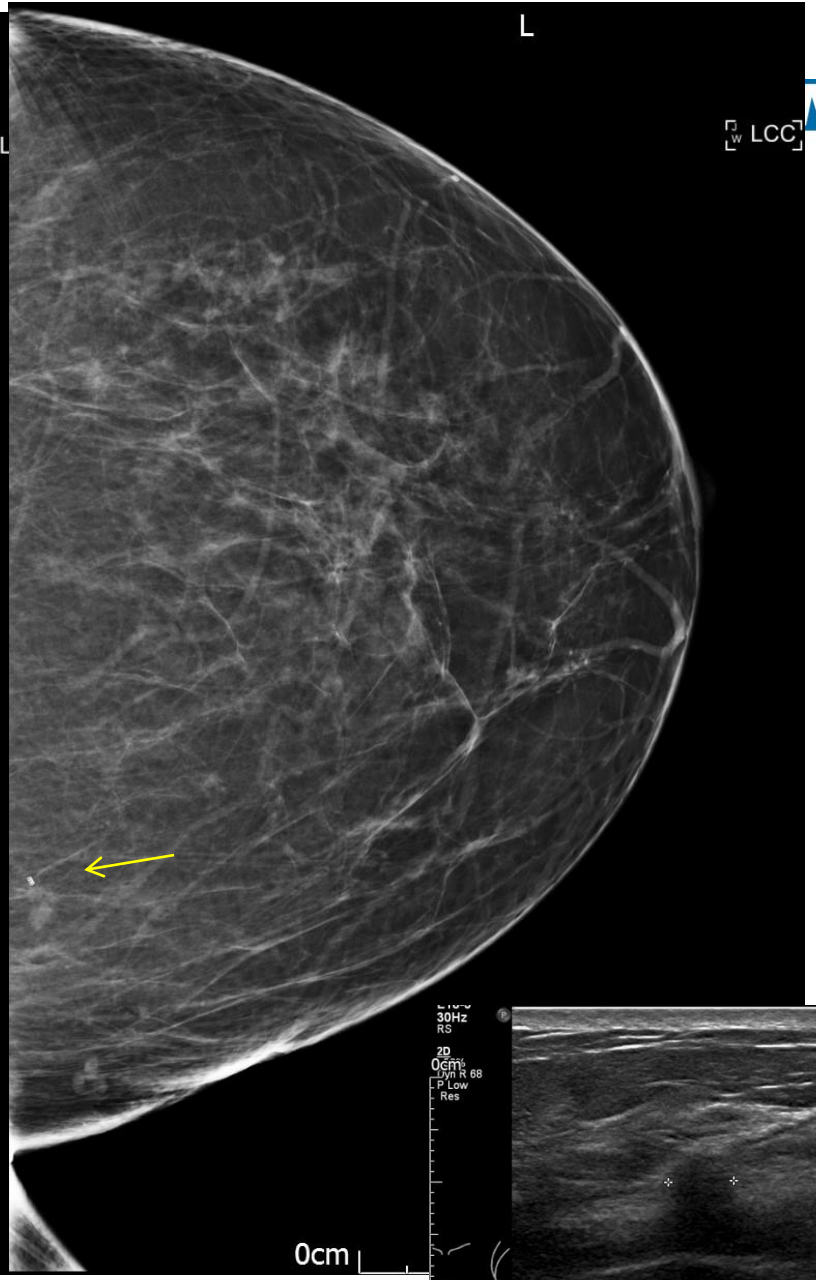
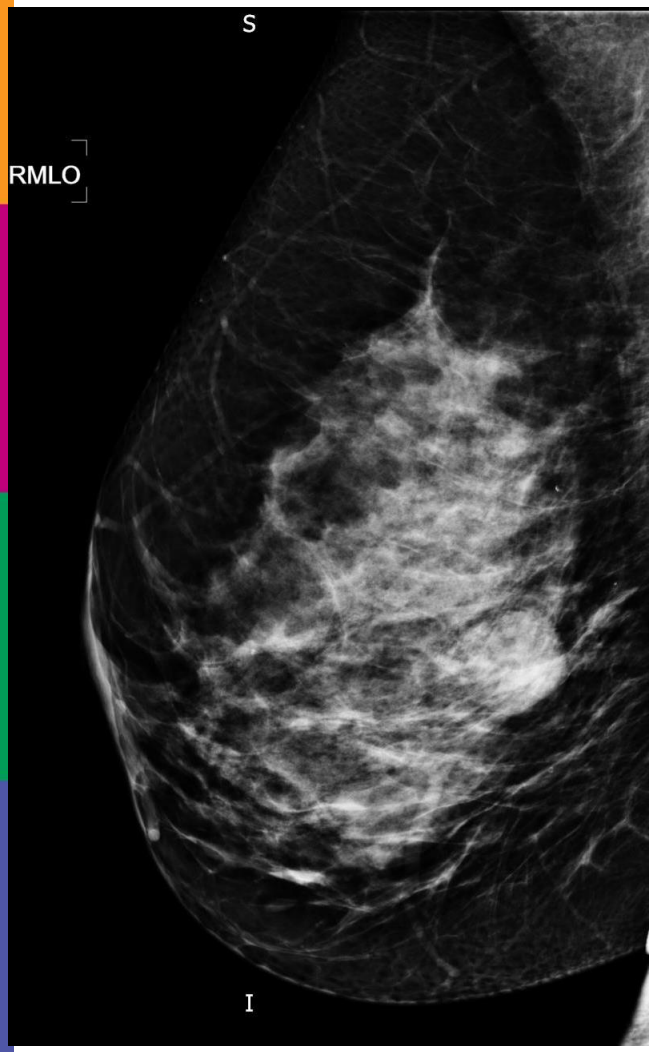
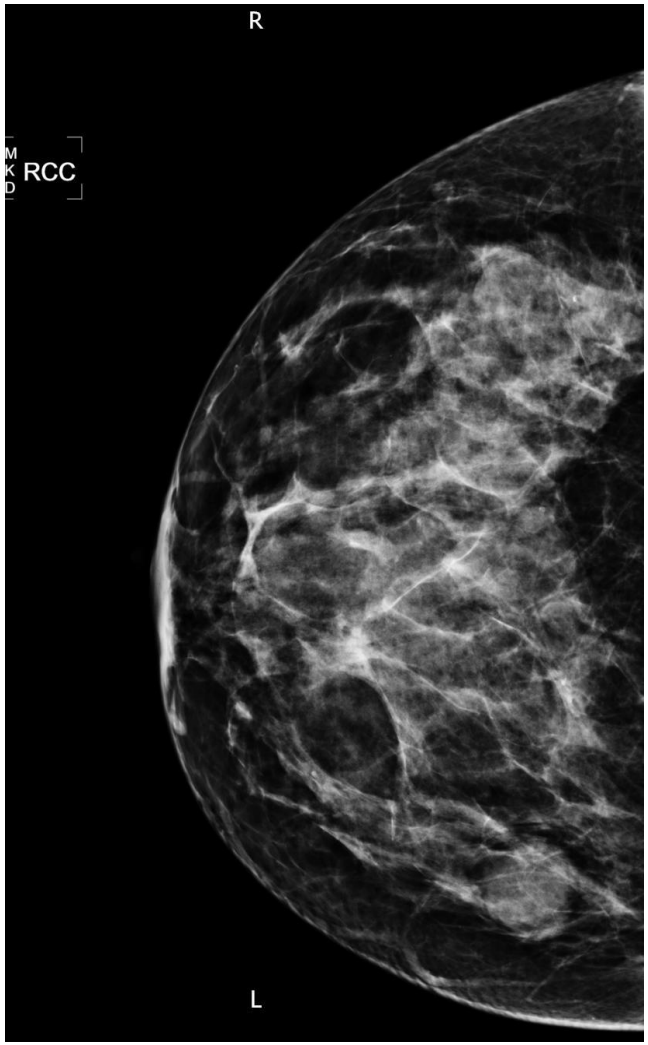


L breast : grade 1 invasive ductal carcinoma;B5b





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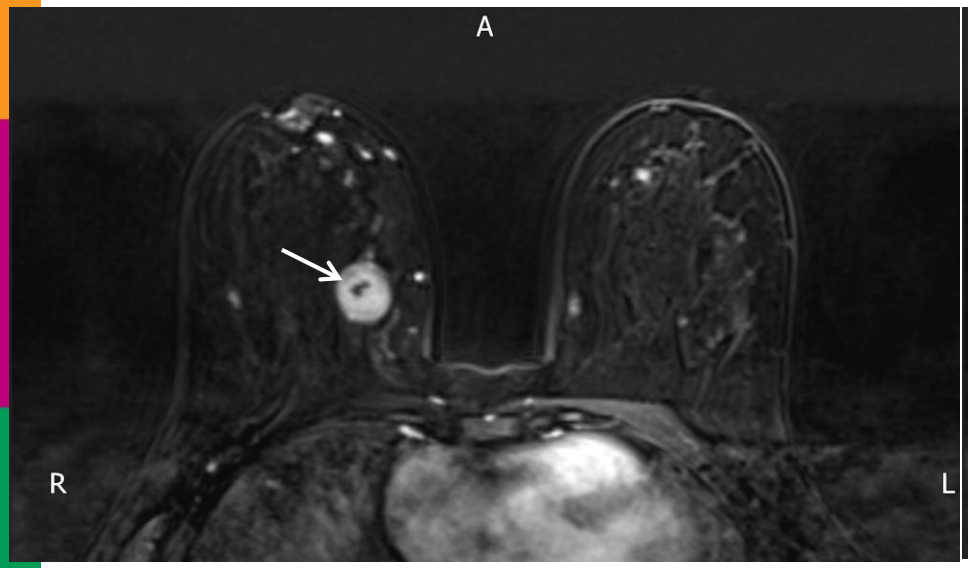
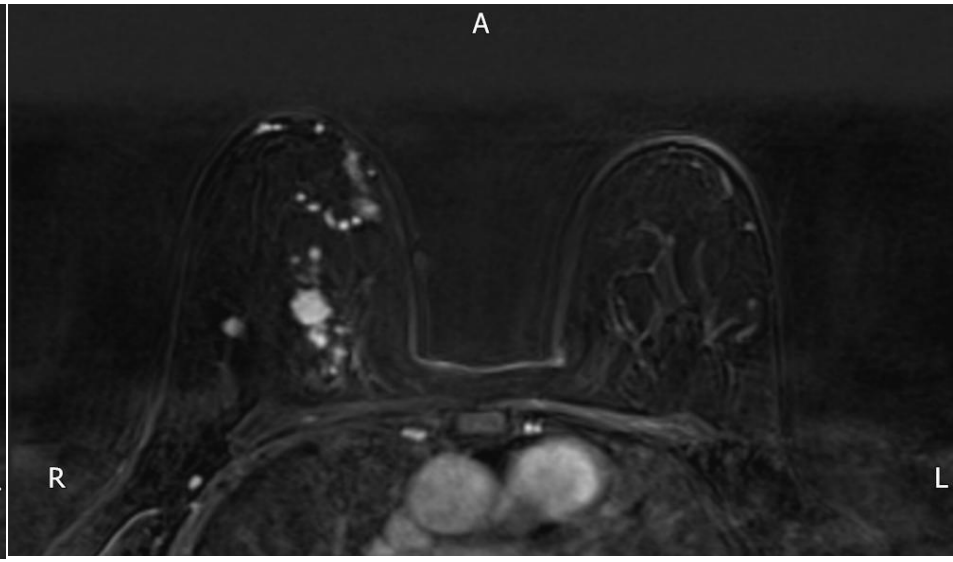
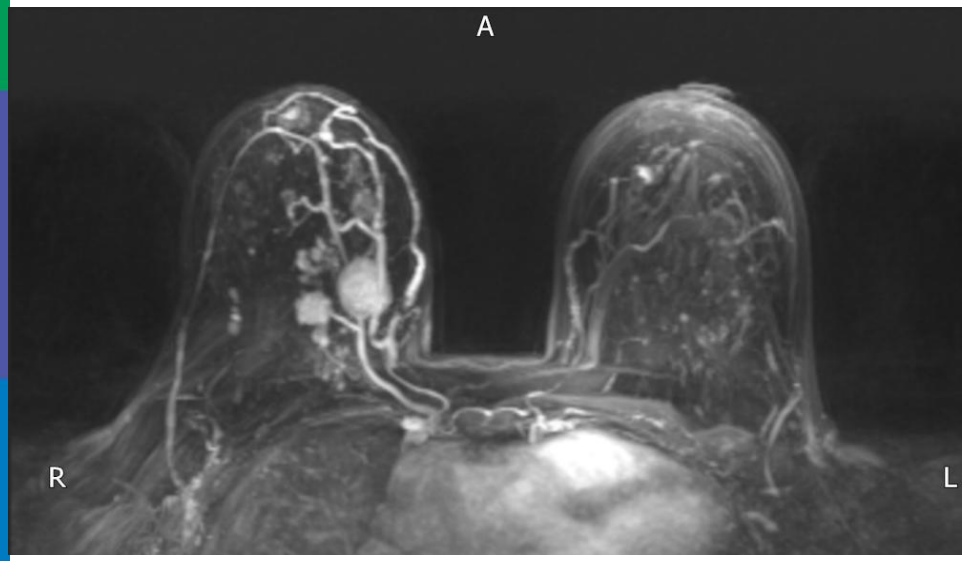
43 yo lady

firm palpable lump at 3 o'clock in the right breast.

US guide core:
G3 IDC







Multicentric disease: mastectomy

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INVASIVE LOBULAR CARCINOMA

MRI	83-100%
Mx	57–81%
US	68–87%

MRI sensitivity for detecting ILC is superior to MX and US

Brem RF, Am J Roentgenol 2009;192:379–83.
Mann RM. Breast Cancer Res Treat 2008;107:1–14.

Breast Cancer Res Treat (2010) 119:415–422
DOI 10.1007/s10549-009-0616-6

CLINICAL TRIAL

The impact of preoperative breast MRI on the re-excision rate in invasive lobular carcinoma of the breast

R. M. Mann · C. E. Loo · T. Wobbes · P. Bult · J. O. Barentsz · K. G. A. Gilhuijs · C. Boetes

Table 3 Rate of re-excisions and mastectomies in the entire study population

	MR− ($N = 168$)	MR+ ($N = 99$)	P value
Re-excisions	25 (15)	5 (5)	0.014
Initial mastectomies	78 (46)	44 (45)	0.753
Final mastectomies	99 (59)	48 (48)	0.098

Numbers between parenthesis represent percentages

Table 4 Results in the subset of patients that initially underwent BCS

	MRI−	MRI+	P value
N	90	55	
Mean tumor size (cm)	2.1 ± 1.4	2.0 ± 1.4	0.724
Multifocal	37 (41)	19 (34)	0.431
Re-excisions	24 (27)	5 (9)	0.010
Final mastectomies	21 (23)	4 (7)	0.013

Numbers between parenthesis represent percentages

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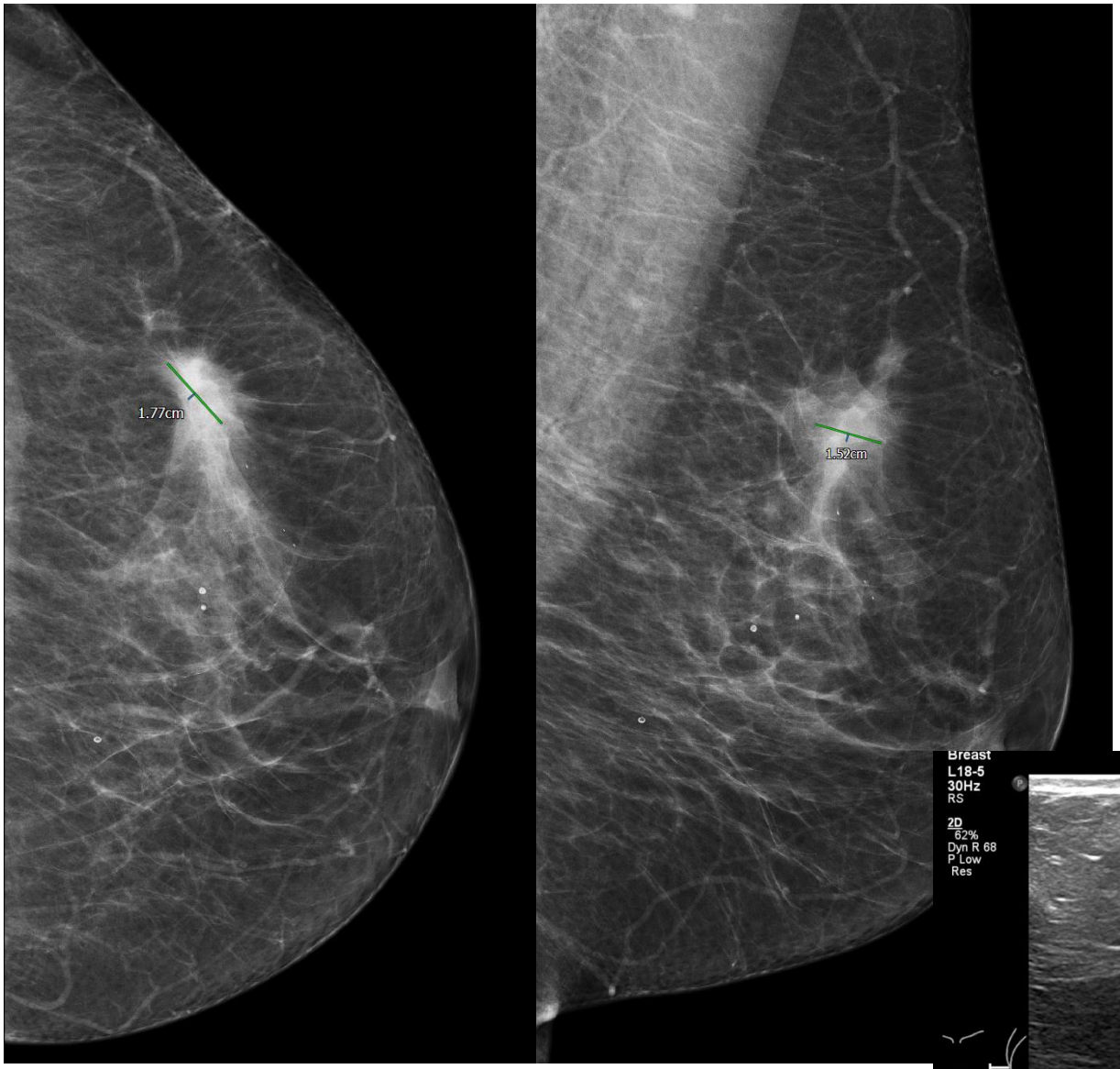
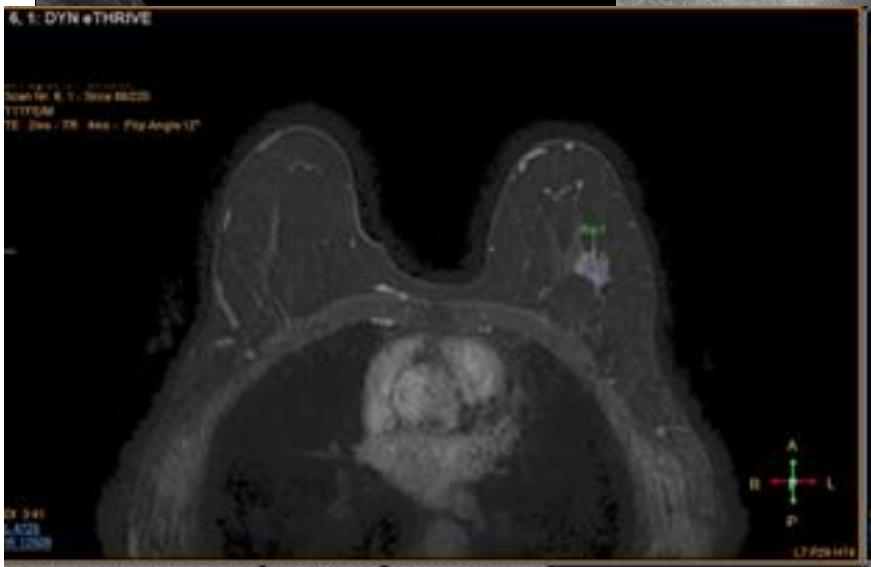
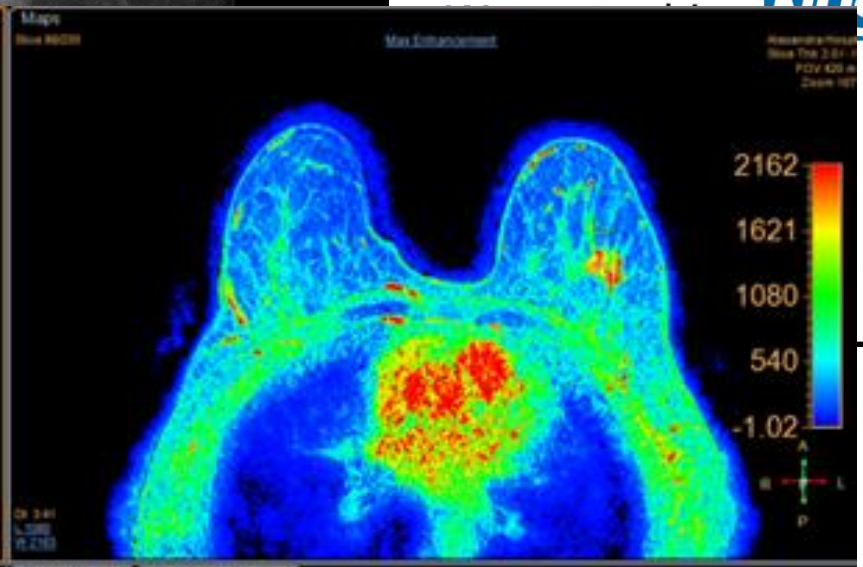


73 yo lady

screen detected ILC L breast


6, 1: DYN eTHRIVE


Maps
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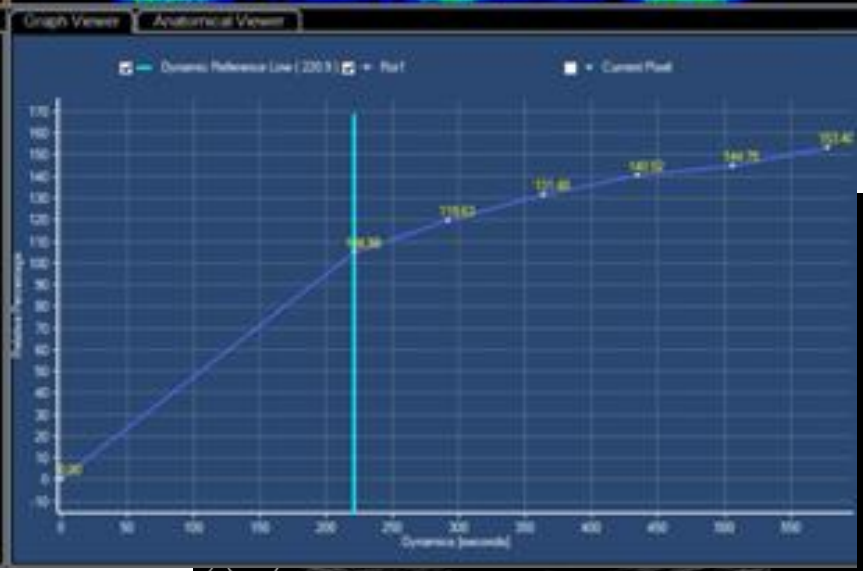
Subtracted - 6, 1: DYN eTHRIVE
Table Viewer
Anatomical Viewer


Graph Viewer
Anatomical Viewer

Dist 2.21 cm
3.5cm

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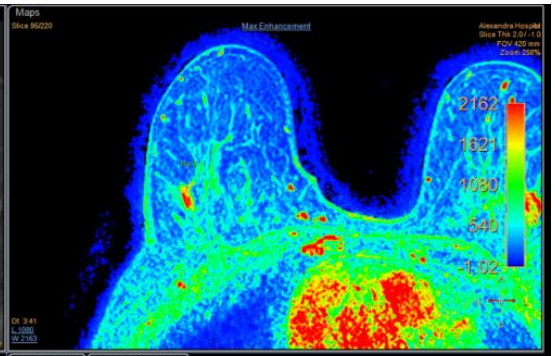

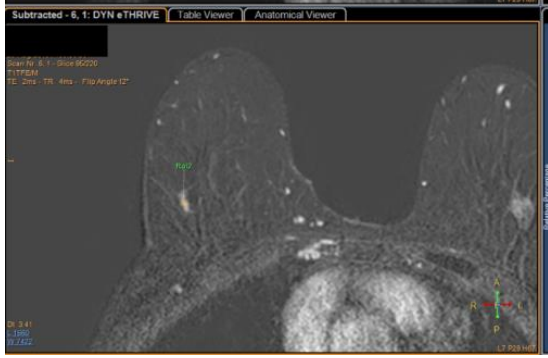

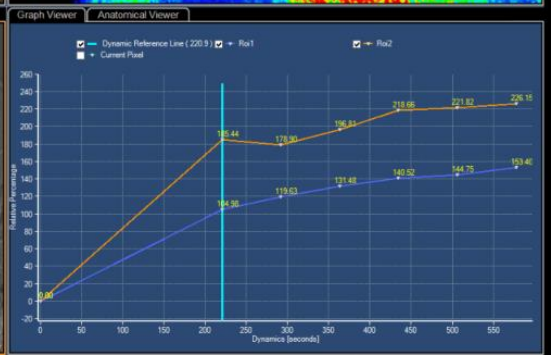

SCREENING FOR HIGH RISK PATIENTS

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Annual MRI as screening test to selected population:

- High risk = >20 – 30% lifetime risk
- Genetic/family history
- Previous high dose RT
- Prior to risk reducing mastectomy – within 3/12

SCREENING FOR HIGH RISK PATIENTS

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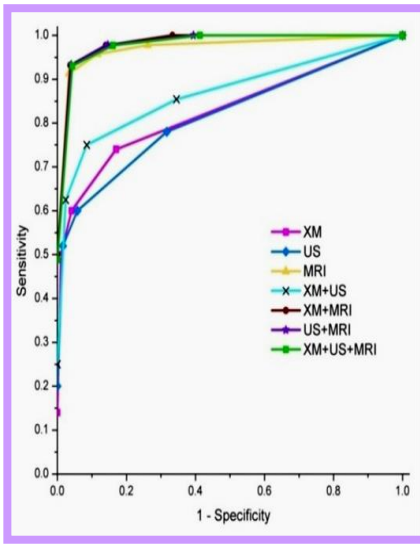
HIBCRIT-1

Modality	*Sensitivity %*	*Specificity %*	*PPV2 %*	*NPV %*
CBE	17.6	**99.4**	60.0	96.1
Mammography	50.0	**99.1**	73.5	97.6
US	52.0	**99.2**	76.5	97.7
MRI	**91.3 ***	**97.4**	**61.8**	**99.6 ***
Mam + US	62.5	**98.4**	65.2	98.2
MRI + Mammo	93.2	**97.0**	58.6	99.7
MRI + US	93.3	**97.1**	60.0	99.7

18 centers
501 women
1592 rounds

* Stat significant



Sensitivity for pT1a-b

Mammo & US	10/20	*50%*
MRI	18/19	*95%*

Sardanelli F et al. Invest Radiol 2011

SCREENING FOR HIGH RISK PATIENTS

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VOLUME 32 · NUMBER 22 · AUGUST 1 2014

JOURNAL OF CLINICAL ONCOLOGY ORIGINAL REPORT

Abbreviated Breast Magnetic Resonance Imaging (MRI): First Postcontrast Subtracted Images and Maximum-Intensity Projection—A Novel Approach to Breast Cancer Screening With MRI

Christiane K. Kuhl, Simone Schrading, Kevin Strobel, Hans H. Schild, Ralf-Dieter Hilgers, and Heribert B. Bieling

-prospective observational study in 443 who underwent 606 screening MRIs.

-17 minutes versus 3 minutes MRI reading protocol

-11 breast cancers were diagnosed. Median tumor sixe of 8.4 mm.

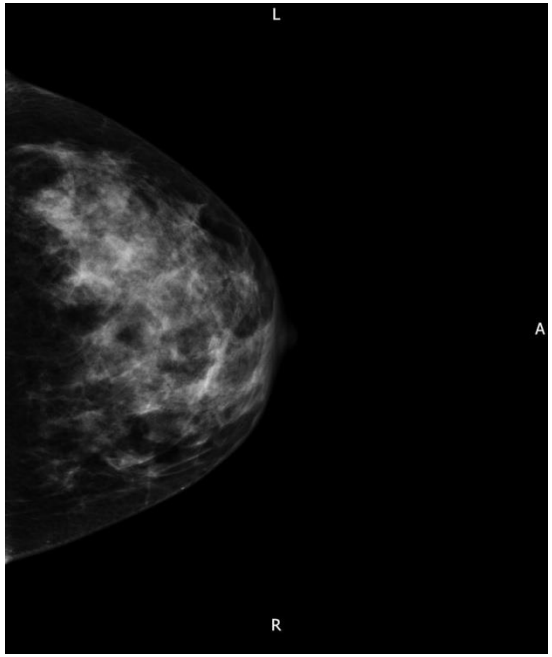
-MIP readings were positive in 10 (90.9%) of 11 cancers, with a negative predictive value (NPV) of 99.8% (418 of 419).

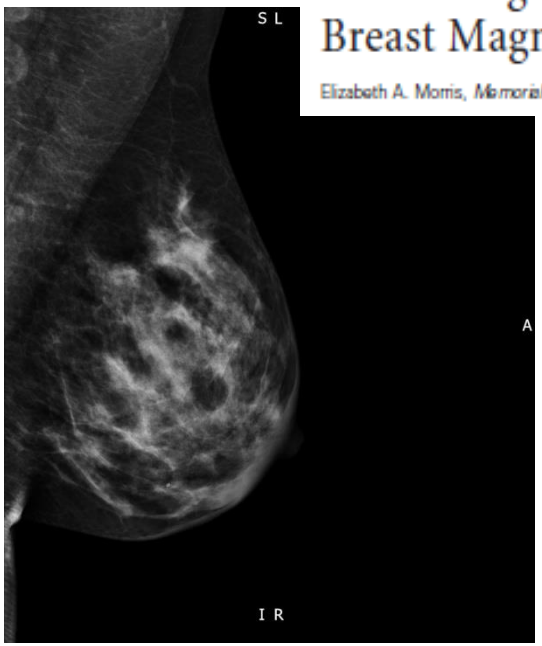
Conclusion

An MRI acquisition time of 3 minutes and an expert radiologist MIP image reading time of 3 seconds are sufficient to establish the absence of breast cancer, with an NPV of 99.8%. With a reading time < 30 seconds for the complete AP, diagnostic accuracy was equivalent to that of the FDP and resulted in an additional cancer yield of 18.2 per 1,000.

VOLUME 32 · NUMBER 22 · AUGUST 1 2014
JOURNAL OF CLINICAL ONCOLOGY
EDITORIAL

SCREENING FOR HIGH RISK PATIENTS





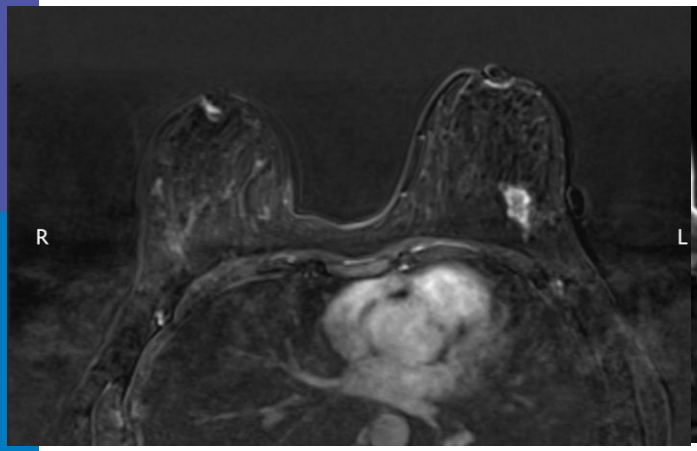
Rethinking Breast Cancer Screening: Ultra FAST Breast Magnetic Resonance Imaging

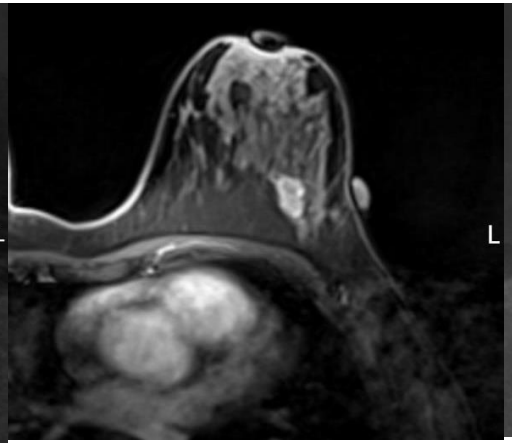
Elizabeth A. Morris, *Memorial Sloan Kettering Cancer Center, New York, NY*

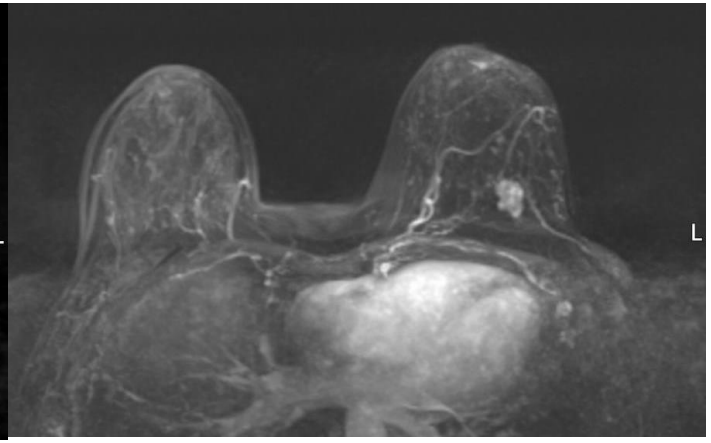
44 yo

BRCA 1 carrier

G2 IDC







50yo
BRCA carrier
Annual screening

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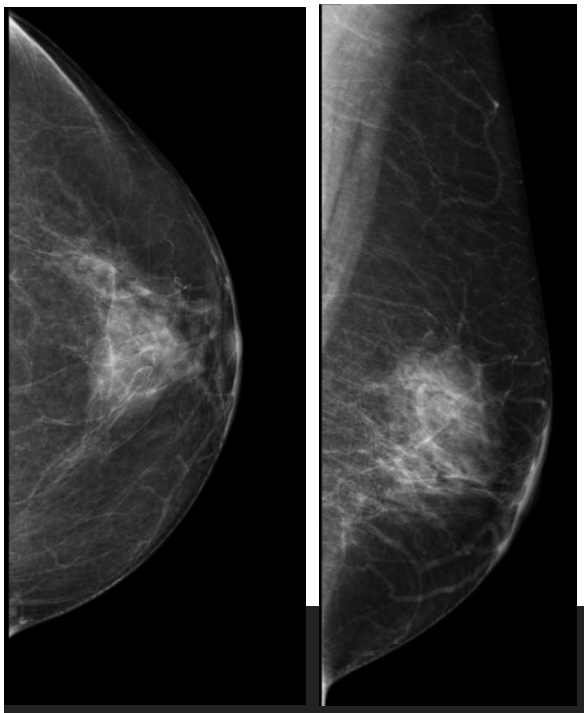

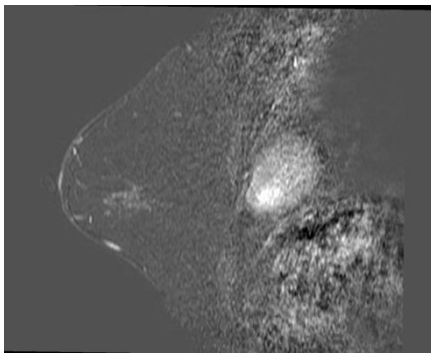

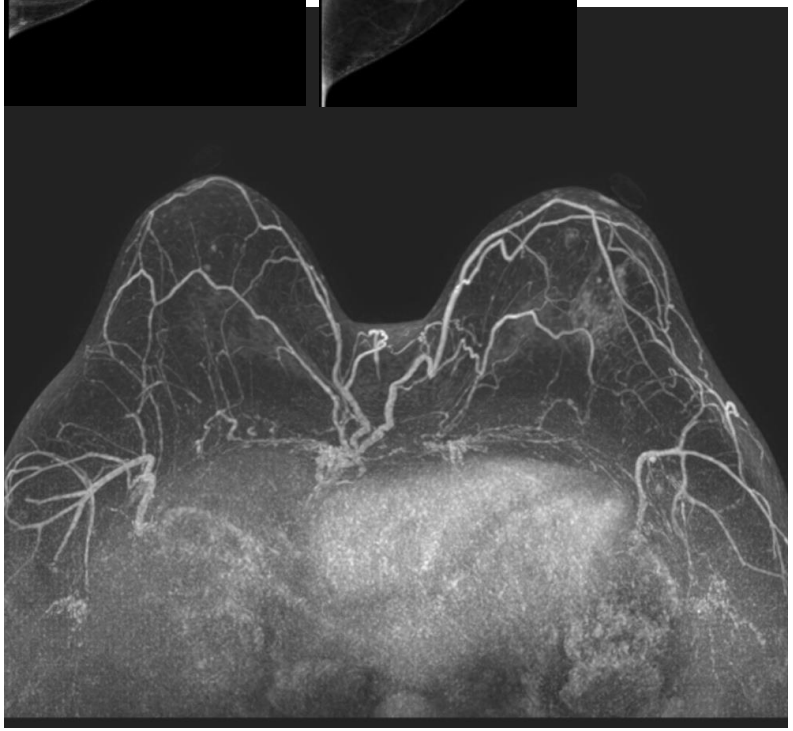

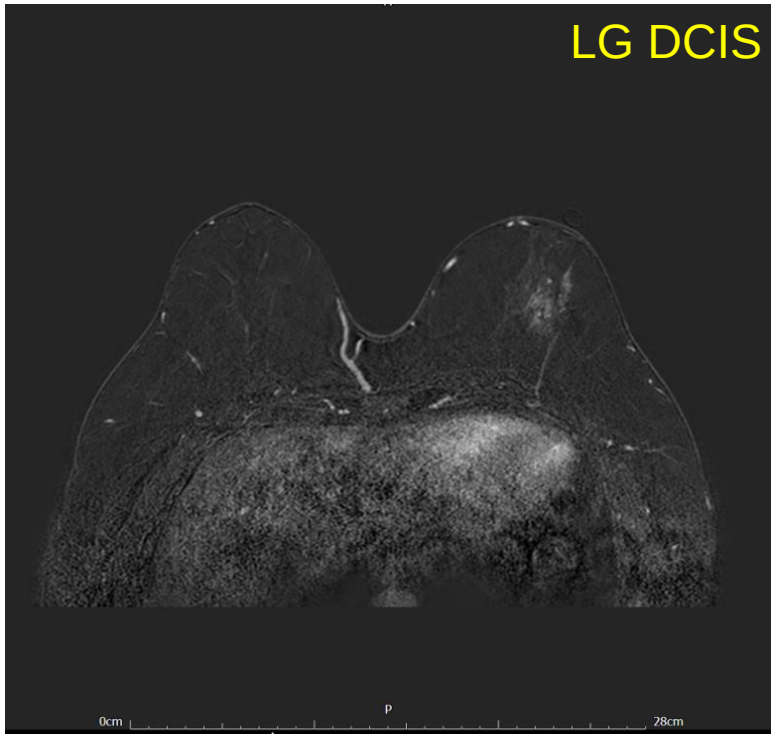

4D-TRAK XD

Field strength	1.5T, 3.0T.
Main applications	Angiography.
Sequence	Dynamic contrast-enhanced MR Angiography.
Maps	MIP's of multiple phases.
Speed	Leverages the efficient dS SENSE parallel imaging technology to provide superior speed performance.[1] High spatial and temporal resolution, simultaneously.
Image quality	Optimal signal-to-noise due to dStream's digitization at the patient.

1 Compared to first generation SENSE.

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4D Time-Resolved Angiography using Keyhole

fast, dynamic contrast-enhanced MR Angiography method with flexible sampling of both the arterial- and venous phase enabling high spatial and temporal resolution simultaneously

European Journal of Radiology 89 (2017) 90–96

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journal homepage: www.elsevier.com/locate/ejrad

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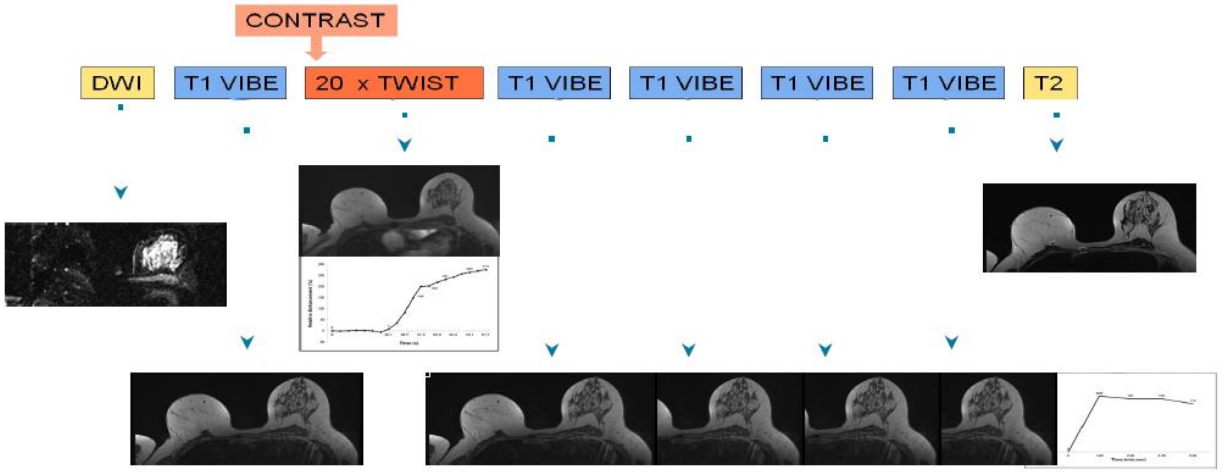
Editorial Musings

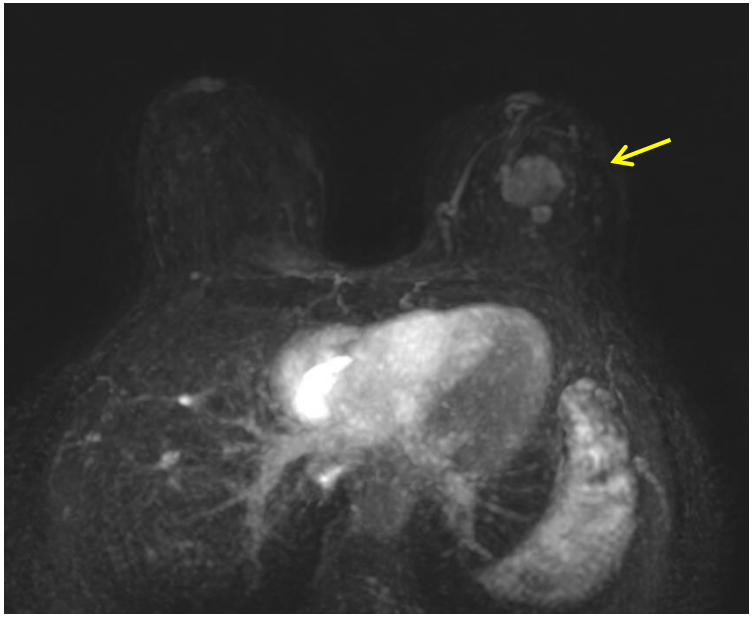
Time to enhancement derived from ultrafast breast MRI as a novel parameter to discriminate benign from malignant breast lesions

Roel D. Mus[a], Cristina Borelli[b,c,*,1], Peter Bult[d], Elisabeth Weiland[e], Nico Karssemeijer[a], Jelle O. Barentsz[a], Albert Gubern-Mérida[a], Bram Platel[a], Ritse M. Mann[a]



TWIST acquisition :102 s.

to compare TTE (time to enhancement) to conventional curve type evaluation as a classifier to discriminate between malignant and benign breast lesions.



4D TRAK

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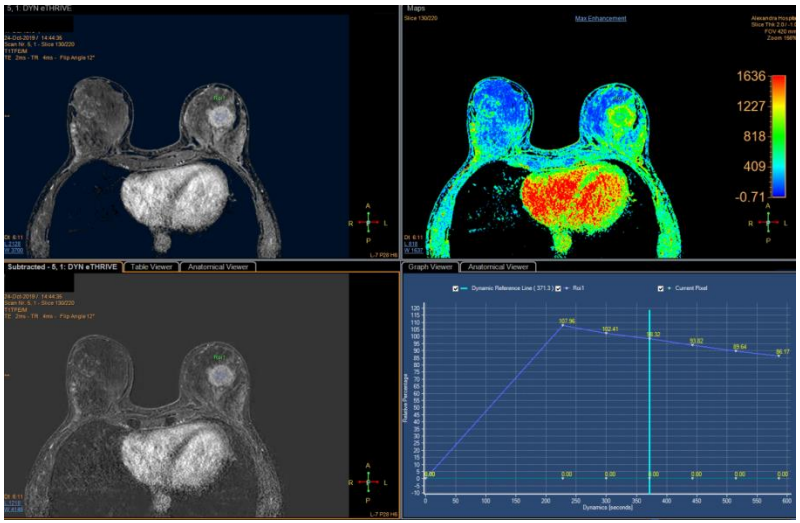
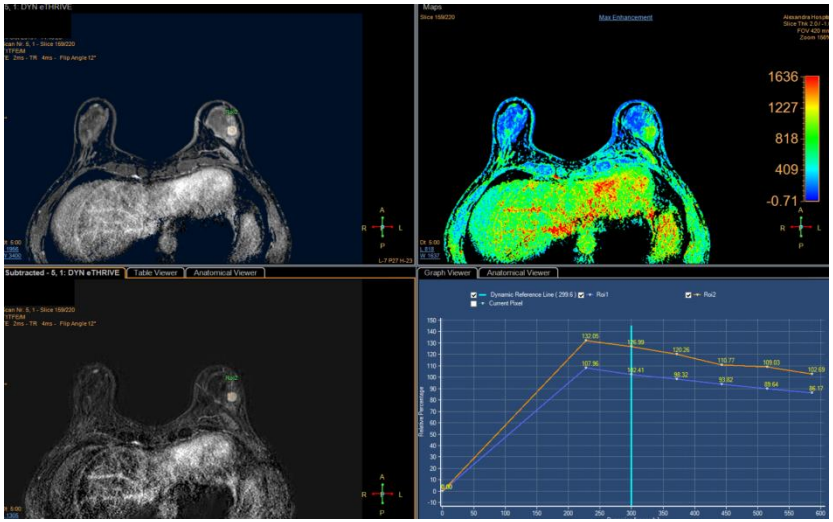
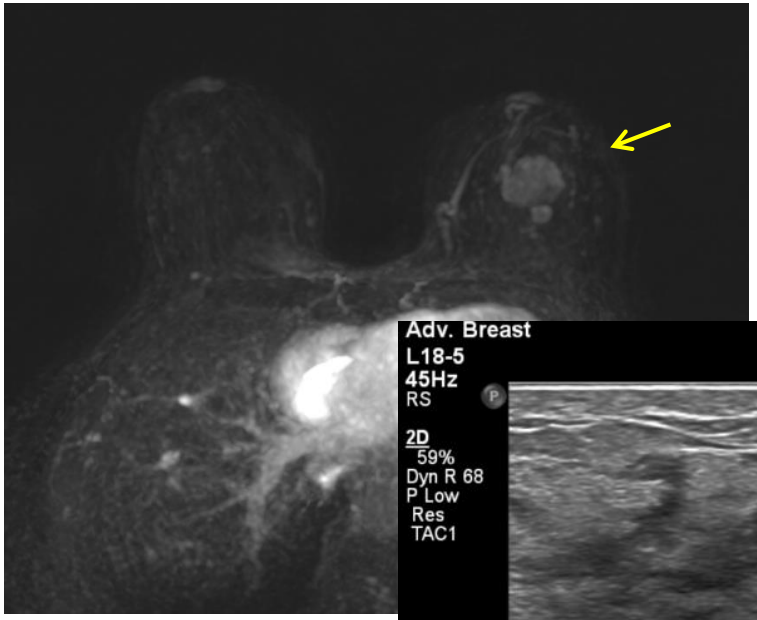
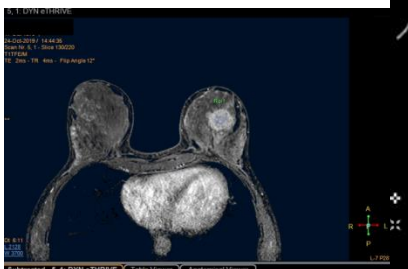


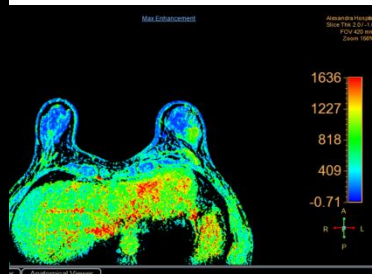


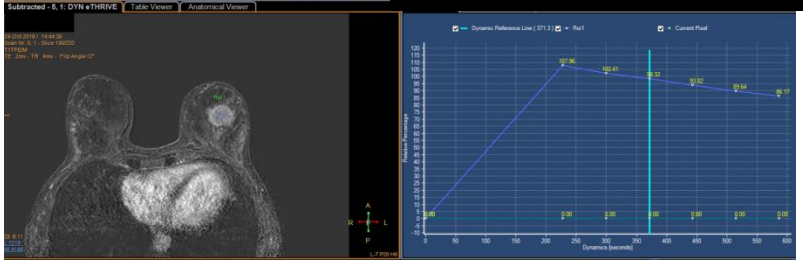
4D TRAK CASE 1

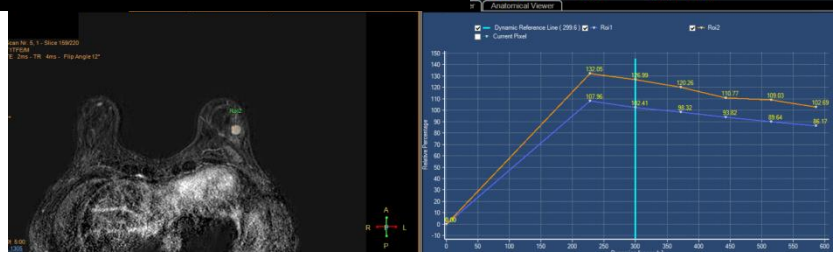


4D TRAK

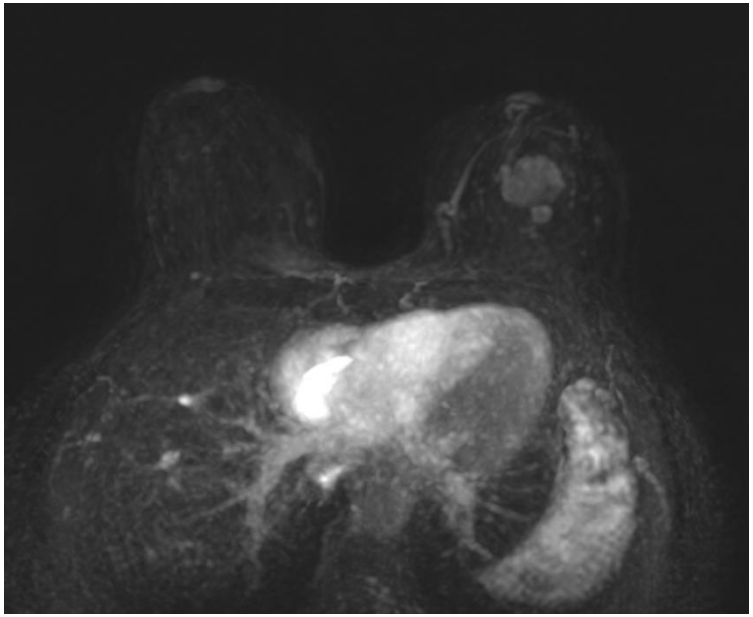






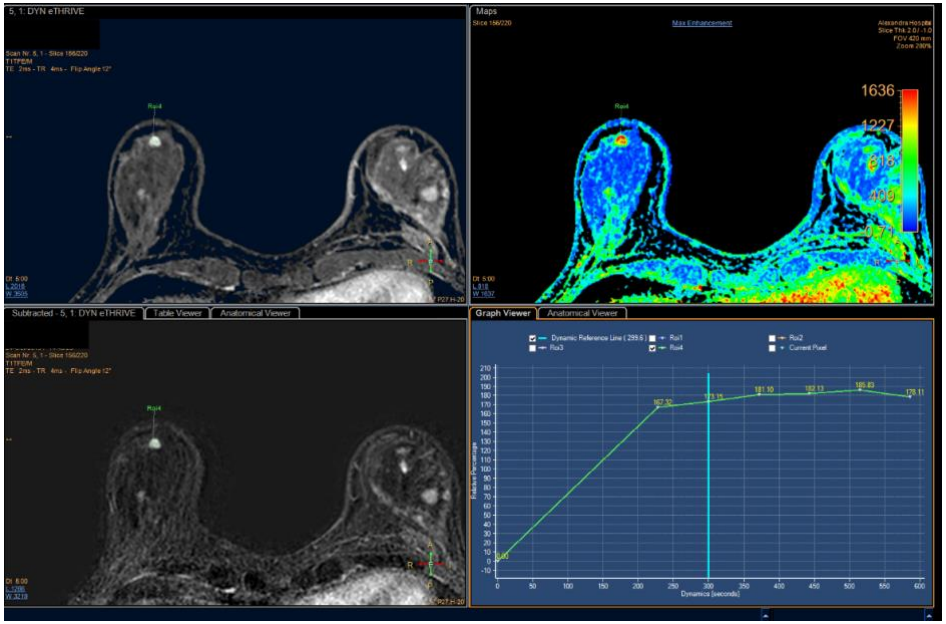


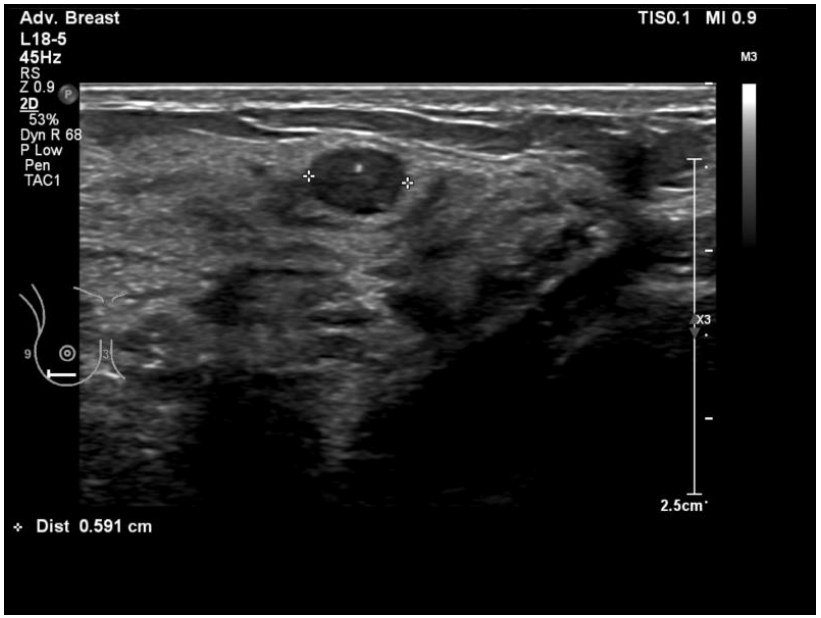
4D TRAK CASE 1



4D TRAK

THRIVE





4D TRAK CASE 1

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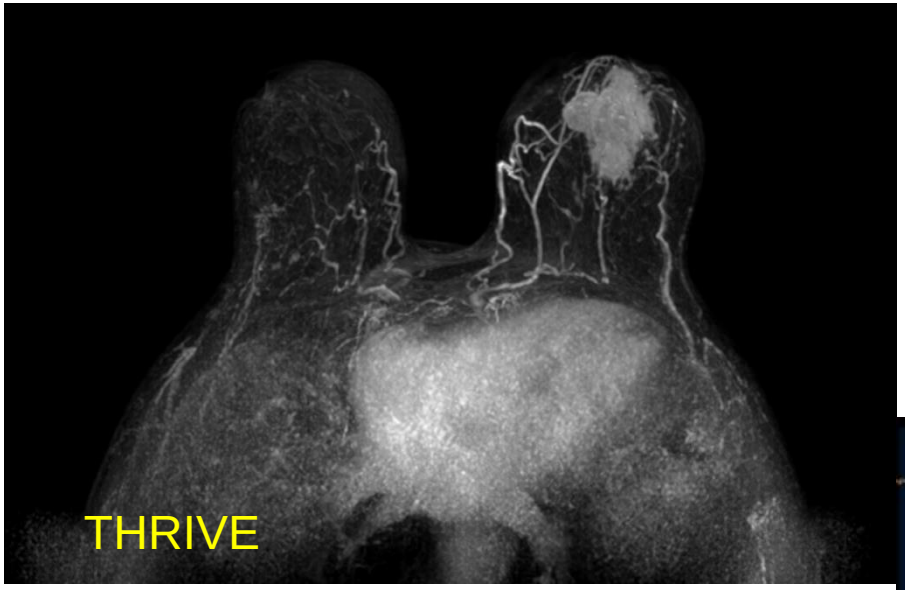

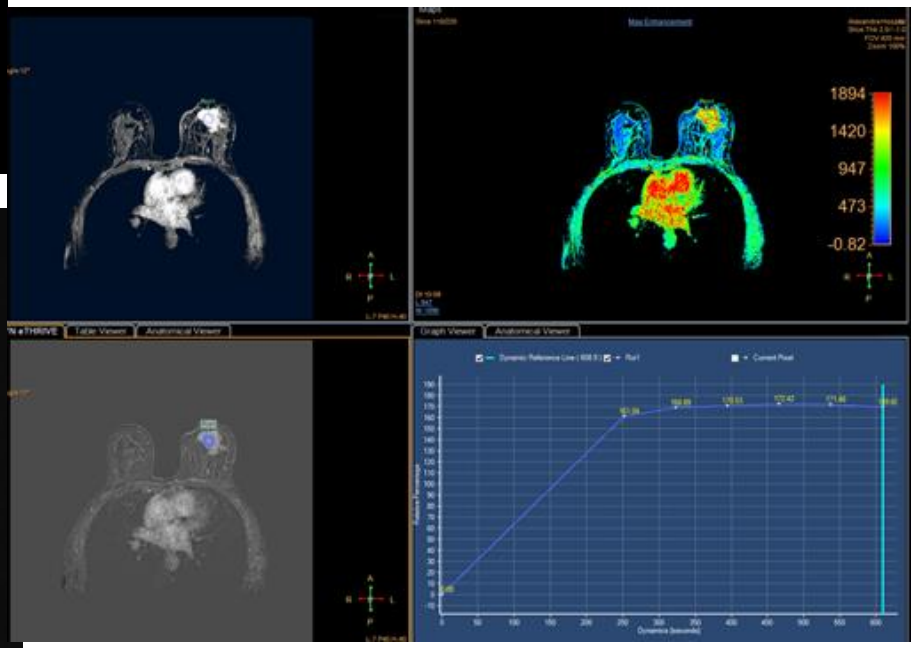

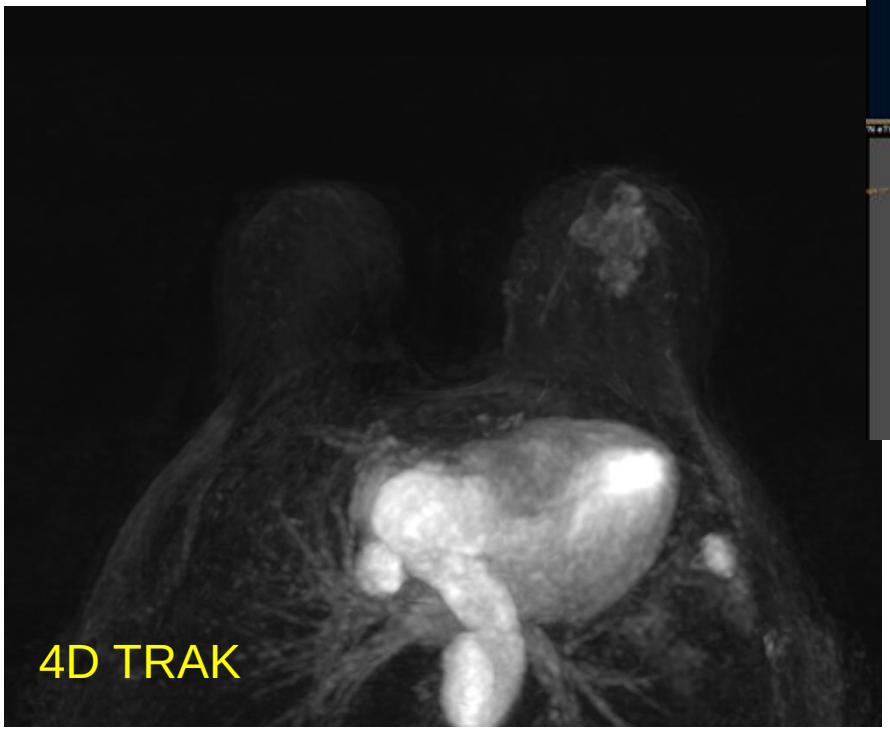

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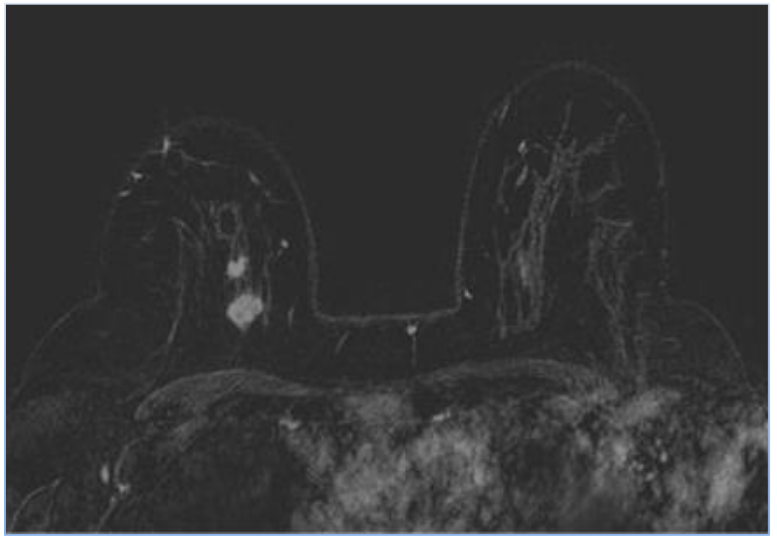
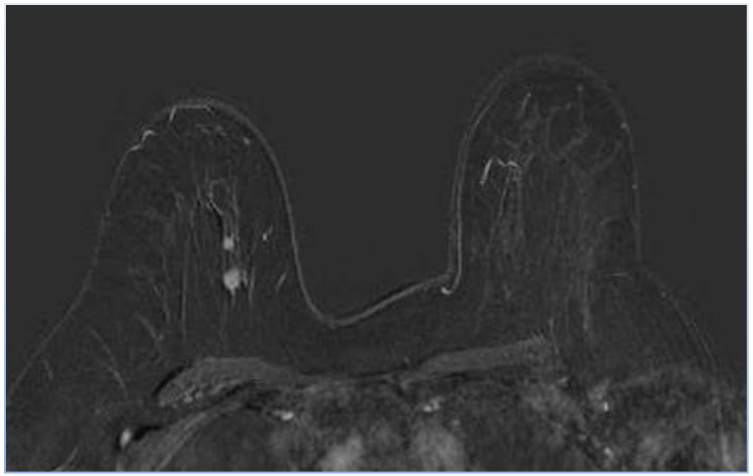
RESPONSE TO NEO-ADJUVANT CHEMOTHERAPY

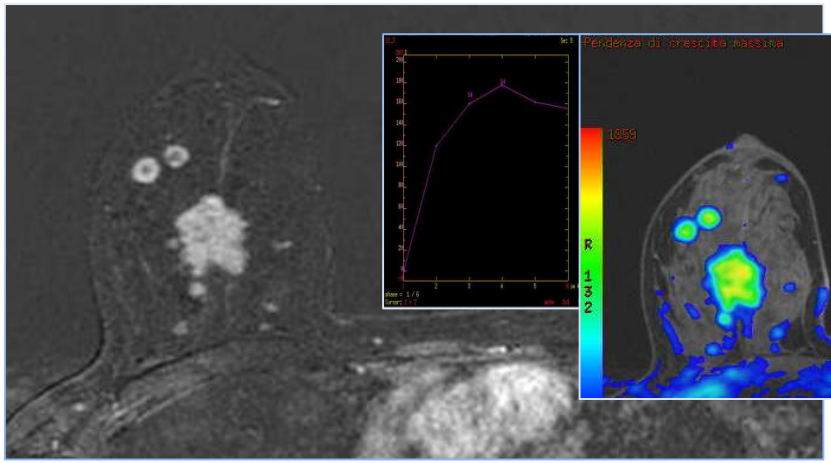
Author	Correlation coefficient	P-value
Partridge et al.	0.89	<0.001
Cheung et al.	0.982	<0.001
Martincich et al.	0.72	<0.001
Segara et al.	0.749	<0.0001
Kim et al.	0.645	<0.001
Moon et al.	0.584	NA
Wright et al.	0.49	NA
Park et al.	0.667	NA
Nakahara et al.	0.21	NS
Wang et al.	0.866	<0.01
Dongfeng et al.	0.698	<0.001
Fangberget et al.	0.87	<0.001
Guarneri et al.	0.53	NS
Shin et al.[a]	0.97	NA
Chen et al.	0.30	0.03
Kim et al.	0.619	<0.0001
Shin et al.[b]	0.781	NA

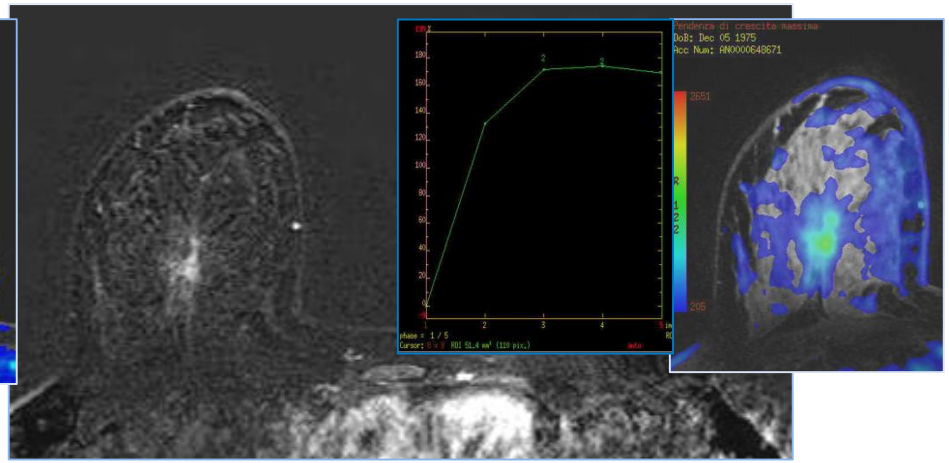
NA not available, *NS* not significant

M Lobbes et al, Insight Imaging, 2013

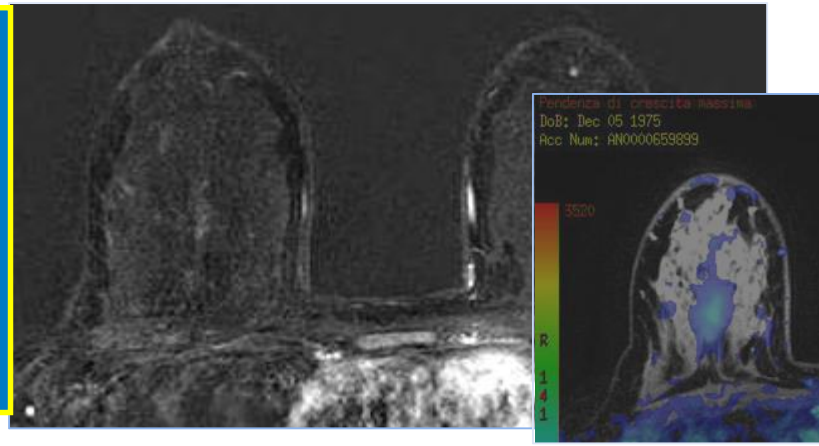








- SENSITIVITY 82 % (95% CI: 0.6454 - 0.9302)
- SPECIFICITY 86 % (95% CI: 0.6509 - 0.9709)
- ACCURACY 83 % (95% CI: 0.7120 - 0.9223)
- PPV 90 % (95% CI: 0.7347 - 0.9789)
- NPV 76 % (95% CI: 0.5487 - 0.9064)



Telesca M et al. Accuracy of 3T Magnetic Resonance imaging with a high-relaxivity contrast agent in assessing treatment response in patients undergoing NAC. ECR 2015

BREAST IMPLANTS EVALUATION

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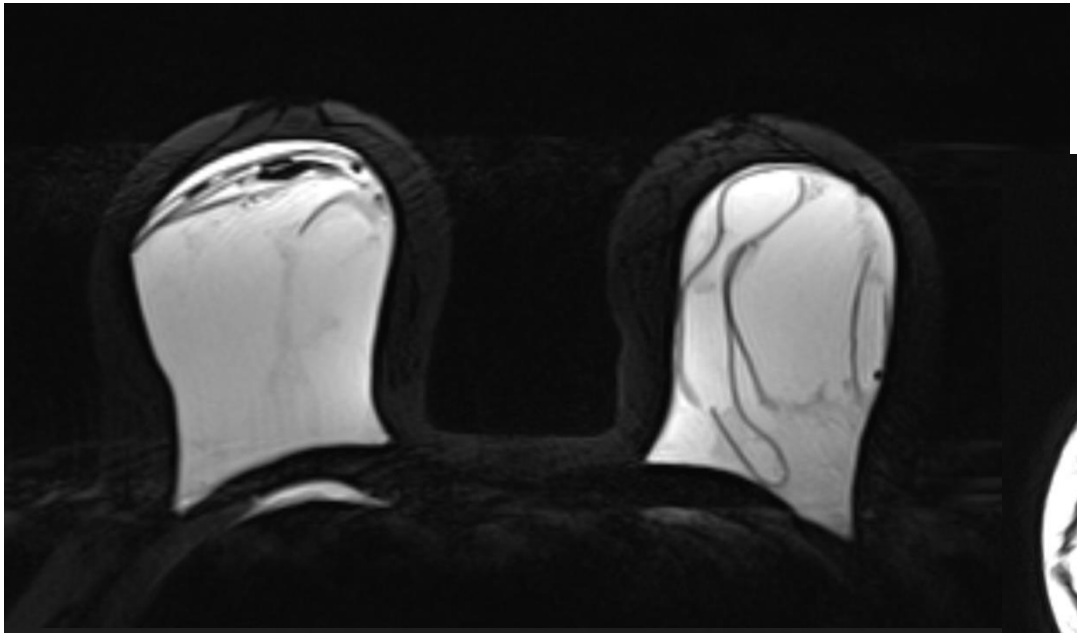
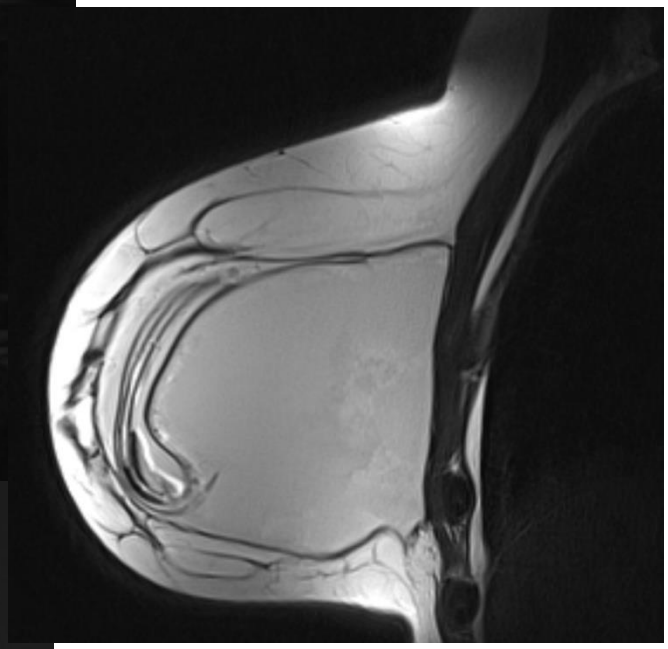
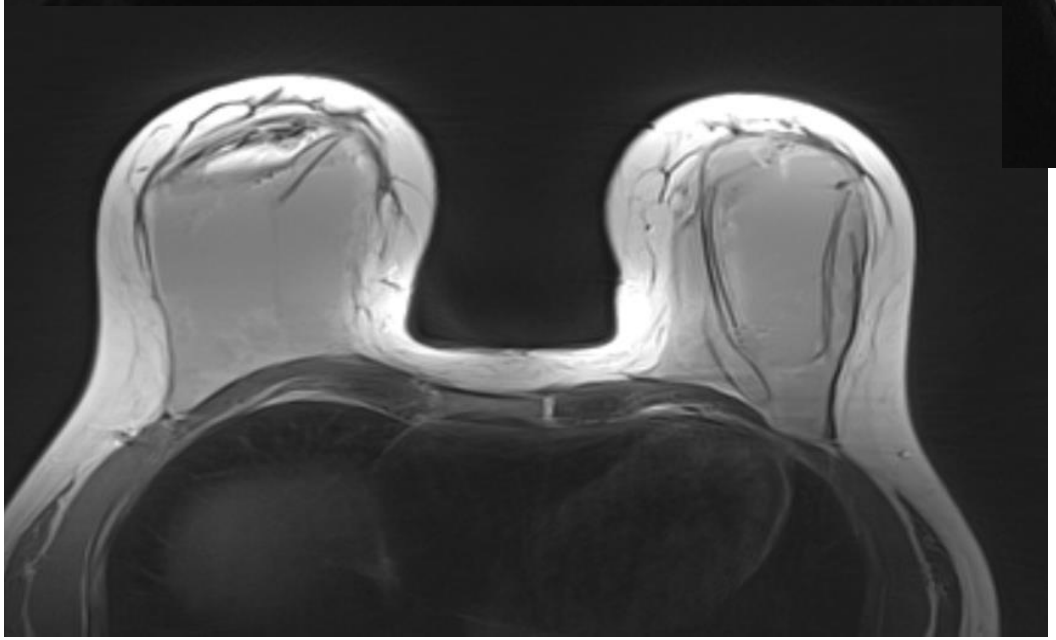
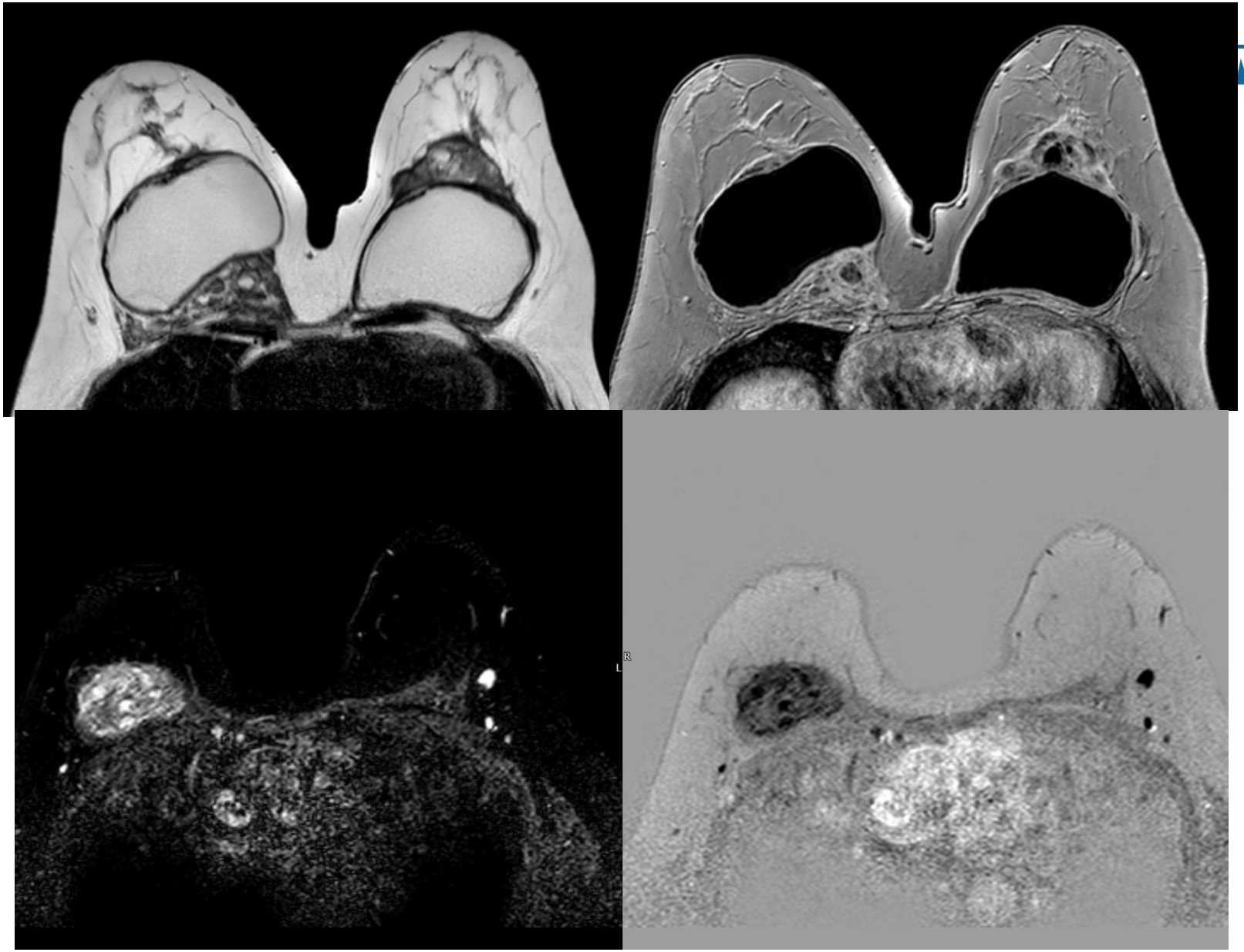




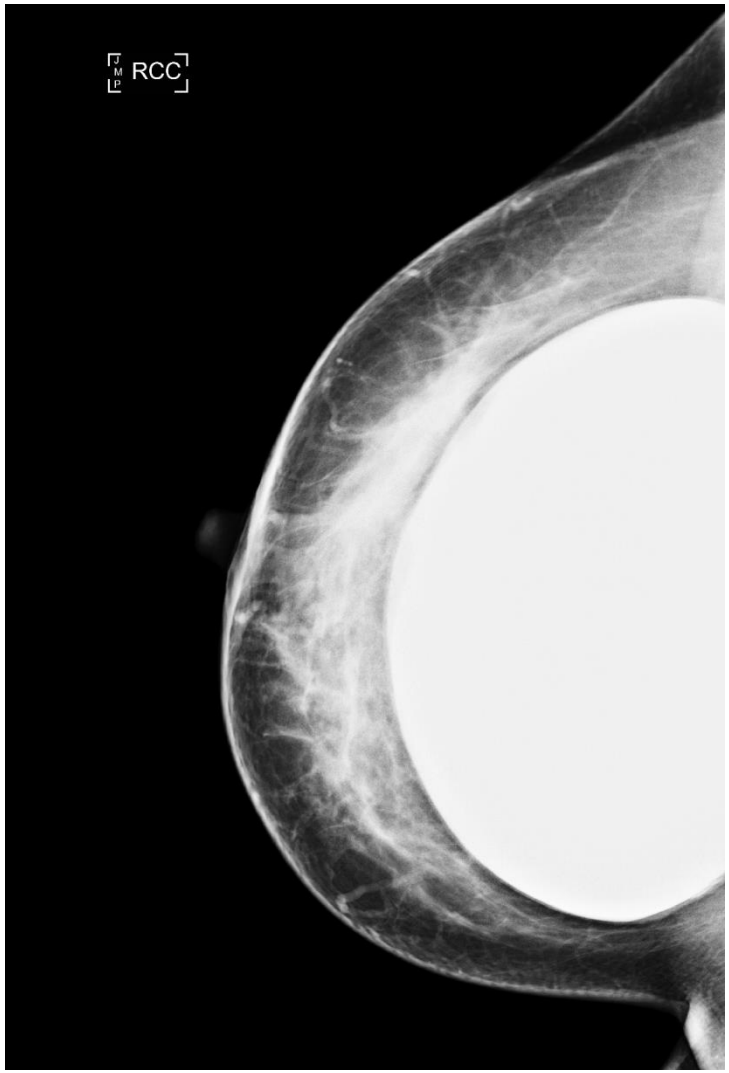


“ linguini sign”



Extracapsular rupture


RMLO


RCC

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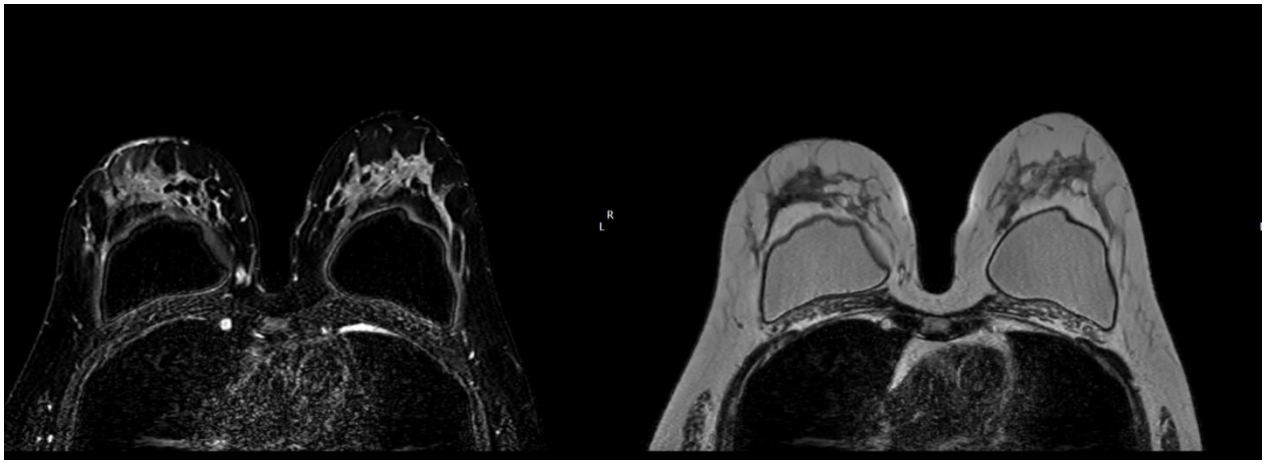

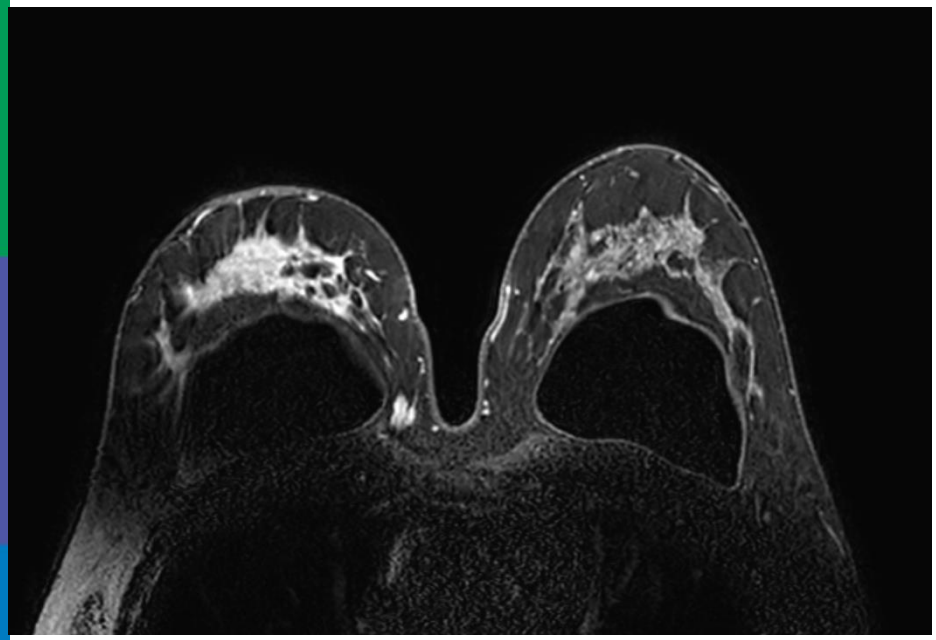

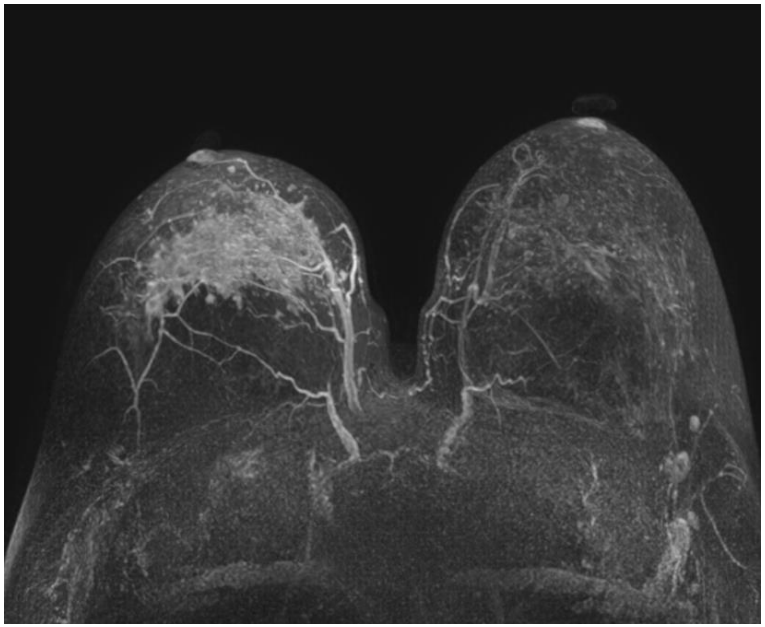

ILC

OCCULT BREAST CANCER

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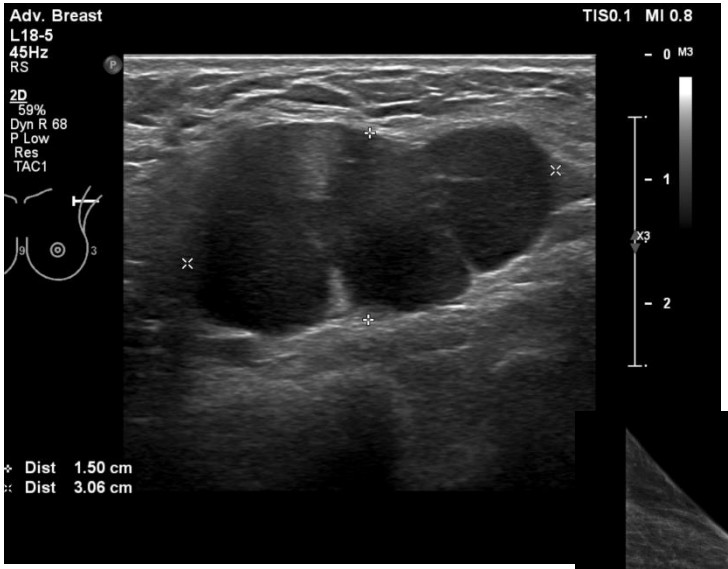

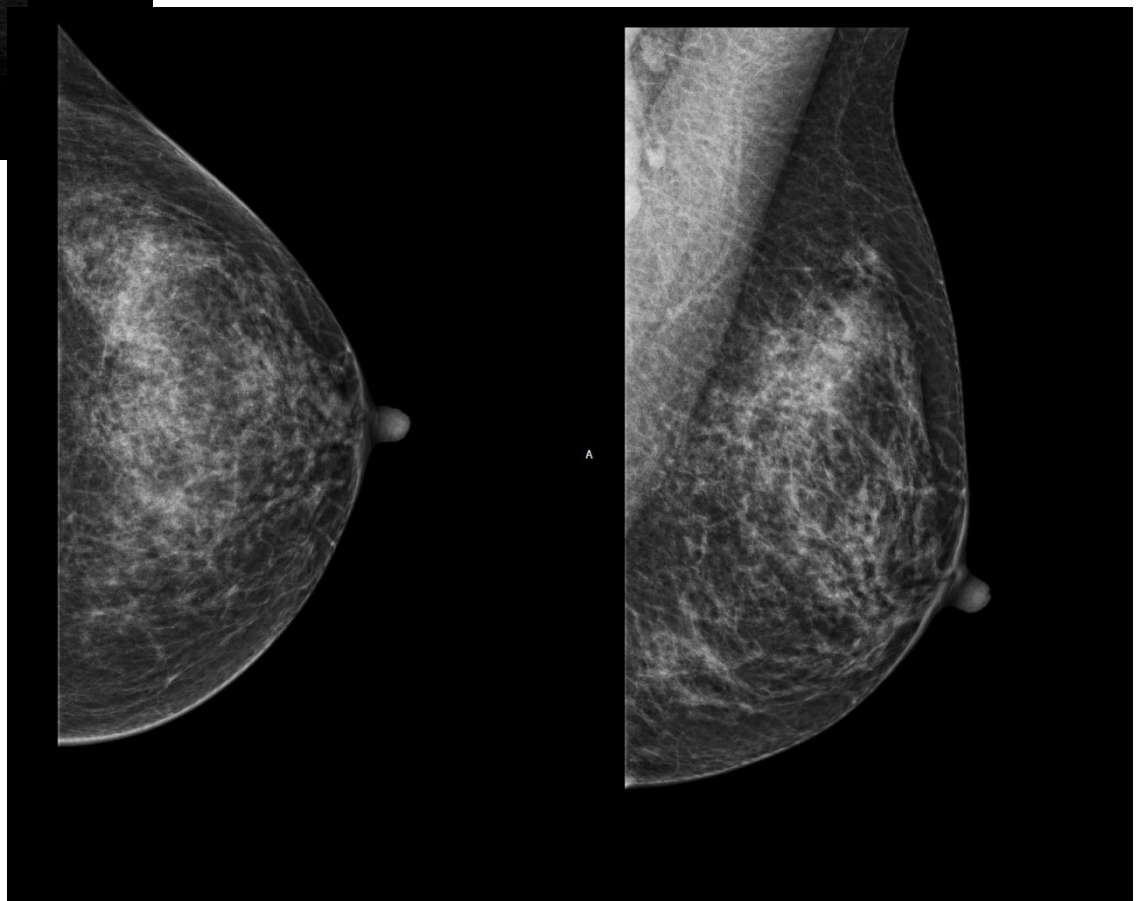

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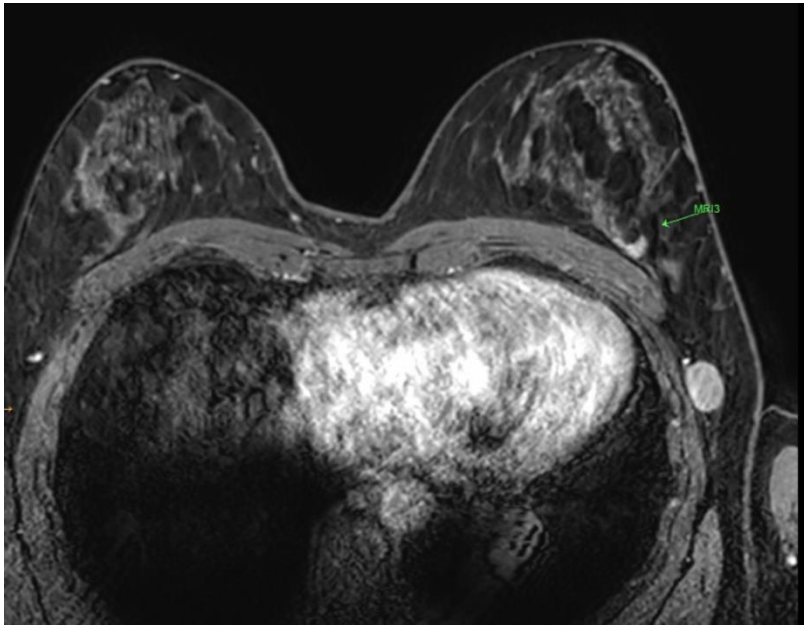

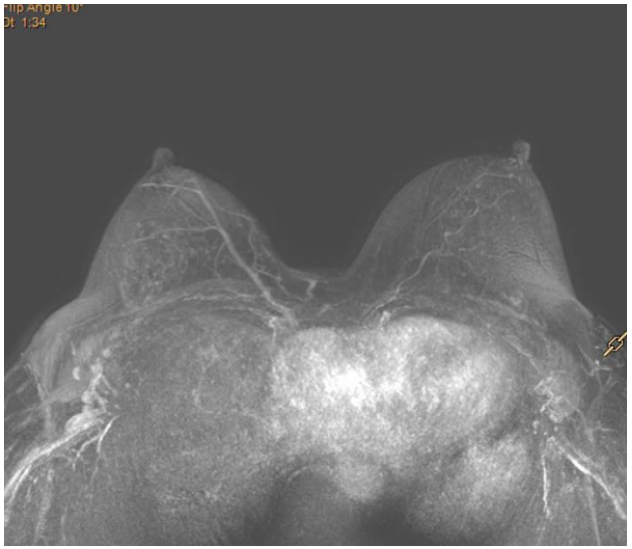

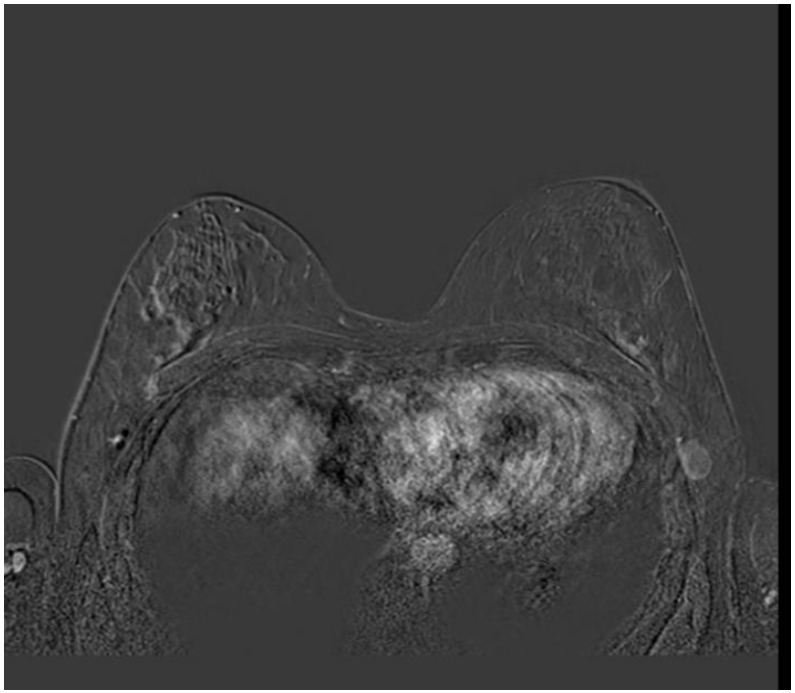

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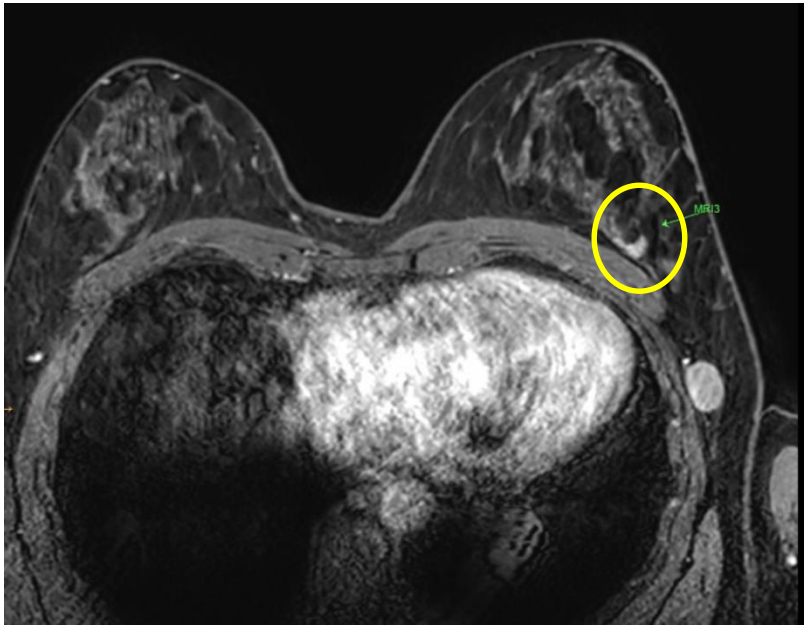

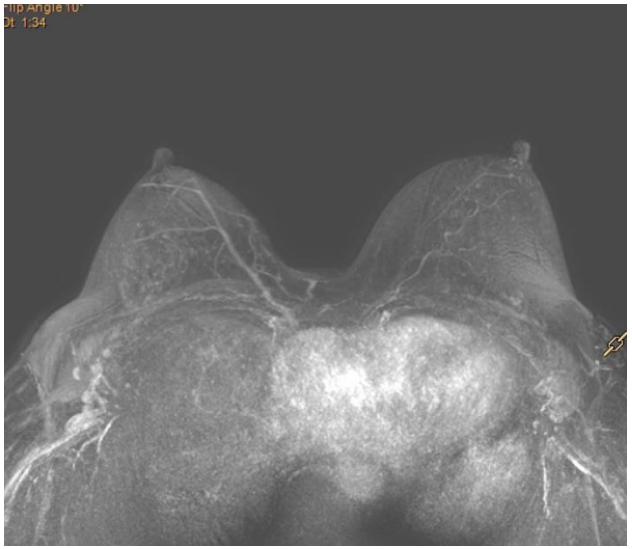

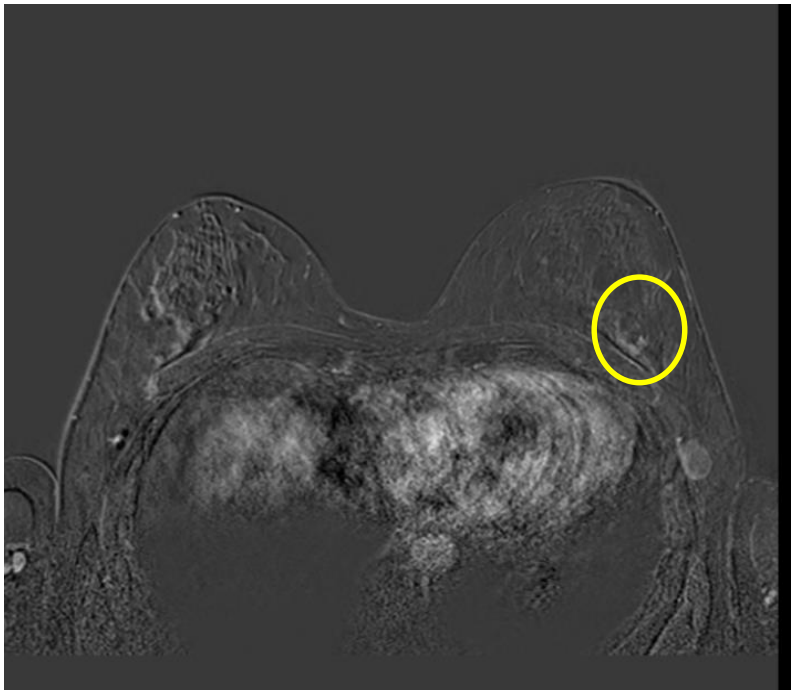

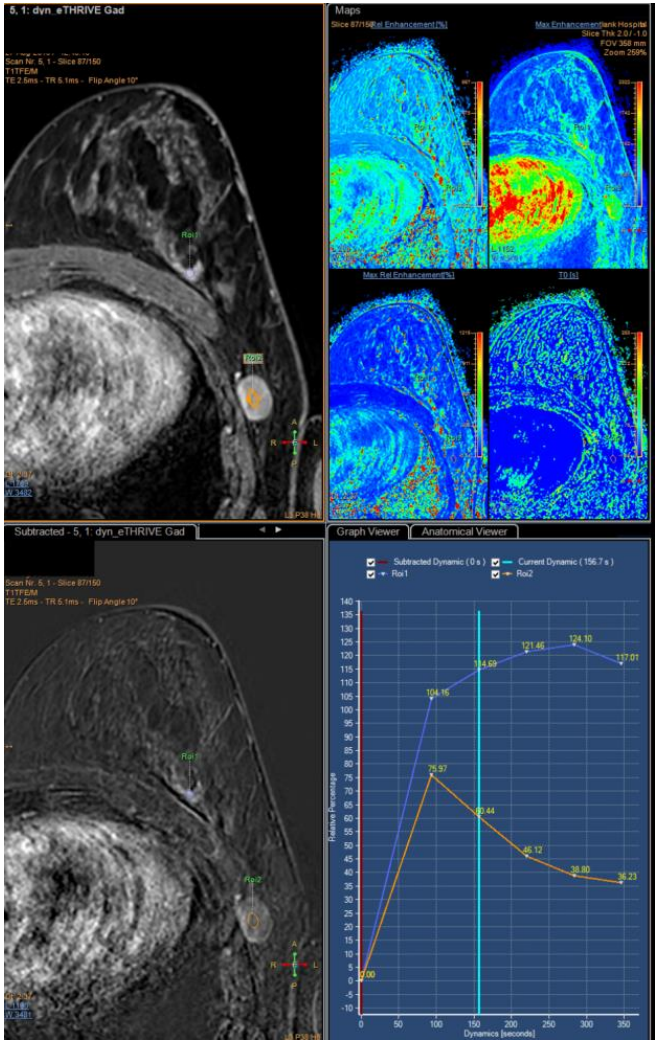

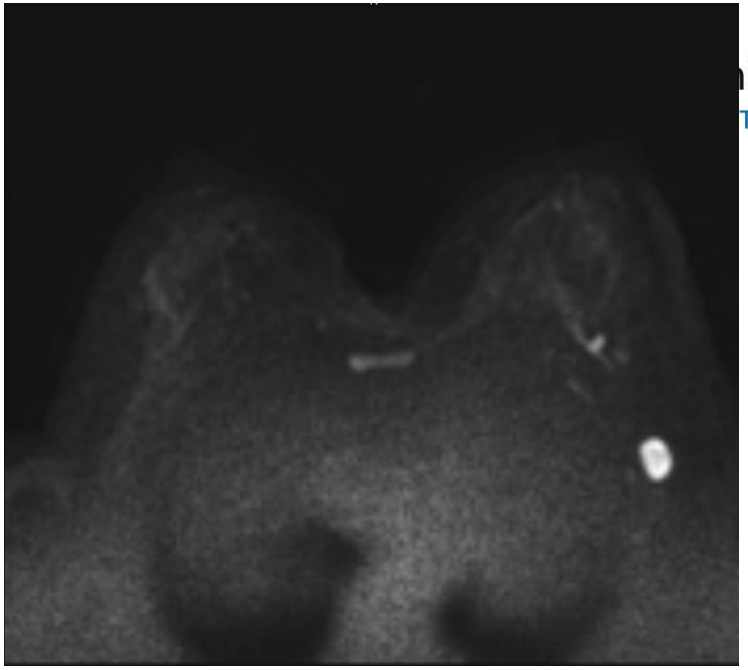

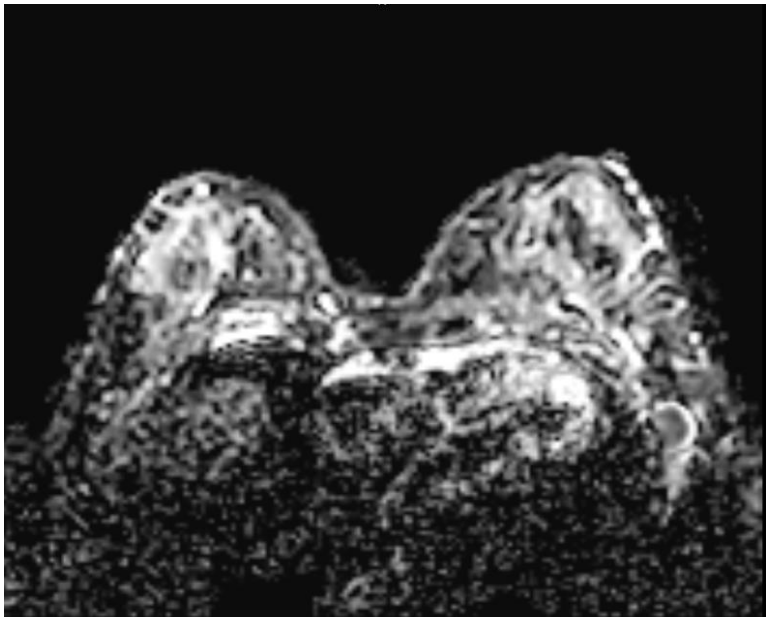

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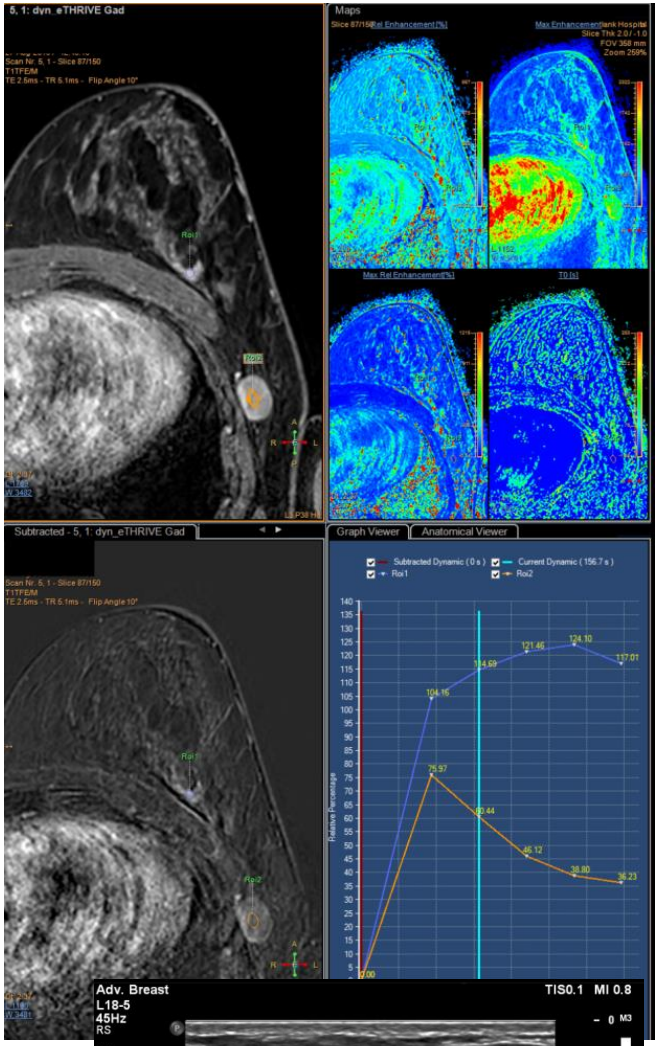

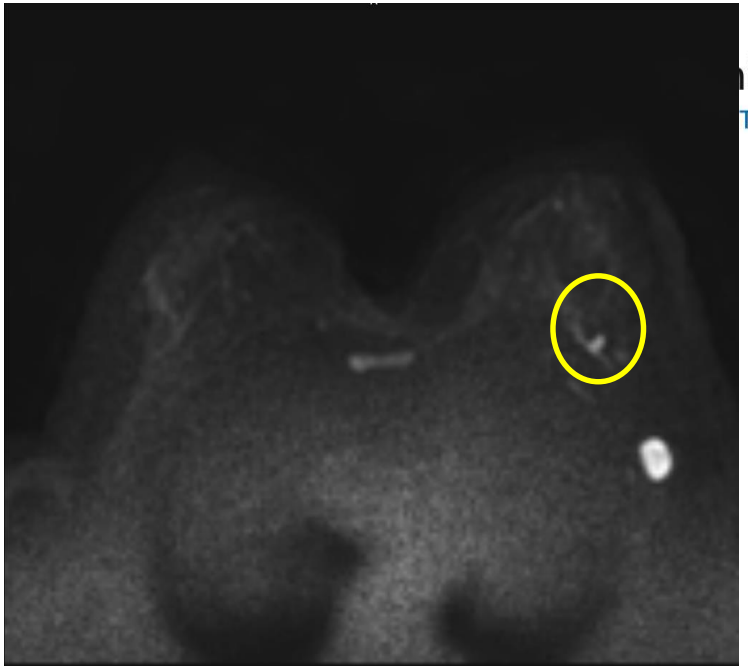

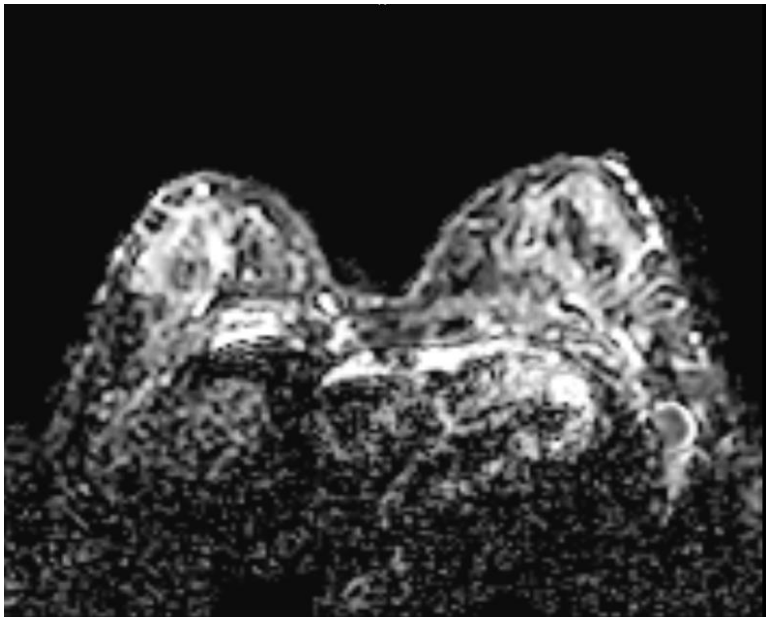

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Equivocal findings at mammo/US

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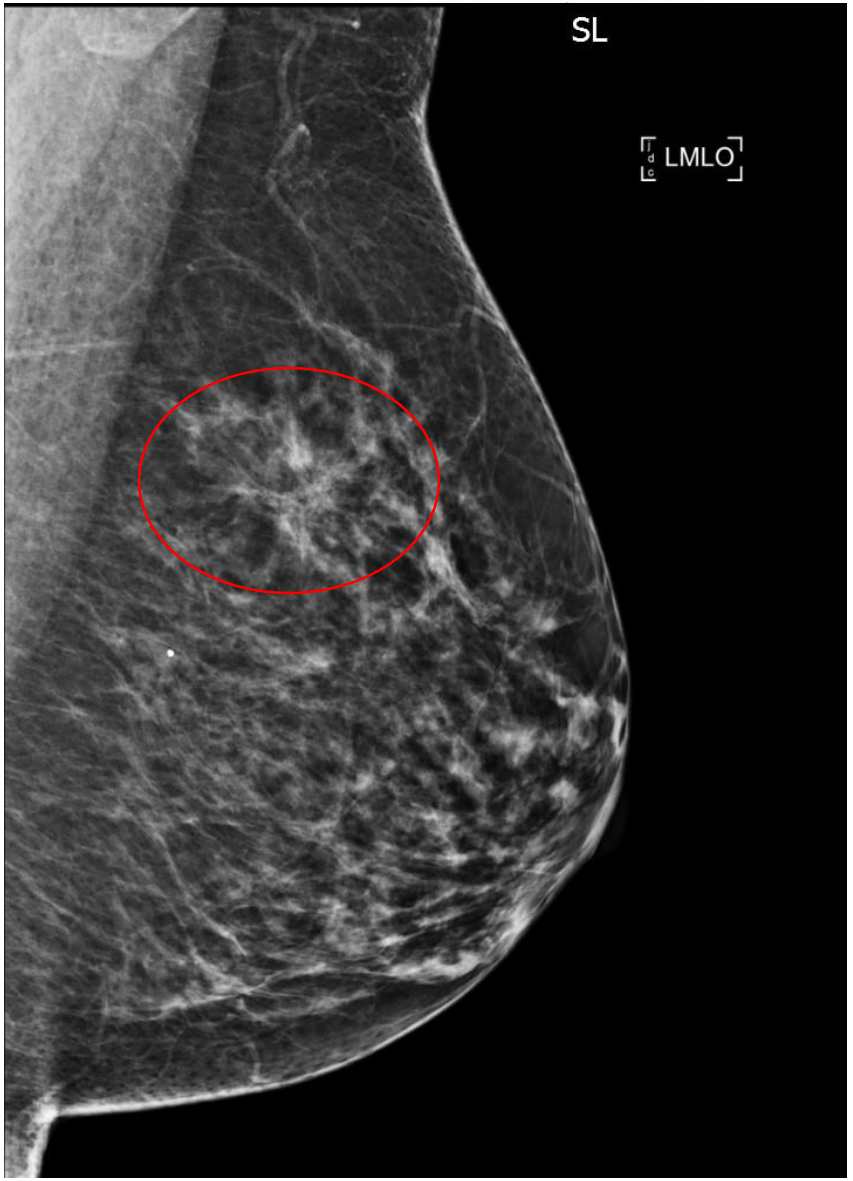
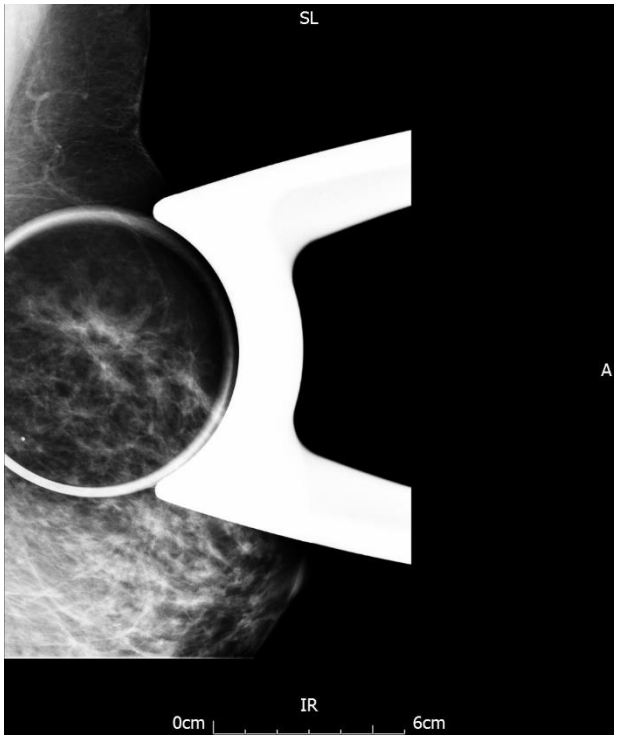
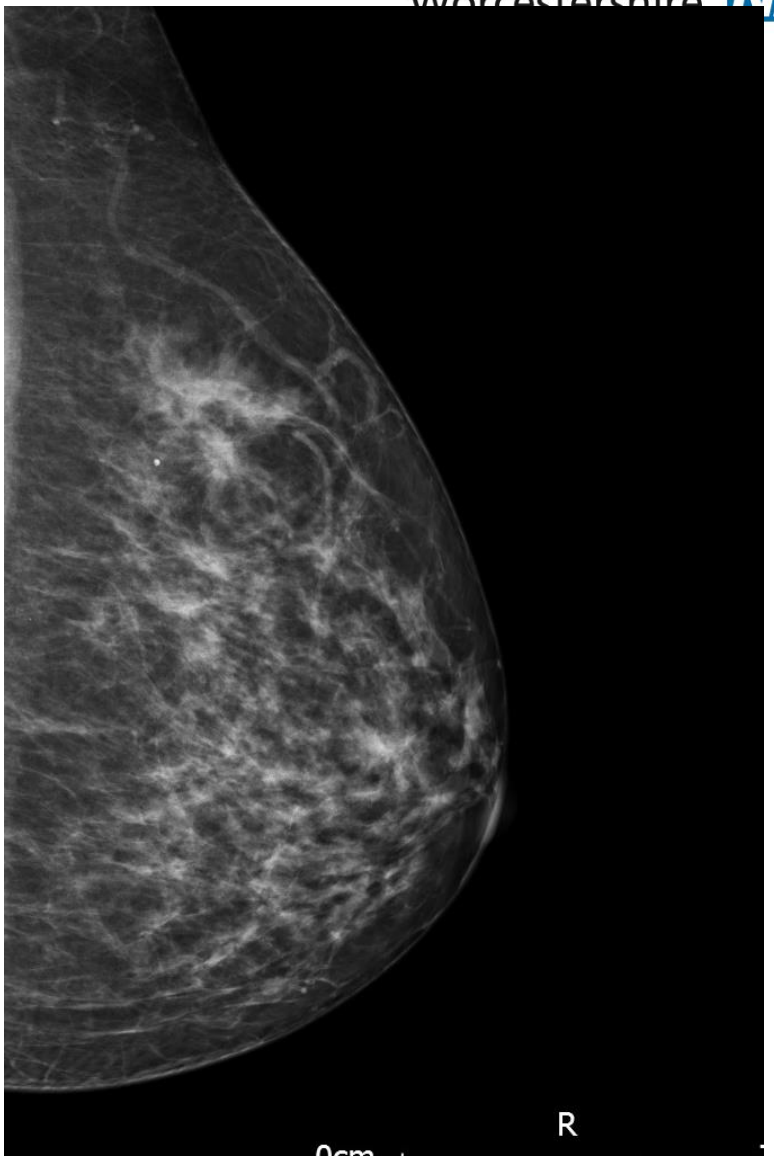
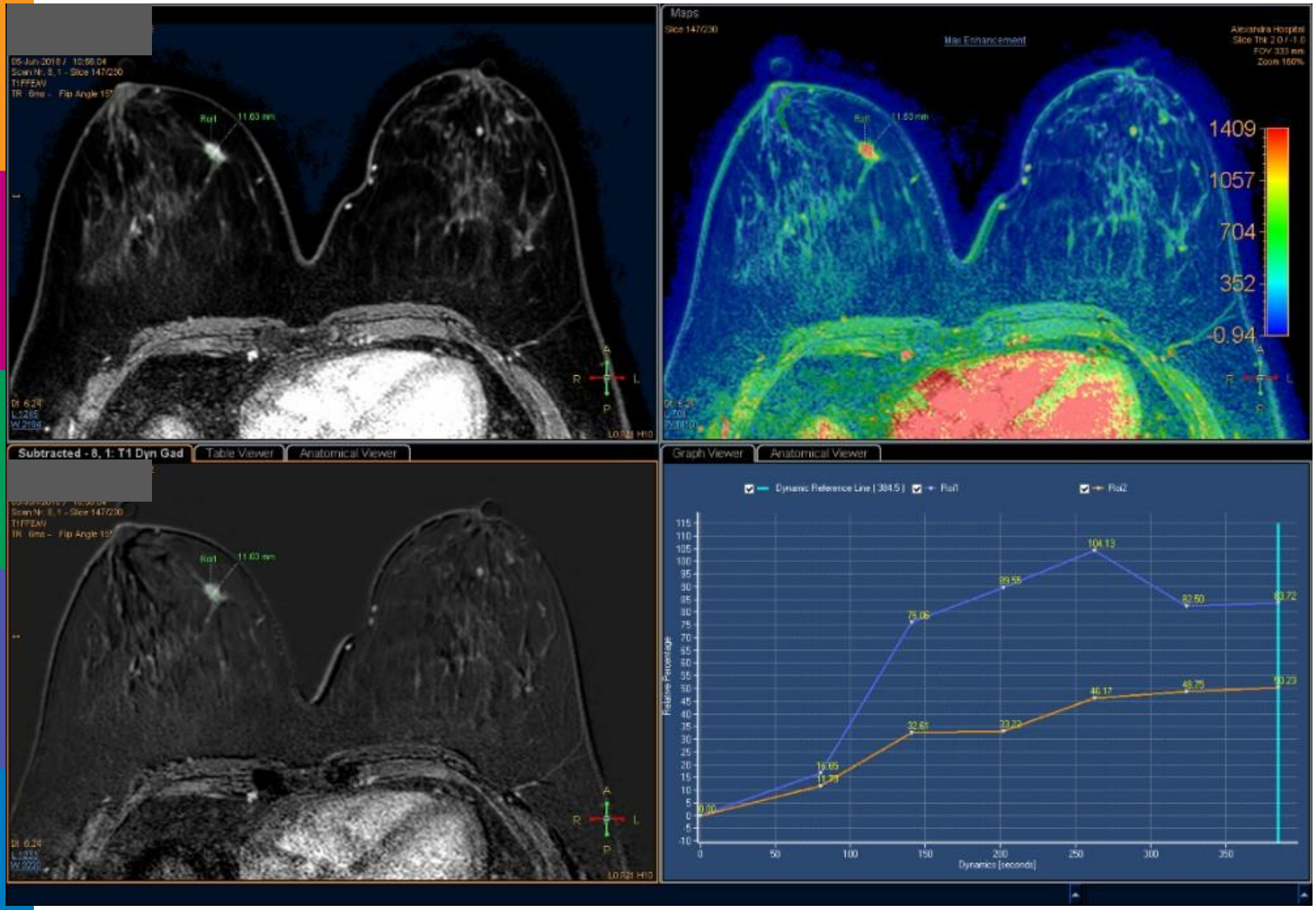


Case 1: screening patient





Targeted USS : U1


Maps
Max Enhancement
Alexandra Hospital
1409
1057
704
352
-0.94
Subtracted - 8, 1: T1 Dyn Gad
Table Viewer
Anatomical Viewer
Graph Viewer
Anatomical Viewer
Dynamic Reference Line [384.5]
Roi1
Roi2
Relative Percentage
Dynamics [seconds]
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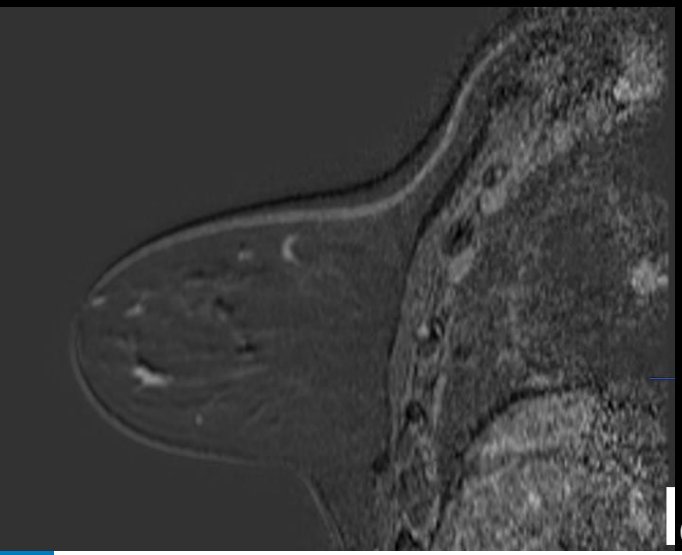
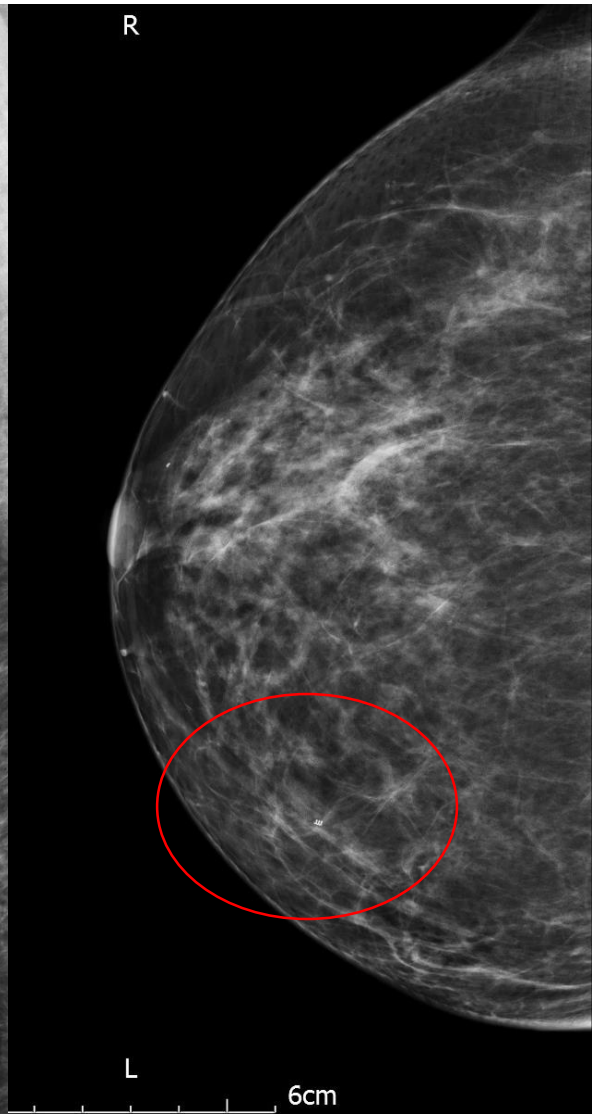
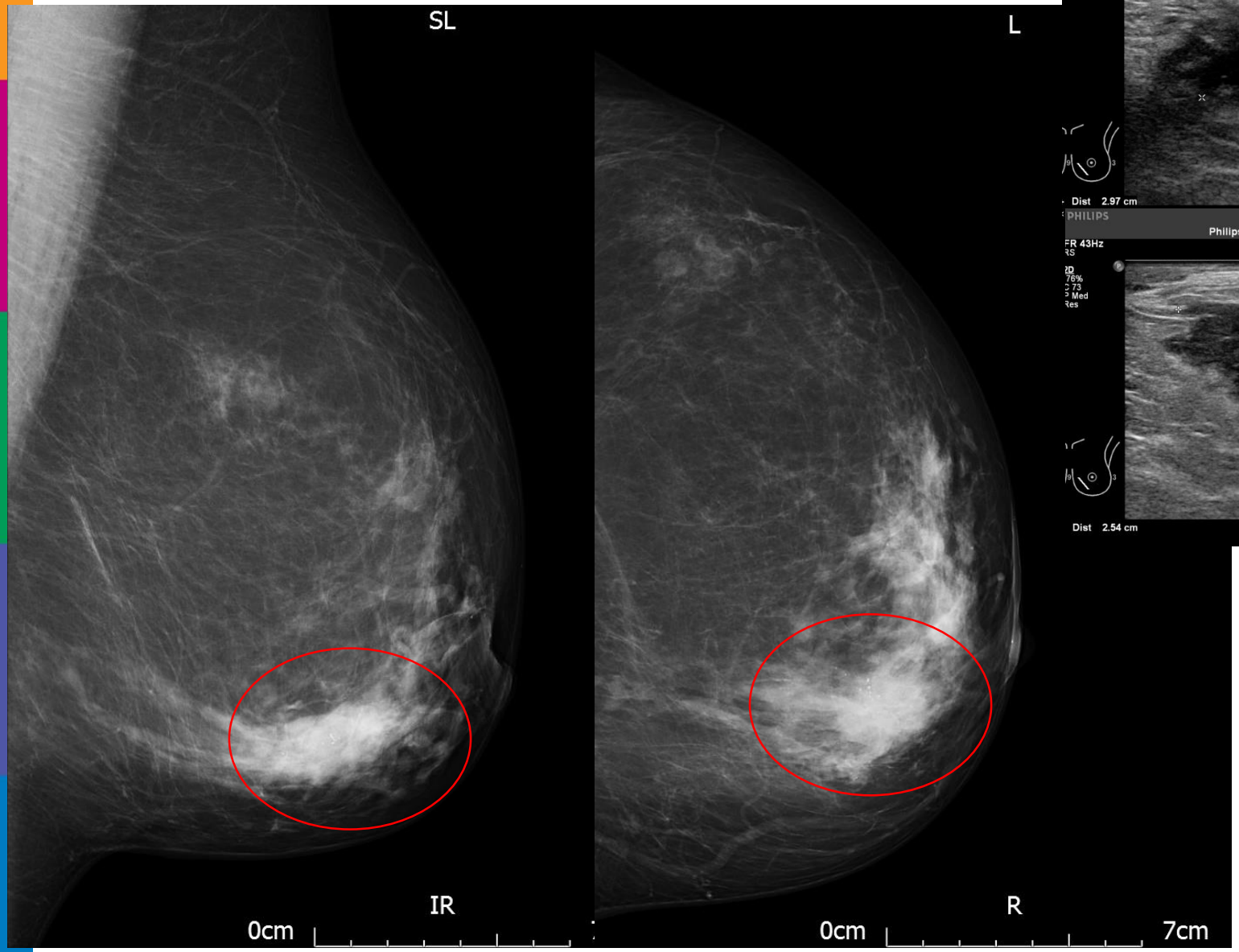
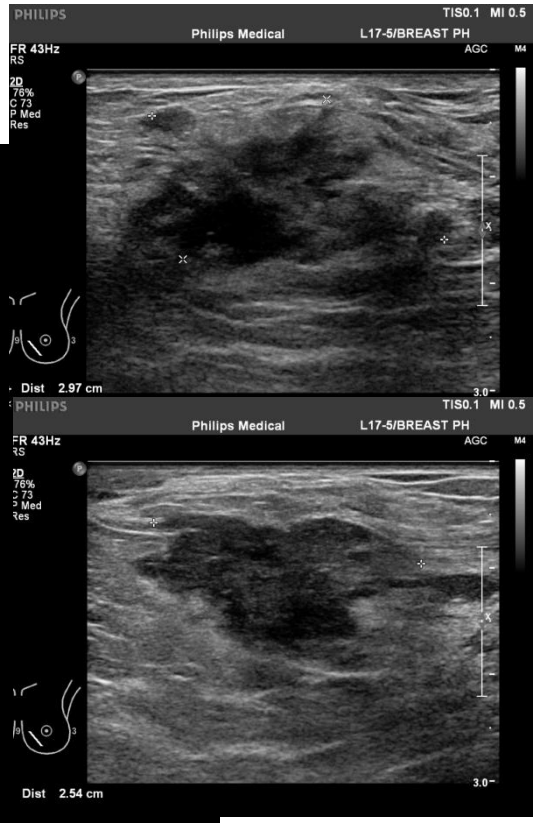


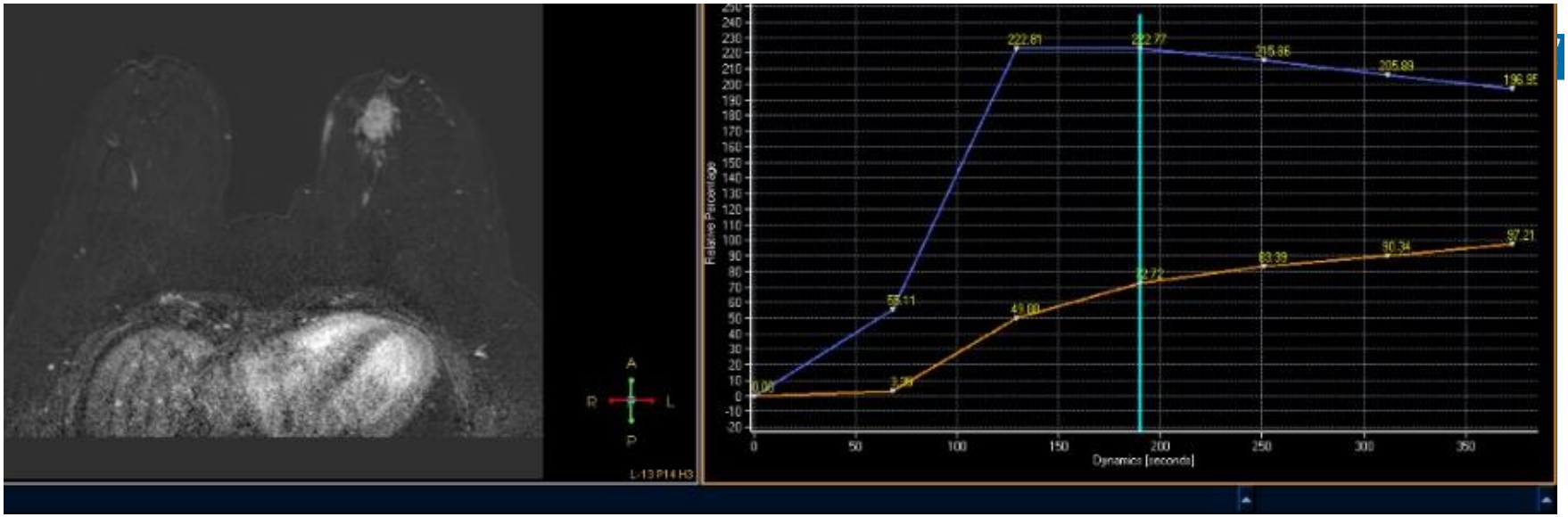


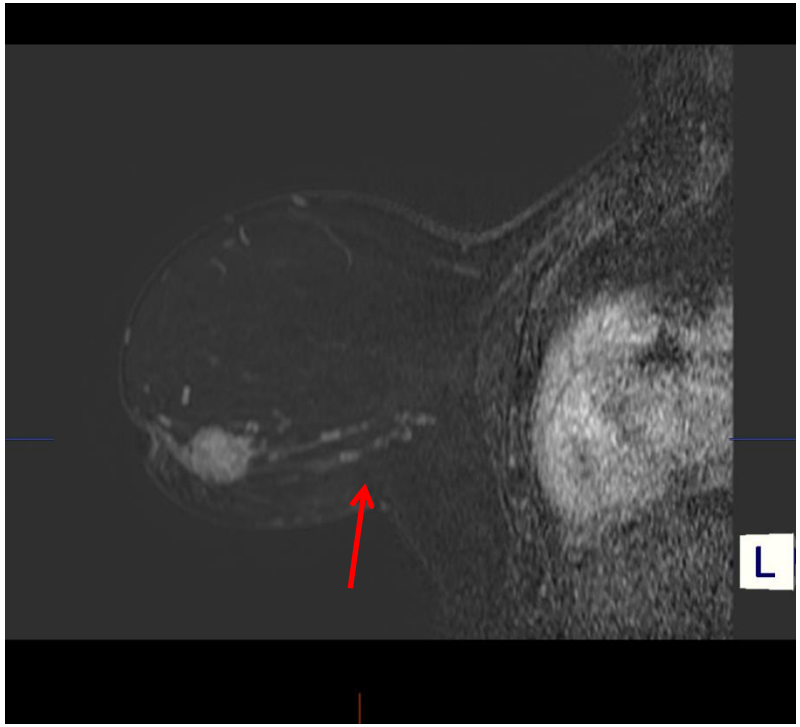
Invasive carcinoma type: Ductal with lobular features (E-cadherin positive on core biopsy)
Grade: 2
Focality: unifocal
Invasive tumour measurement: 10mm

CASE 2: screening patient






A
R
L
P
Dynamics [seconds]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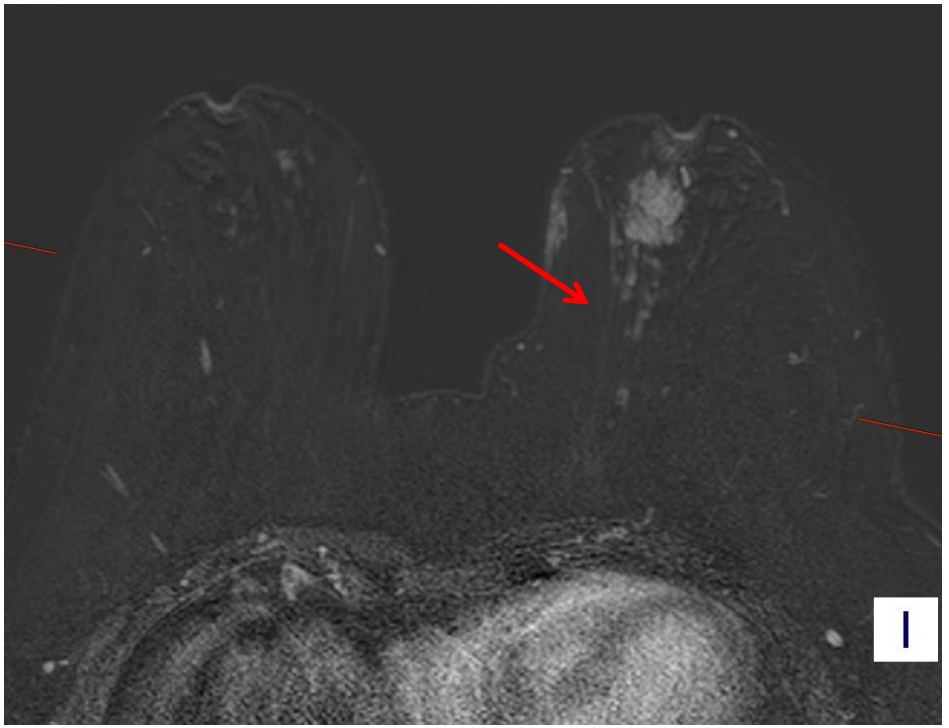
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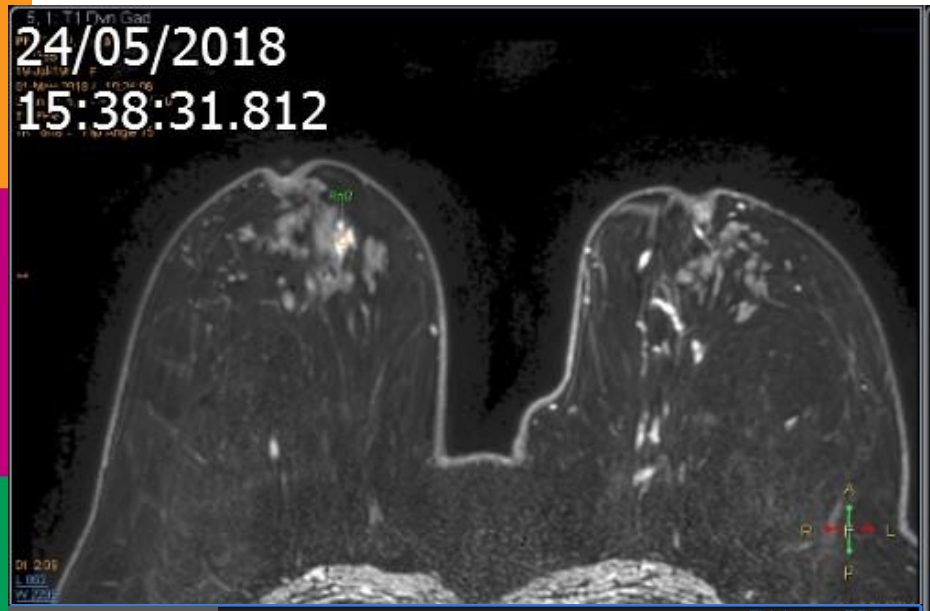

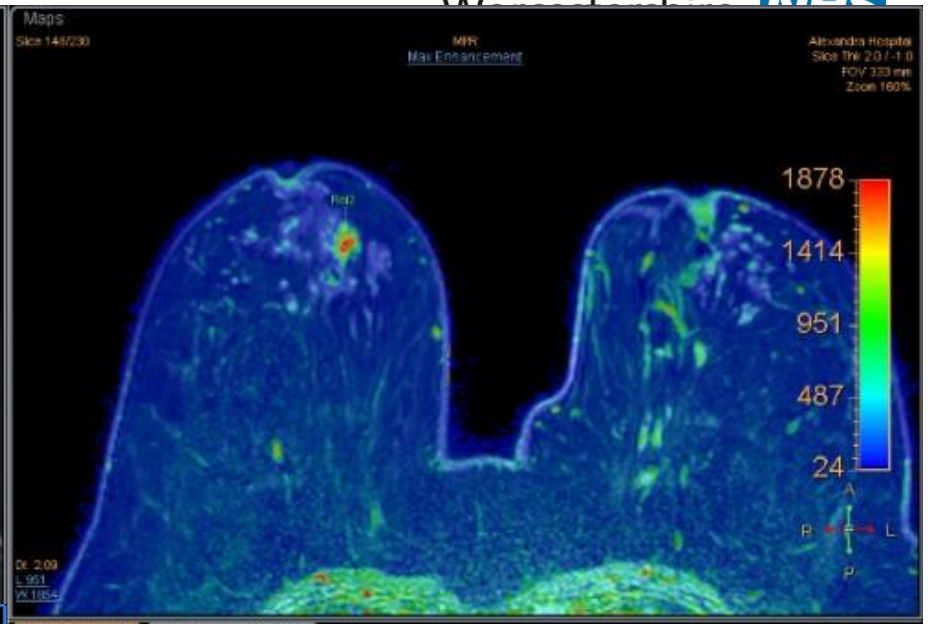

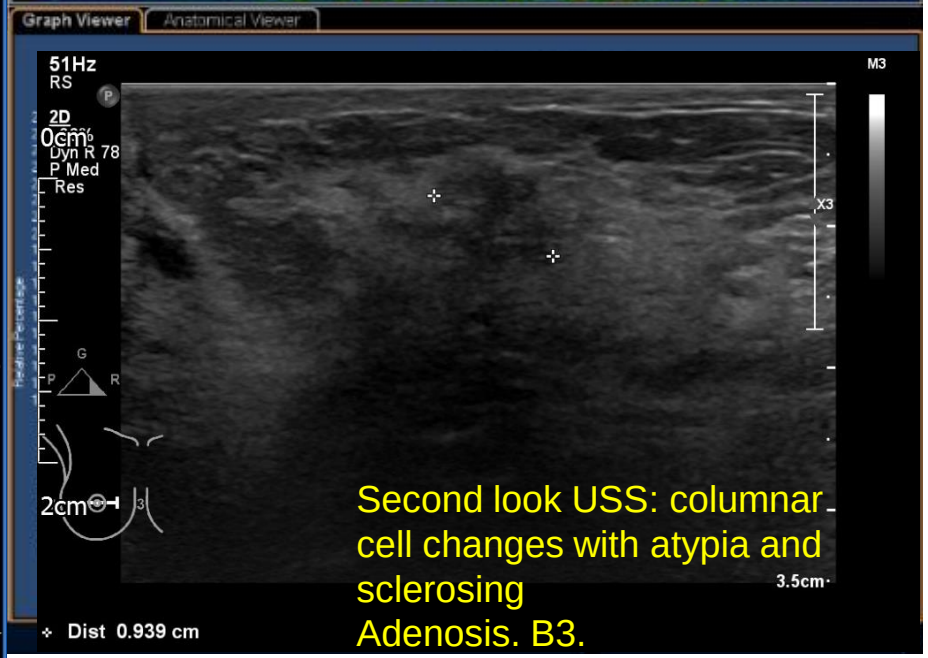

Second look USS: columnar cell changes with atypia and sclerosing Adenosis. B3.

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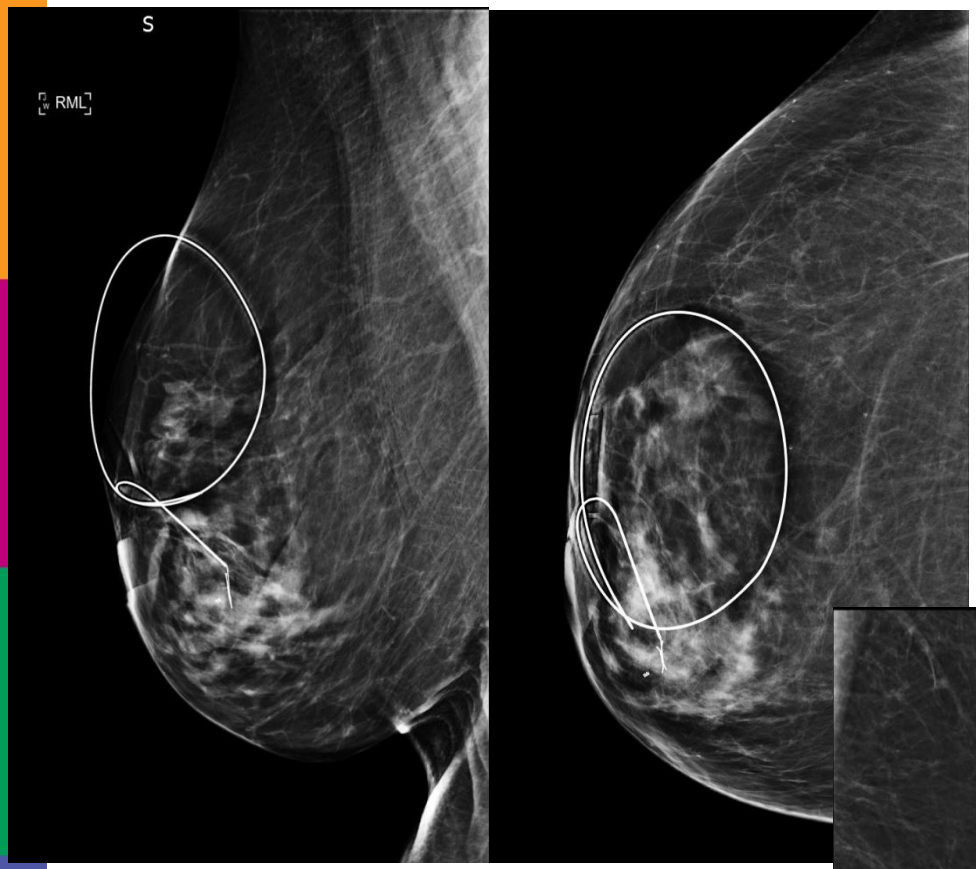
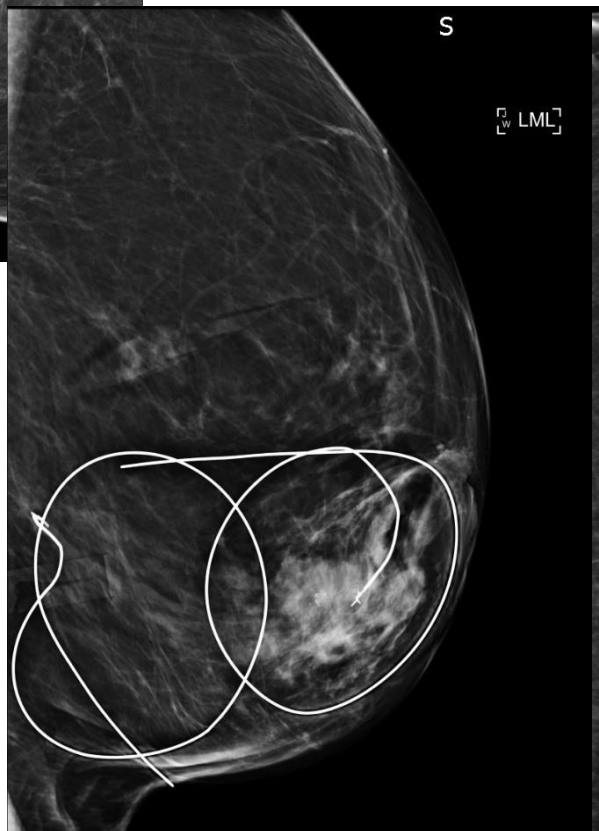
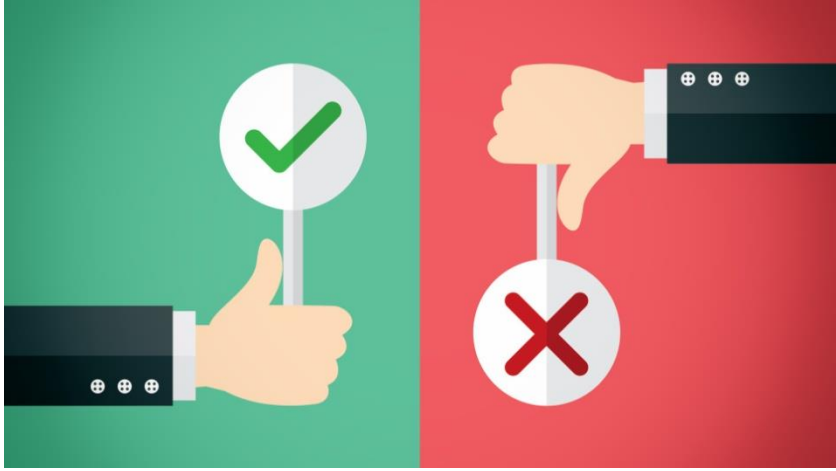


R breast WLE : atypical ductal hyperplasia



L breast therapeutic mammoplasty :
grade 3 infiltrating duct carcinoma
DCIS at the site of the posterior wire

CRITICISMS



- **Cost and limited access**

- **Technical (high-quality MR systems, dedicated breast coils, contrast agents)**

- **Interpretation**

- **Clinical (treatment delay, unnecessary biopsy, etc..)**

EVIDENCE-BASED INDICATION??

LONG TERM OUTCOMES??

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TAKE HOME POINTS

1. **Breast MRI has been increasingly used and investigated, and shows a great potential for the future**
2. **Breast MRI has not only high sensitivity but also good specifity**
3. **Breast MRI entered the high-risk screening but controversy on indications will continue, especially for the preoperative setting**
4. **Breast MRI is a valid technique in assessing response to NAC**
5. **Breast MRI may expand its role from diagnosis to prognosis**

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-Increased access to the modality

-implementation of new protocols

-Interaction between clinicians

-High quality research