



Advanced MRI and Mammography techniques in early detection and management of breast cancer

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Introduction

- Breast cancer is one of the most common causes of malignancies in women worldwide
- It is the leading cause of cancer mortality.
- Although the incidence rate of breast cancer is thought to be more in the developed countries, it is increasing in the developing countries, where the majority of cases are detected in the advanced stages.

- There is a large variation of the breast cancer survival rate in developed and developing countries. An estimated 5 years survival rate of the breast cancer is 80% in high-income group as compare to below 40% in the low-income countries.
- Diagnosis of the breast cancer at the advanced stages contributes to the high mortality rate in these women.
- Less awareness, limited access to diagnostic and treatment facilities in the rural and suburban areas.

- Few factors, which contribute to presentation in advanced stages like social stigma, gender inequality, fear, and no screening program.
- Indian women having breast cancer are one decade younger than their western counterparts.
- Breast carcinomas in the younger women are more aggressive as compare to older women and the studies suggest that it peaks at 40-50 years in the Indian women.

- Early detection is the key for better prognosis as most of the symptomatic patients are of stage II or III.
- With the increasing incidence of breast cancer cases in India and disproportionately higher mortality rate, it is necessary to work for the cancer awareness and plan a comprehensive screening program for early detection.

Challenges

- In India challenges are that the women present in later stages of breast cancer with large lumps, secondary changes of malignancy, multiple lesions and sometimes bilateral cancer/ metastatic lesion in contralateral breast.
- Lump is not associated with pain, most of the time so that leads to delay in seeking diagnosis and treatment.



Screening

- Early detection is the key for good prognosis as most of the symptomatic patients are stage II or III.
- Screening test is very important to detect malignant lesions in asymptomatic patients.
- Advances and ongoing improvements in imaging technologies have improved the sensitivity of breast cancer detection and diagnosis, but each modality is most beneficial when utilized according to individual traits such as age, risk factor, and breast density

Different Modalities for Breast Imaging

- Mammography-'Gold standard ' in evaluation of breast lesions.
- Breast Ultrasound-High resolution USG
 - Elastography: New sonographic technique that provides additional characterization information on breast lesions
- Magnetic Resonance Imaging : As adjuncts to mammography ,problem solving and in pre and postoperative workup.
- Scintigraphy- Tc Scan

ACR-BIRADS Fifth edition of BI-RADS Lexicon

Category 0	Incomplete Study
Category 1	Normal study
Category 2	Benign
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Mammography

- Radiograph of the breast
- Screening mammogram –to check for Ca breast in women who have no sign or symptom of disease
- Diagnostic mammogram-To evaluate the lump or other sign or symptoms, benign and malignant pathologies
- A mammogram can find a breast cancer 2-3 yrs before it present clinically
- No screening tool is 100% effective, however good quality mammogram can detect 85-90% Breast cancer

Mammography

Conventional Mammography

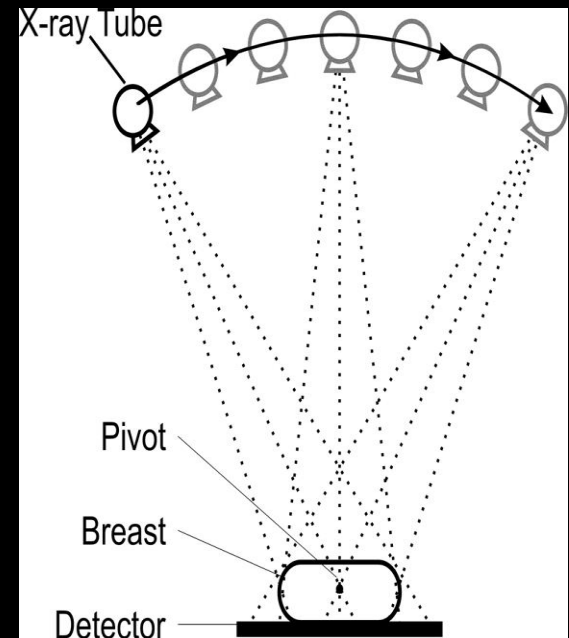
- Conventional two-dimensional (2D) mammography is used for most mammographic examinations.
- A major limitation of this technique is the potential overlap of tissue
- Overlapping tissue can consequently obscure an area of interest and lead to a false-negative finding

Digital with Tomosynthesis

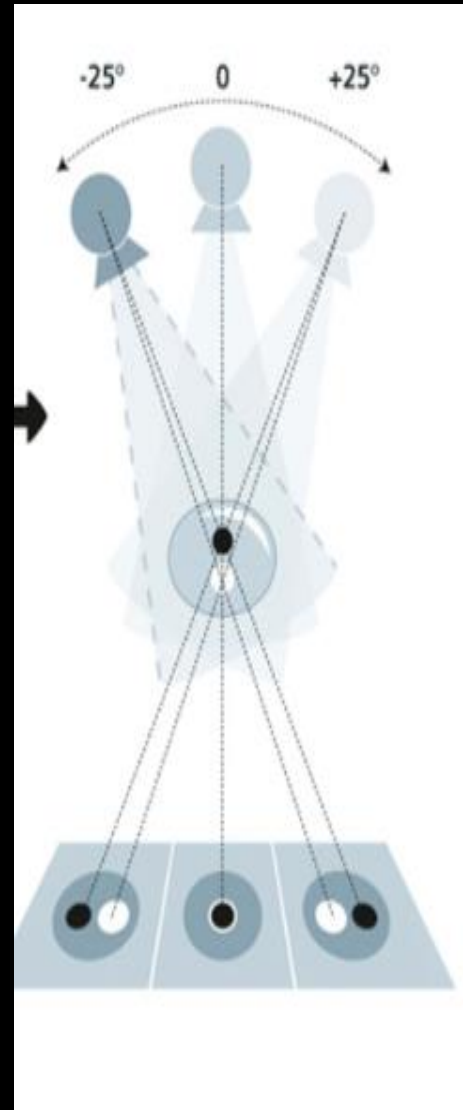
- Digital breast tomosynthesis (DBT) is a new imaging technology that addresses the limitation caused by overlapping structures by acquiring a series of low-dose projection images.

Digital Breast Tomosynthesis

- Multiple low dose digital mammographic images obtain along an arc and then reconstruct .
- Utilizes low-level X-rays to produce multiple images of the breast, layer by layer, using a swinging camera
- This layering of images makes it simpler to detect normal breast structures (milk ducts, lobules, fatty tissues, etc.) from cancerous ones
- X-rays are converted into limited 3-dimensional digital images
- Dense tissue is better examined through Tomography than traditional Mammography



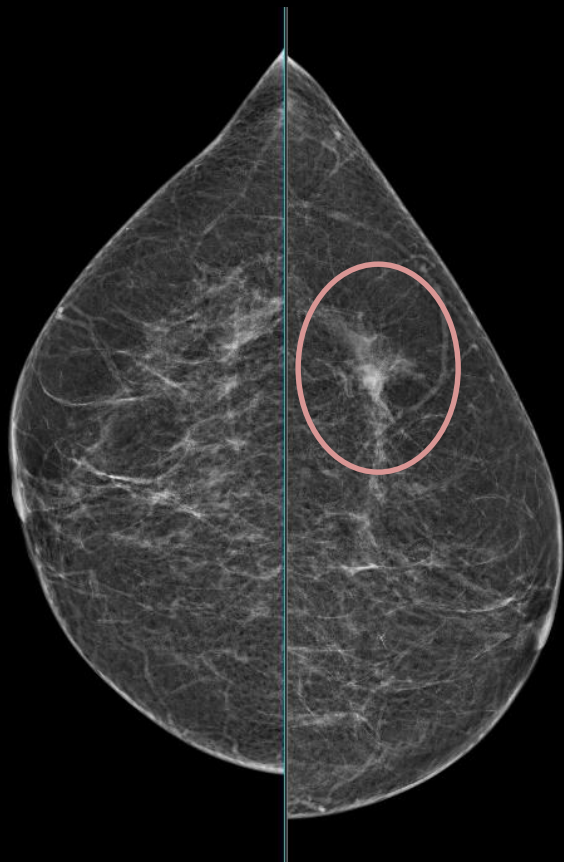
DBT Machine



Case : Early detection of carcinoma in screening

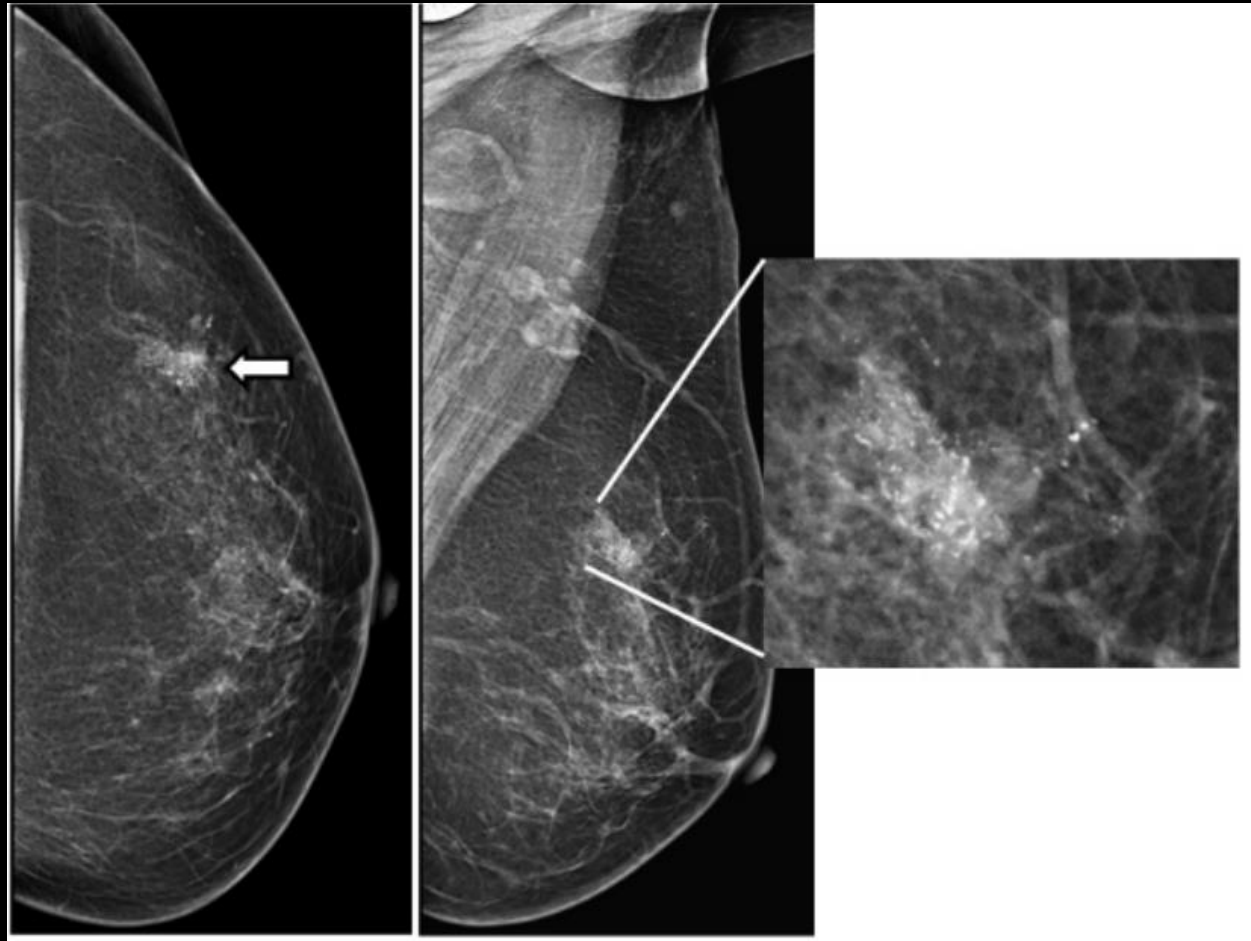


42 years old
premenopausal
female came
for screening
mammography
,no family
history

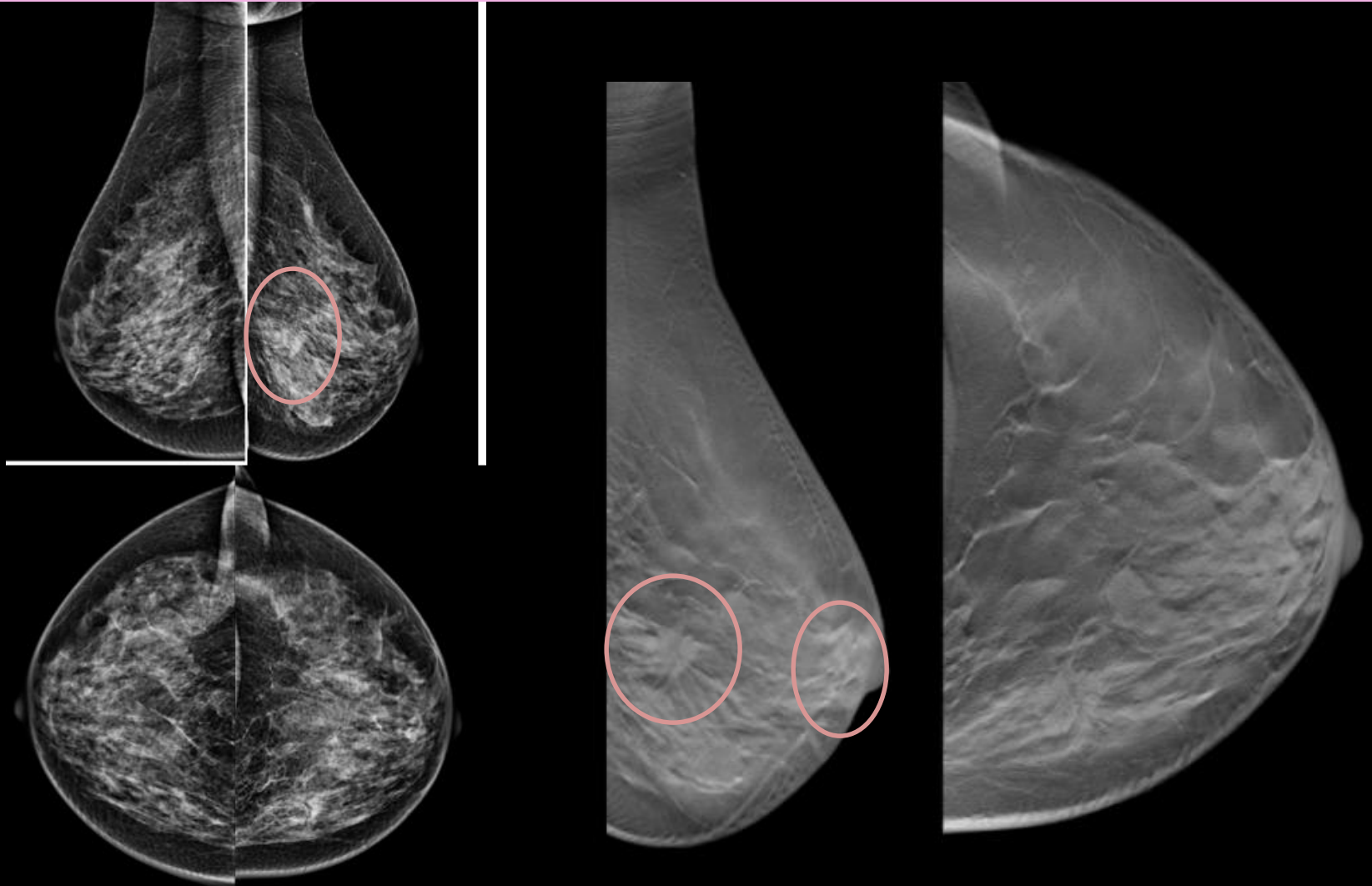


68 yr f came for
screening

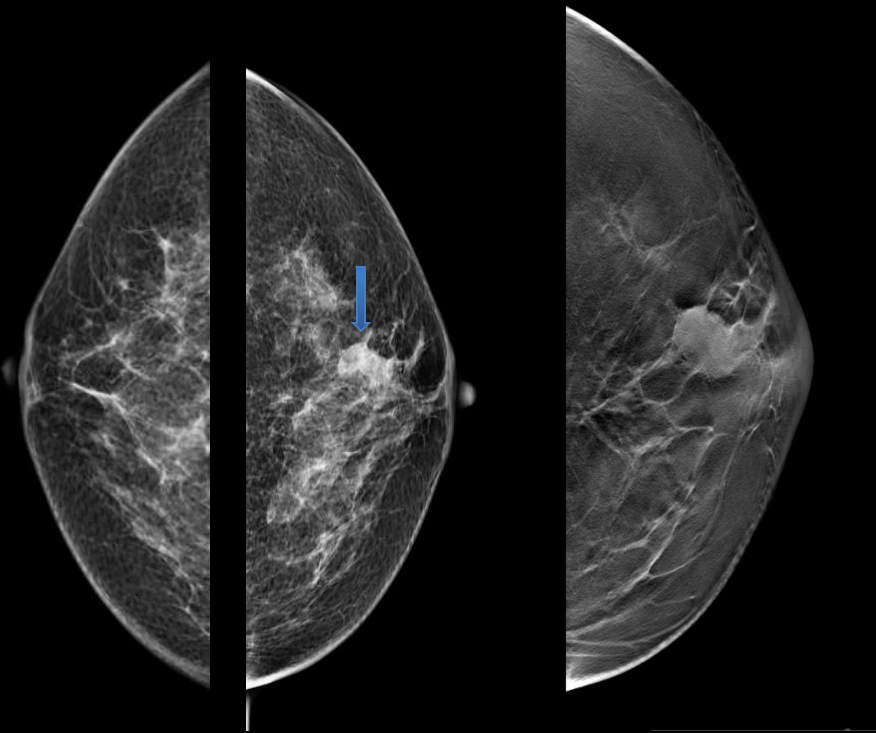
Microcalcification



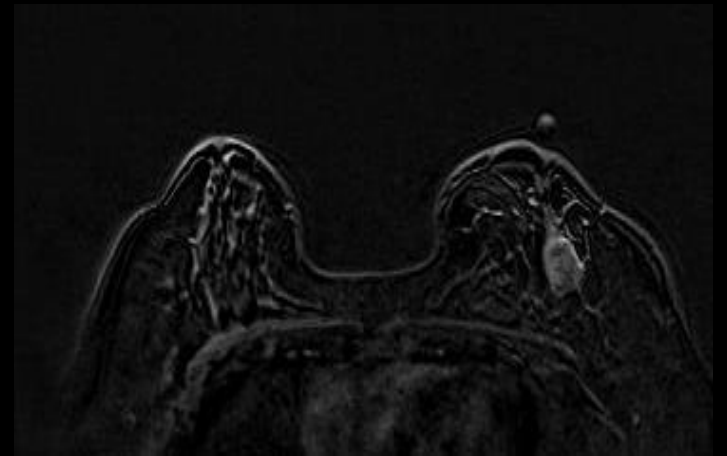
Case : Improved lesion visibility in heterogeneous dense breast with Tomosynthesis



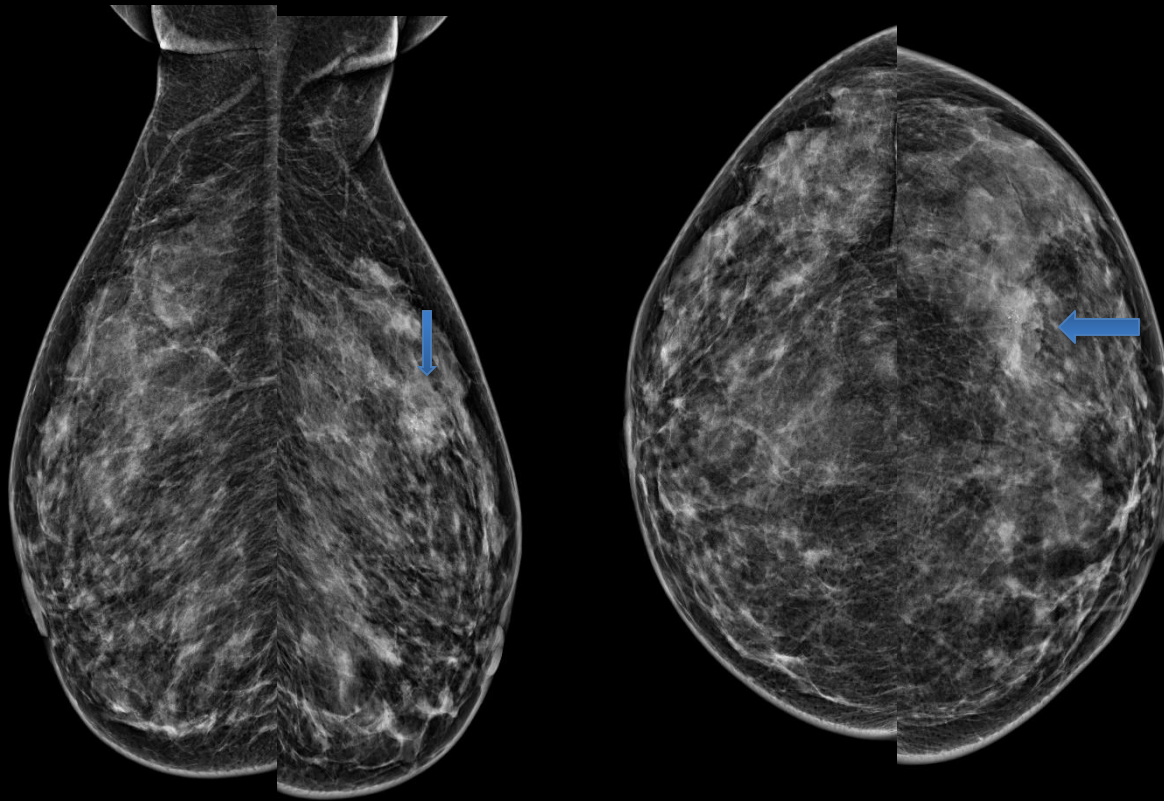
Case : Better characterization of lesion



46 years female
came with lump in
left breast since 3
months .Her sister
had history of
breast carcinoma

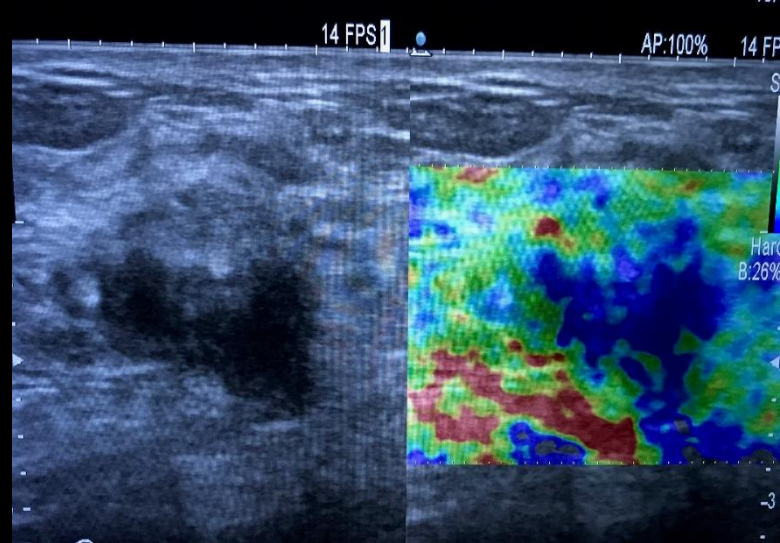
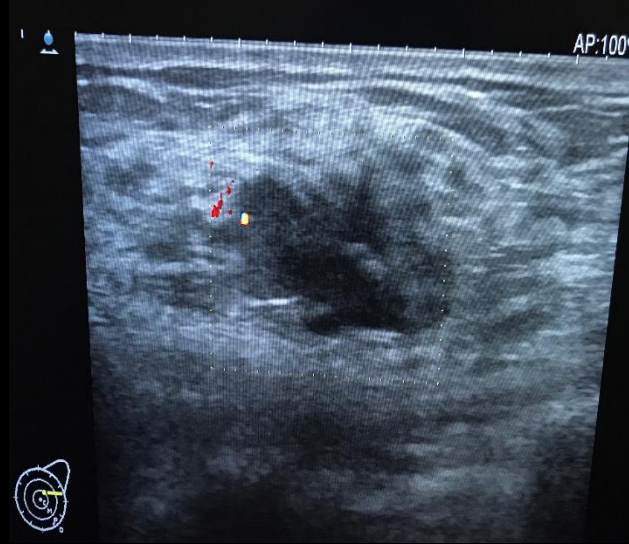
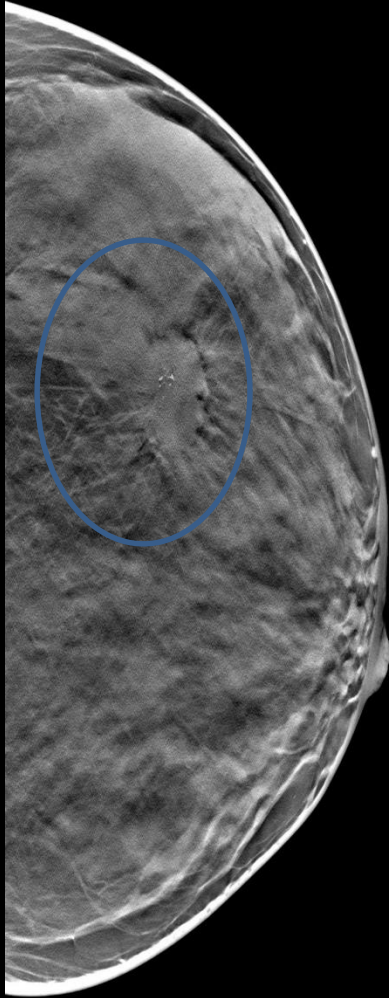


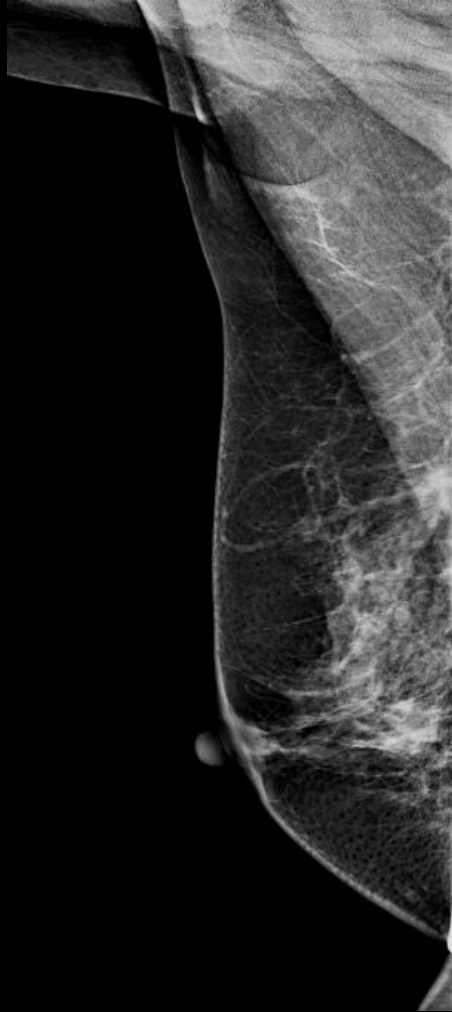
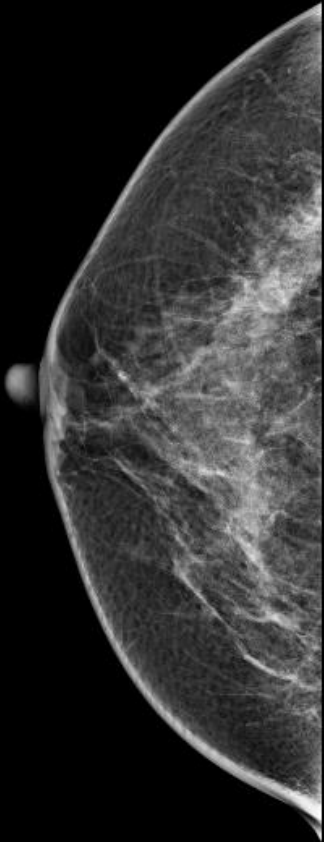
Case : Hidden lesion detection

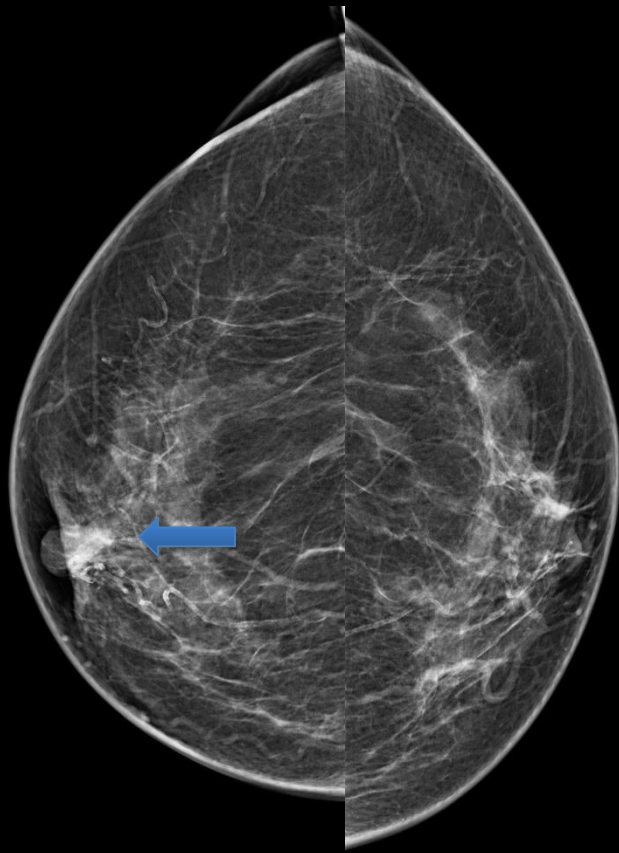


36 years old premenopausal female came with complaint of lump in left breast since 3 months

Case







- Nearly 40 % breast cancer mortality reduction when women start annual screening at the age of 40 yrs.
- Mammography is a powerful screening tool ,however it is inadequate in women with dense breast tissue.
- Sensitivity of mammography for detection of breast cancer is 85% ,however in women with dense breasts it reduces to 47.8- 64.4% .
- Women with extremely dense breast have a 4.7 fold increased risk of breast cancer

Imaging in the dense breast is a challenge for radiologists

- Dense breast tissue appears white on mammograms, as does breast cancer, that is why dense tissue can sometimes obscure a cancer.
- Increased mammographic density not only confers an increased risk of developing breast cancer but also means that an underlying tumor may be masked by dense breast tissue and is less likely to be detected on mammography
- Sensitivity of mammography can be as low as 30–45% in women with dense breasts, compared with 98% in mammographically non- dense breasts

Dynamic Contrast Enhanced MRI- Breast

- MRI has exceptional sensitivity to detect breast cancer and can demonstrate even those cancers, which are entirely occult on the conventional imaging.
- Reported sensitivities to detect invasive breast carcinomas using dynamic contrast agents are consistently greater than 90% and in some studies upto 100%.



Multiparametric MRI Breast

- DCE-MRI is the most sensitive breast imaging investigation with variable specificity.
- It provides high resolution morphological information as well as some functional information about the tumour perfusion and vascularity.
- To overcome limitations in specificity, several other functional MRI parameters can be applied and it is defined as multiparametric MRI.
- DWI and Spectroscopy combined with the CEMR to improve sensitivity and specificity.
- mpMRI breast useful in the morphological and functional assessment at cellular and molecular levels, which further elucidate tumour progression and its response to treatment.

Indications

- Preoperative evaluation
- Response to neoadjuvant chemotherapy
- Evaluate surgical margins, post breast conservation surgery
- Metastatic axillary lymph nodes –Unknown primary
- Breast cancer screening
- Problem solving tool
- Breast implant integrity
- MRI guided biopsy

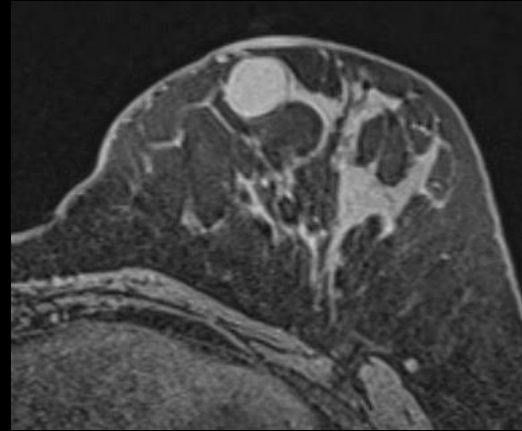
ACR-BIRADS (MRI)

Fifth edition of BI-RADS Lexicon

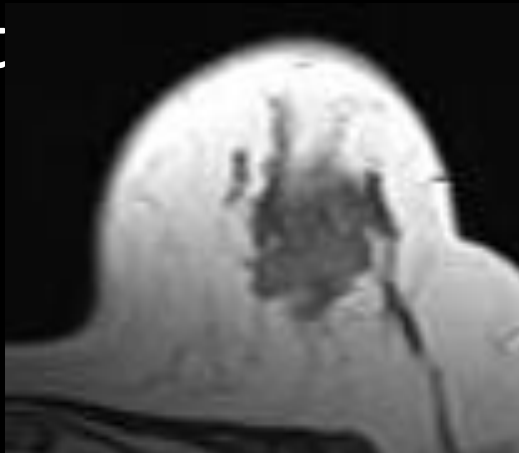
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Margins

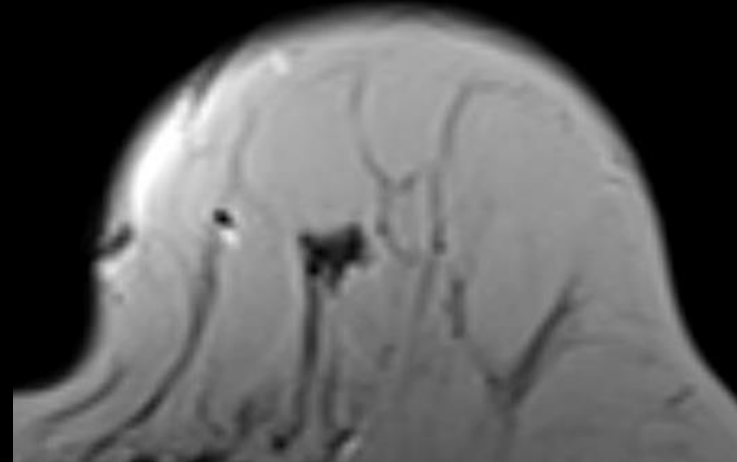
- Circumscribed



- Not



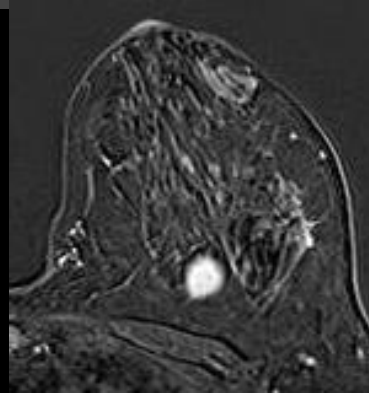
Irregular



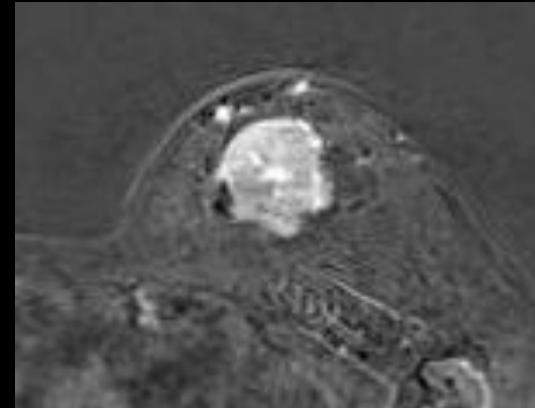
Spiculated

Internal enhancement characteristics

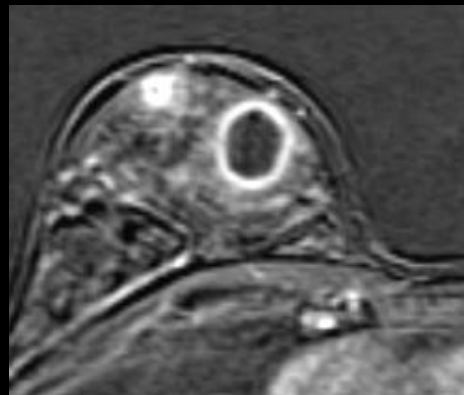
- Homogeneous enhancement

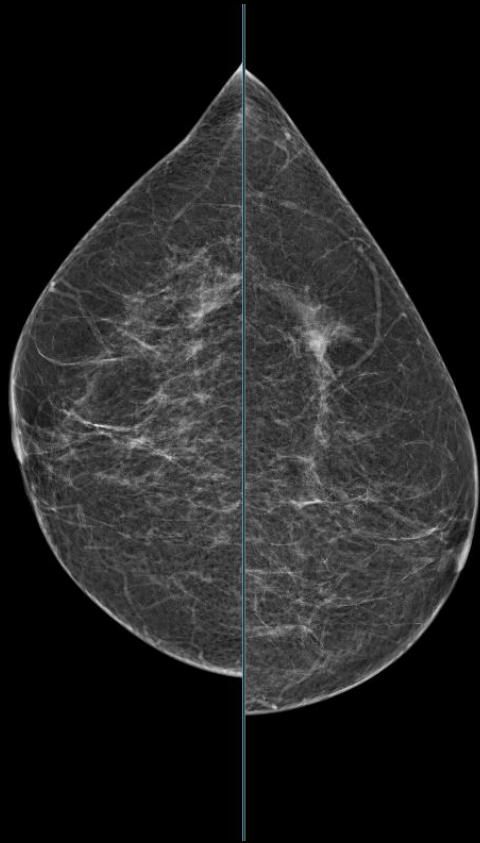


- Heterogeneous enhancement



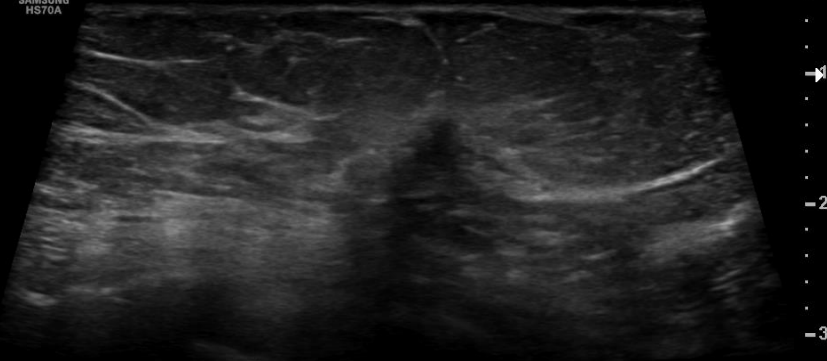
- Rim enhancement



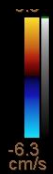
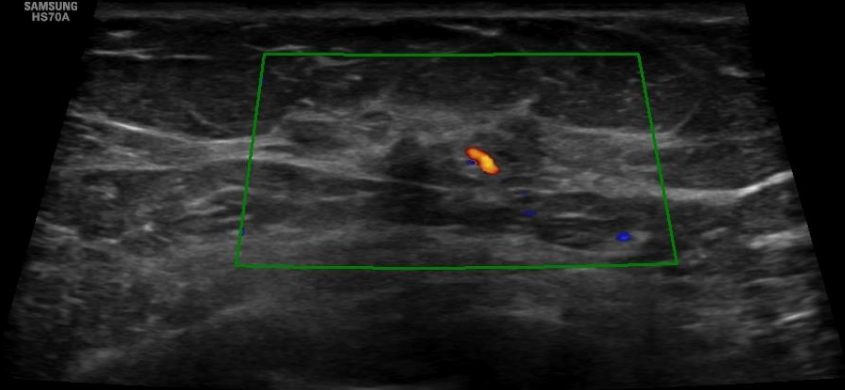


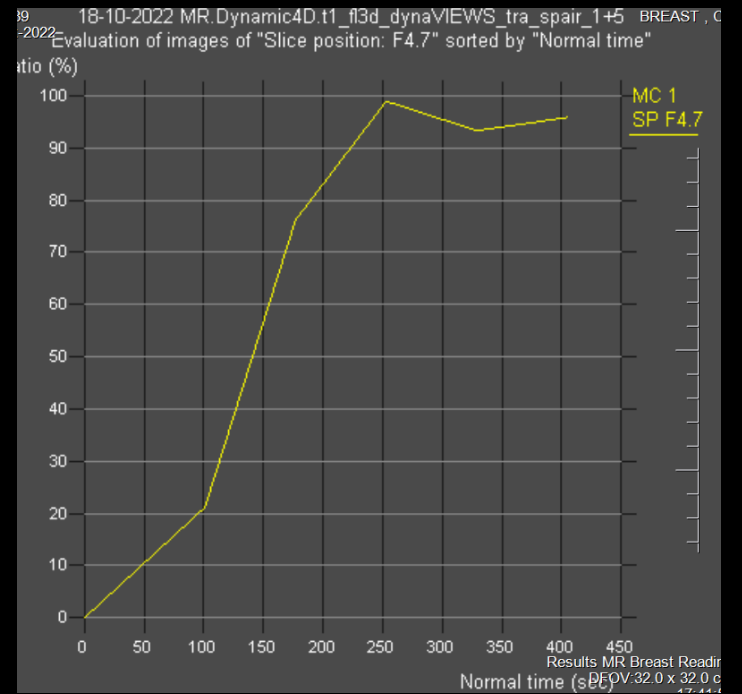
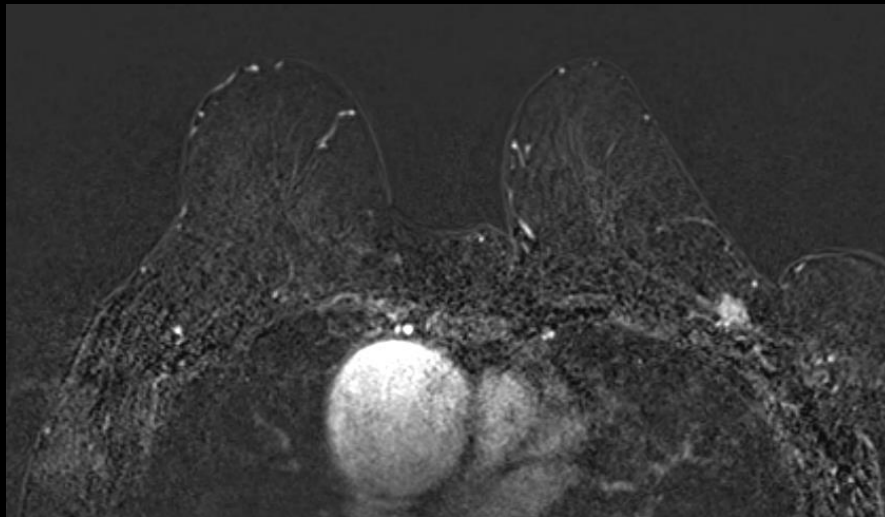
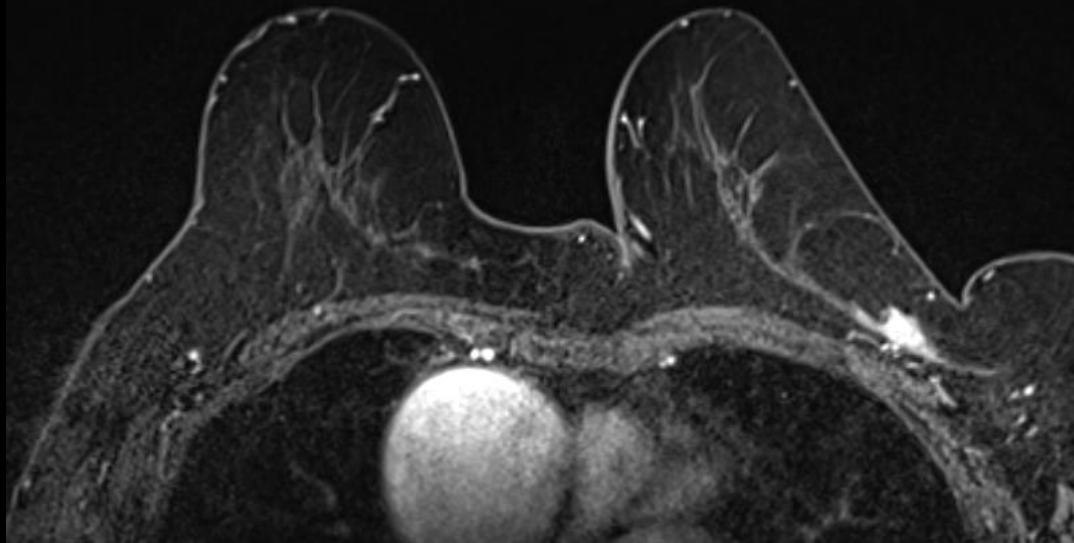
68 yr f

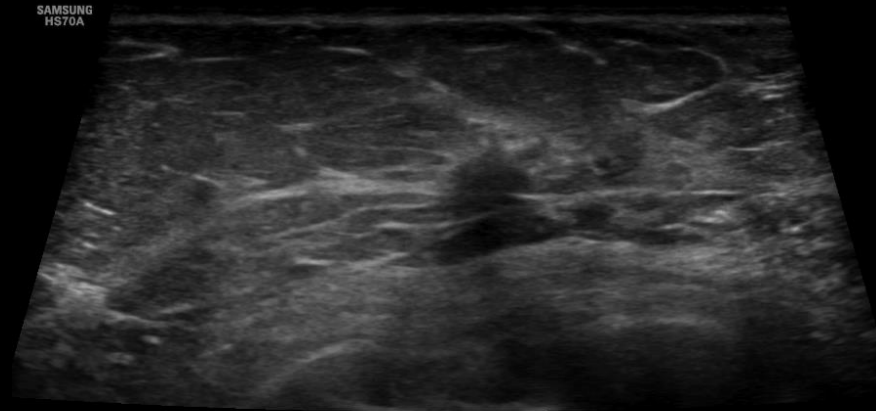
SAMSUNG
HS70A



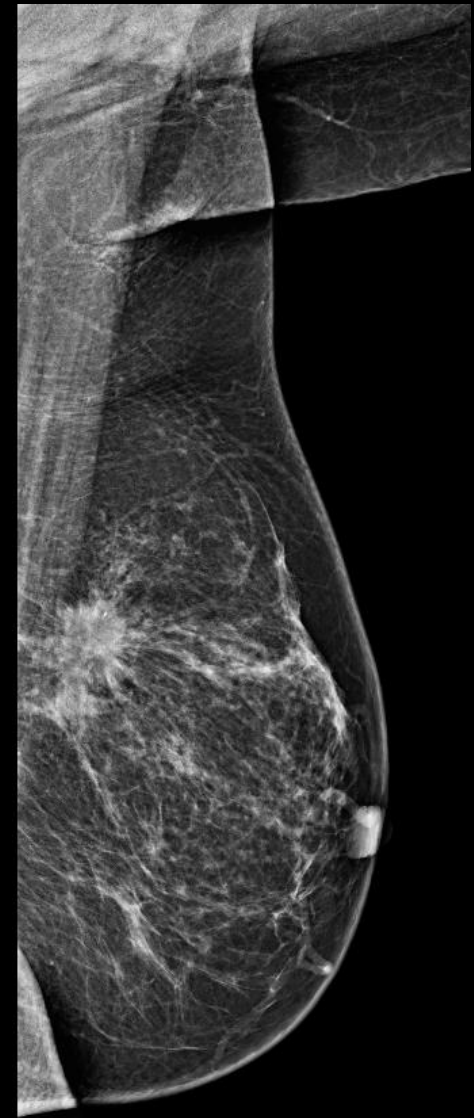
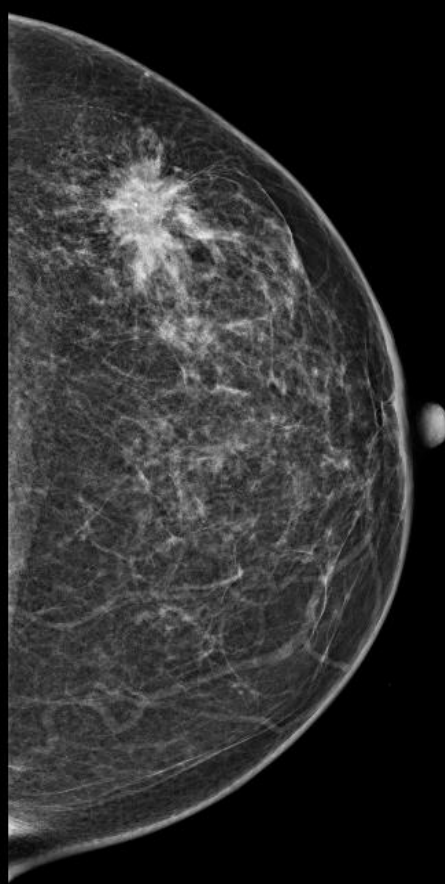
SAMSUNG
HS70A







Invasive ductal carcinoma



49 y f

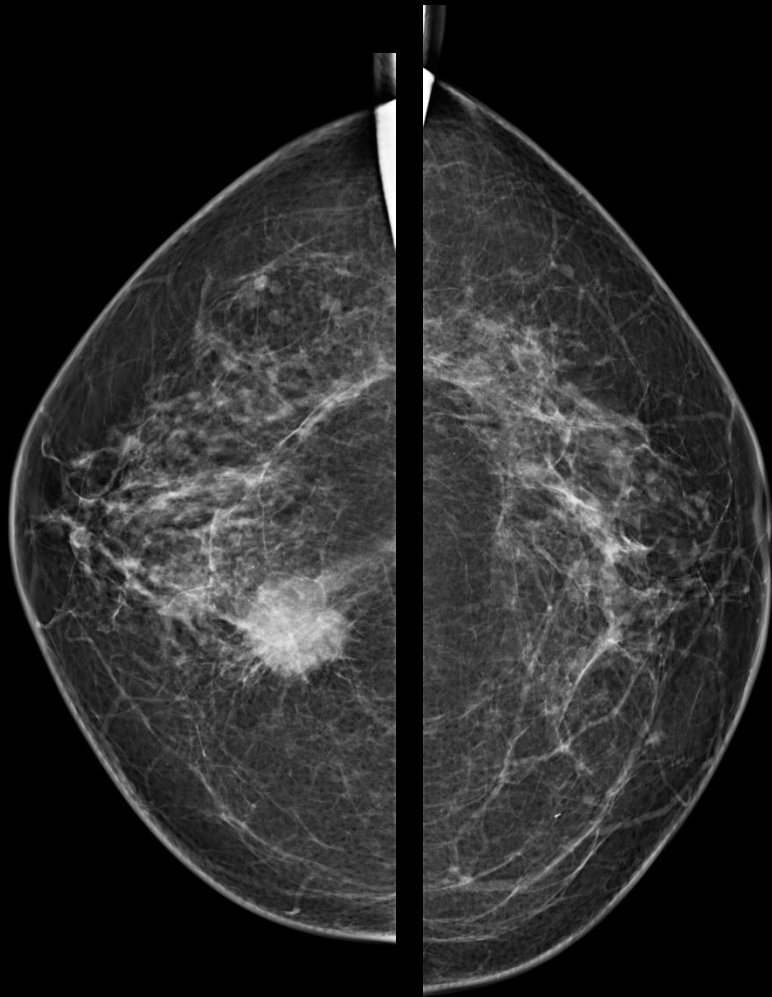
Post op case of right sided MRM.

An irregular ,high density mass with spiculated margins seen in the upper outer quadrant ,involving the retromammary region. It is s/o malignant lesion.

ACR BIRADS 5 – Highly suggestive of malignancy



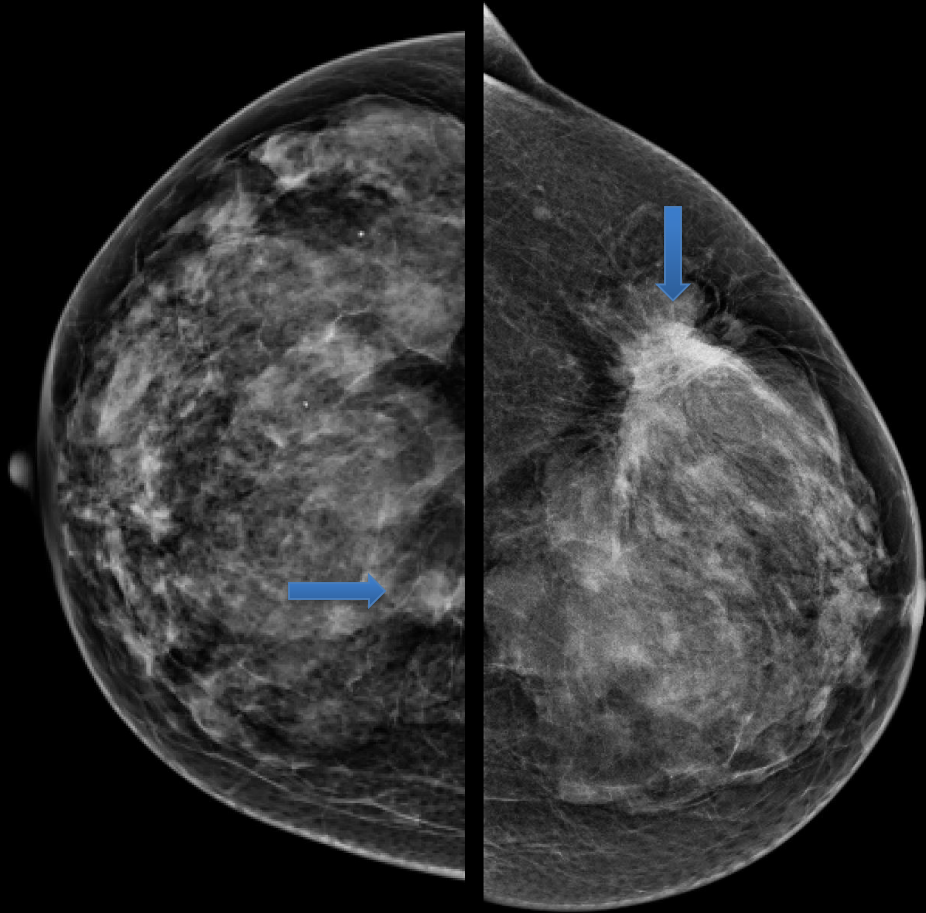
Invasive ductal carcinoma



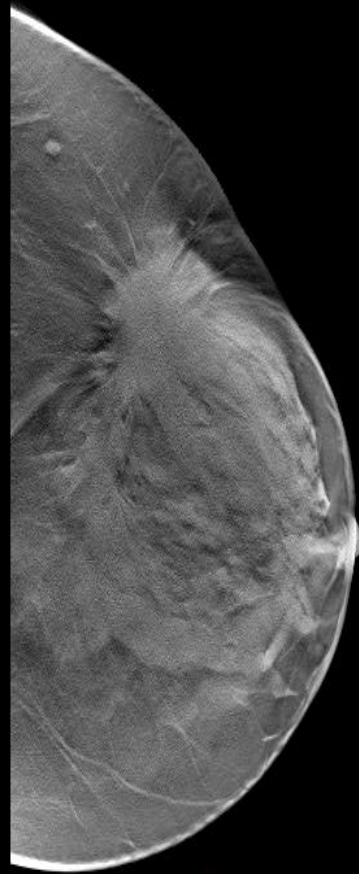
60 yr presented with
Lump in right breast

Case

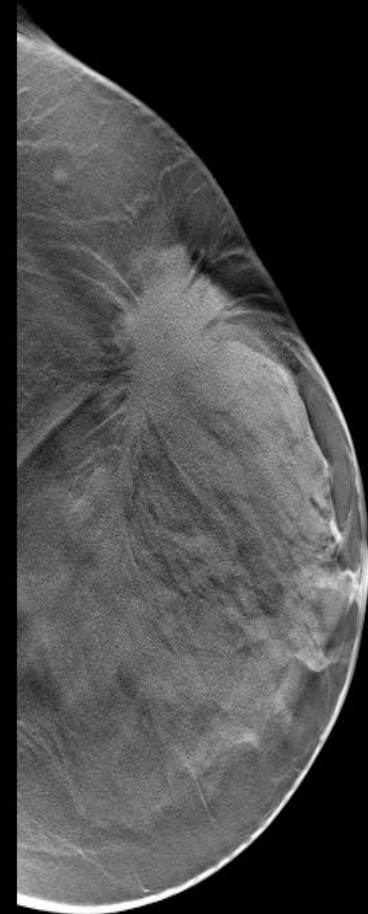
- 54 year post menopausal female came with a complaint of palpable lump in left breast that she observed 1 and half months back.
- No associated pain or nipple discharge.
 - No family history of breast cancer.
 - She is a non smoker and non alcoholic.
 - No history of hormone replacement therapy.



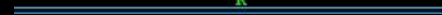
Tomosynthesis



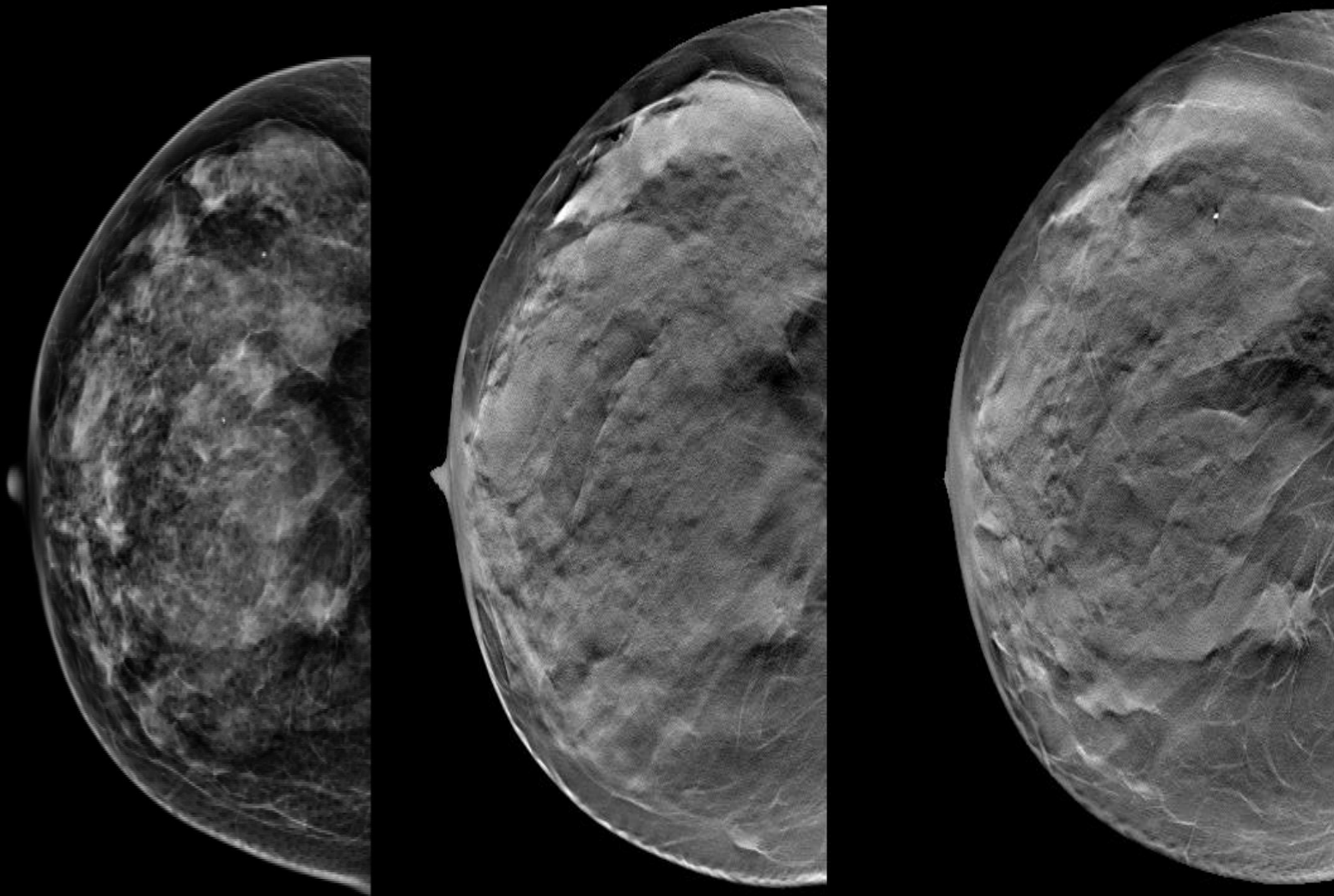
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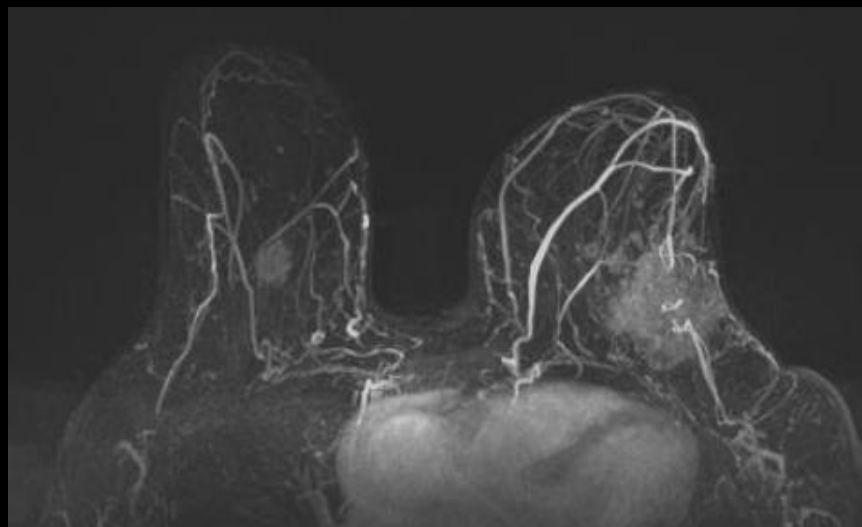
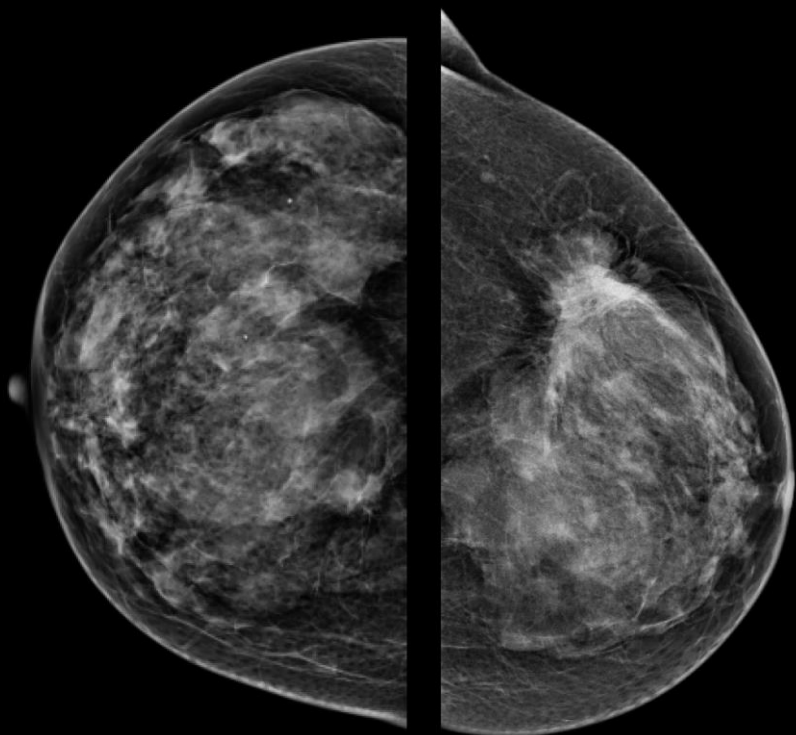
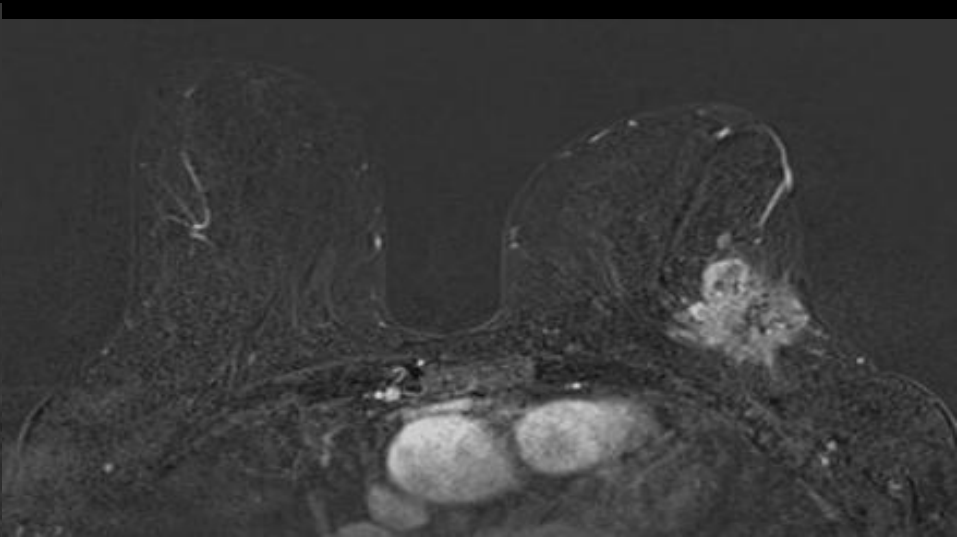
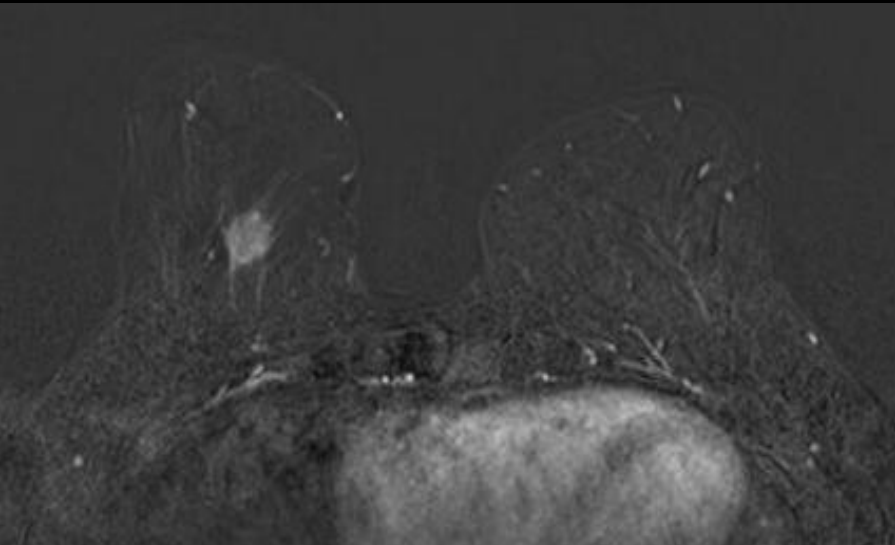


R



Tomosynthesis





- She was worked up for palpable breast lump with an ultrasound of both breasts and a **USG** guided biopsy of both breast lesions

left breast mass- histopathology:

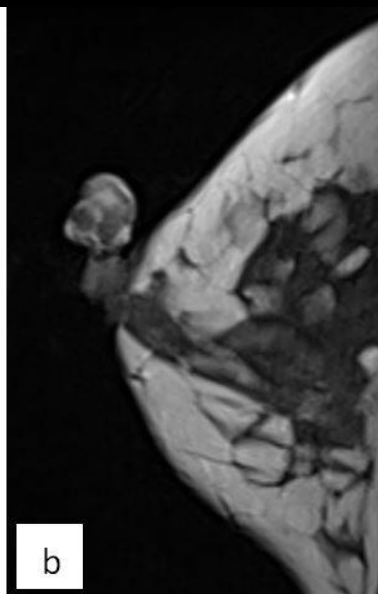
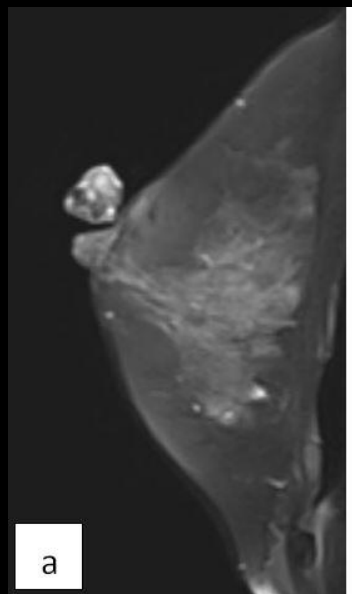
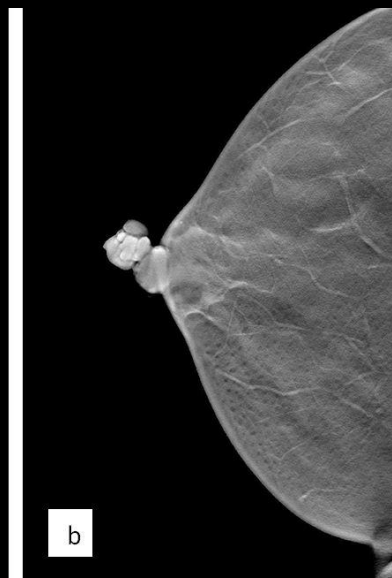
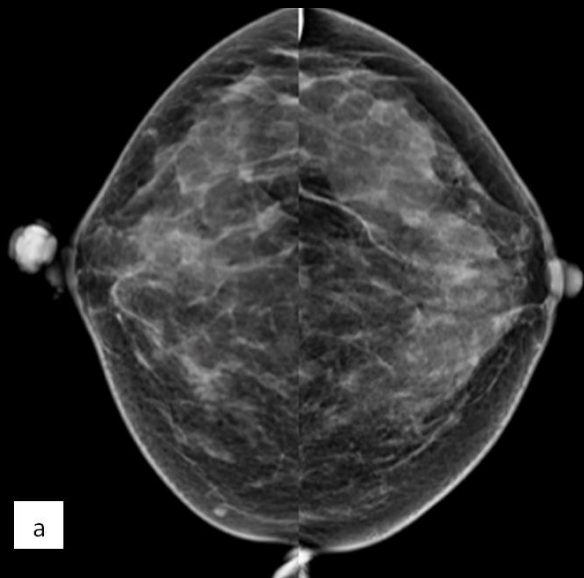
- **Infiltrative ductal carcinoma (Grade-2),**
- Modified RB score – $2+2+2=6$
- With no DCIS seen in the cores
- IHC: ER – positive; PR and HER-2 negative

- USG guided biopsy of the lesion of right breast was done.
- HPE revealed: Invasive lobular carcinoma
- Histological grade A-glandular differentiation (Score-3);
- B-Nuclear pleomorphism (Score-2)
- C-Mitotic rate (Score-1)
- Overall grade-6
- Necrosis is not identified
- Lymphovascular invasion is present
- IHC: ER, PR –Positive; HER-2 and E-cadherin- Negative

- In view of bilateral and multifocal carcinoma breast with different histological subtype and bone metastases, the patient is treated with systemic chemotherapy.



46 years female presented with abnormal growth on the nipple –since around 6 years, progressively increasing, painless, no dischrge





Nipple papilloma with dysplasia

DOI: 10.7860/JCDR/2022/51905.16799

Radiology Section

Case Report

Nipple Papilloma with Dysplasia: A Case Report

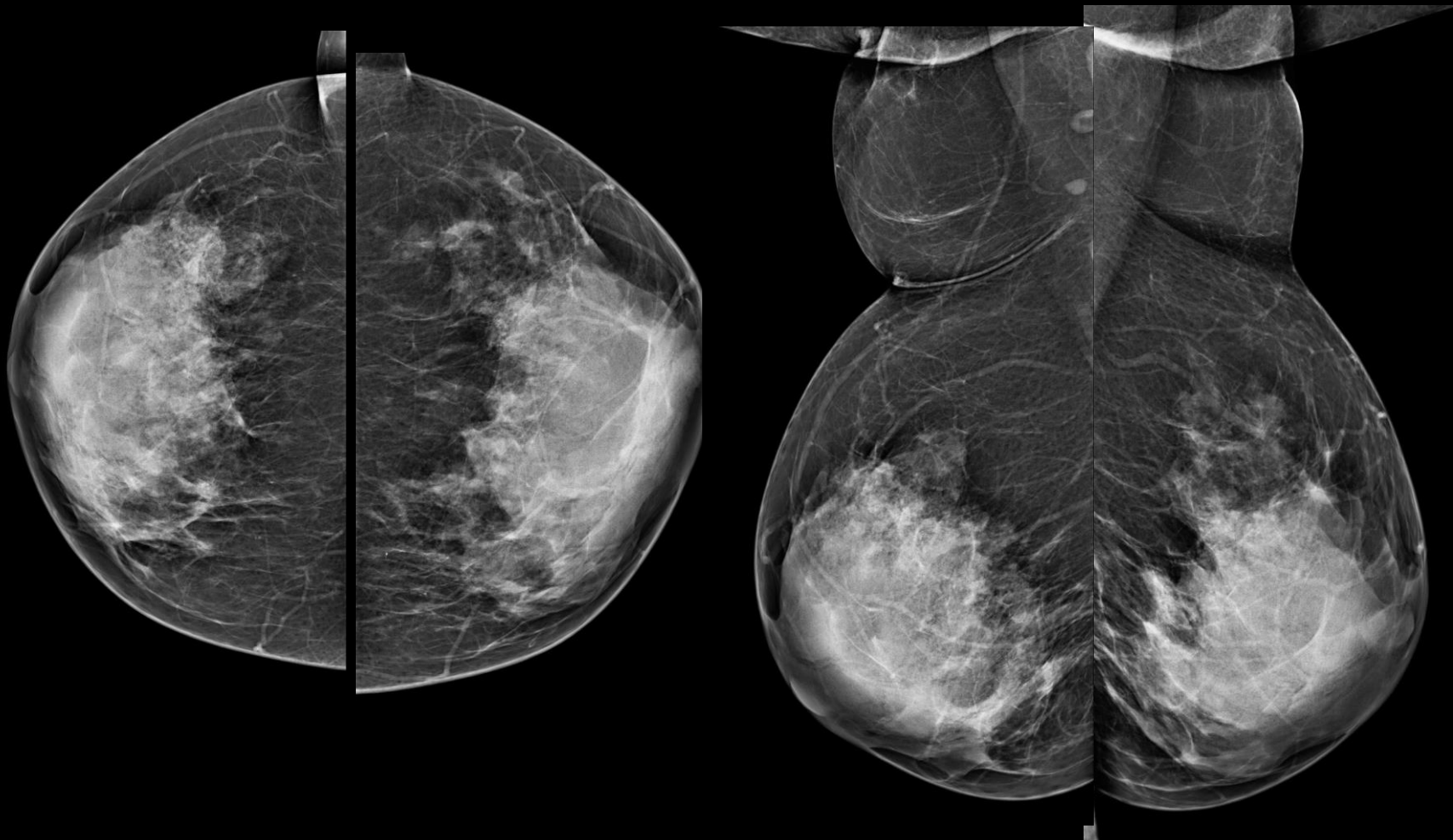
PRATIKSHA YADAV¹, YEWARI SAMEERA², VANSHITA GUPTA³, VARSHA RANGANKAR⁴, TUSHAR KAMBALE⁵

CC BY-NC-ND

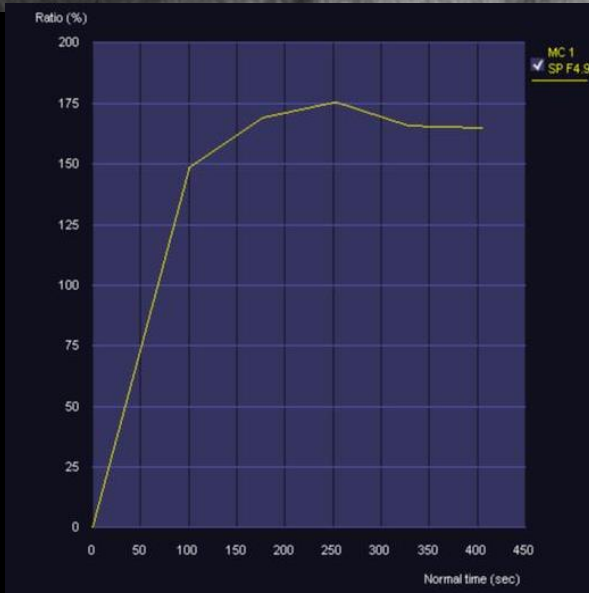
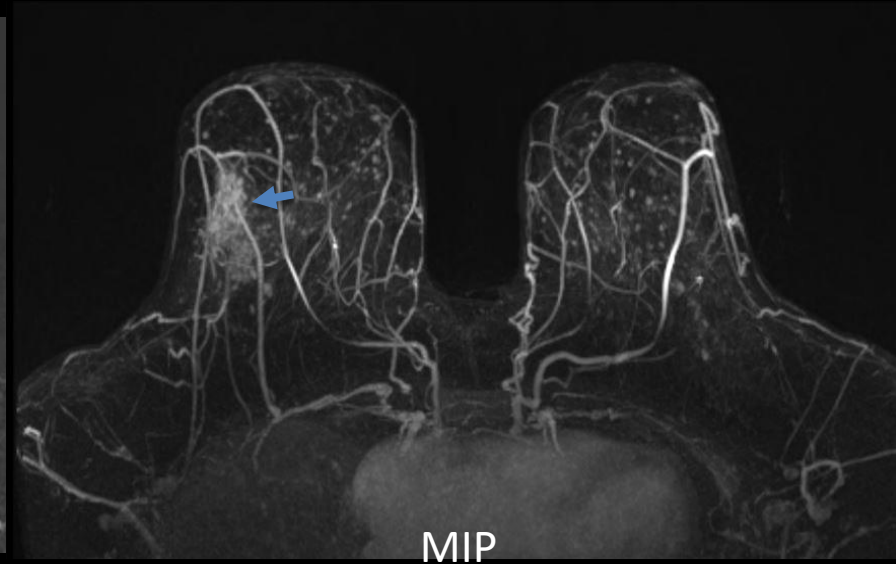
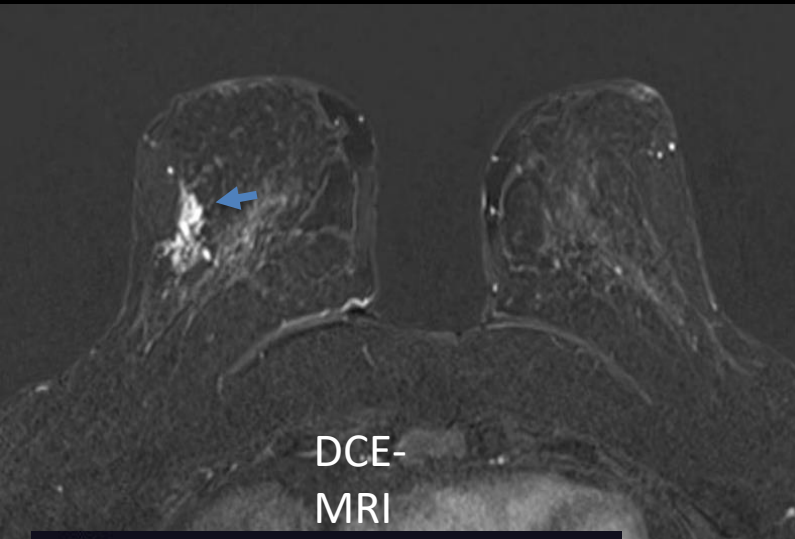
ABSTRACT

Nipple papilloma is an uncommon benign breast tumour. Polypoid lesions arising from the surface of the nipple include nipple papilloma, fibroepithelial stromal polyp of the nipple. These must be differentiated from malignant lesions involving the nipple, like Paget's disease of the nipple, and malignant breast lesion with nipple involvement. Detailed clinical examination, and to a great extent, imaging helps to differentiate these lesions. Hereby, authors report a case of 46-year-old female presented with abnormal growth arising from the right nipple. On full field digital mammography, bilateral breasts revealed scattered fibroglandular breast parenchyma (American College of Radiology (ACR) type B). An irregular hyperdense mass with lobulated margins is seen superior to right nipple which measured approximately 16×14 mm. The case was managed by local curative excision under local anaesthesia. On gross histopathology, the lesion showed squamous epithelium consisting of variable levels of acanthosis and hyperkeratosis, and focal parakeratosis which also shows focal ulceration and moderate to severe dysplasia and mixed inflammation consistent with papilloma. Histopathological examination has a role in differentiating the benign lesions like nipple papilloma from fibroepithelial stromal polyp of nipple and also helps in determining the presence of atypical hyperplasia, dysplasia or carcinoma in-situ.

Case : Non mass enhancementment



Case : Non mass enhancement in DCIS with invasive ductal carcinoma



42 Year old woman presented with bloody nipple discharge from right breast- MRI showed non mass enhancement

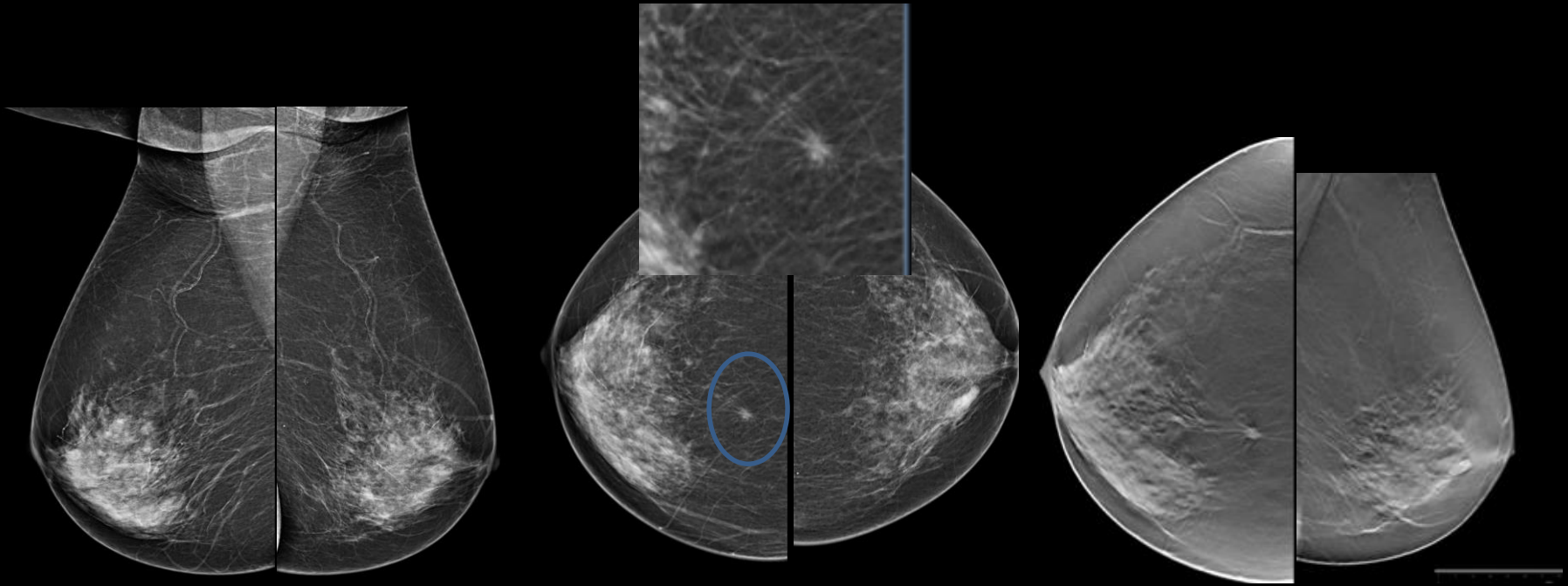
Multiparametric MRI Breast

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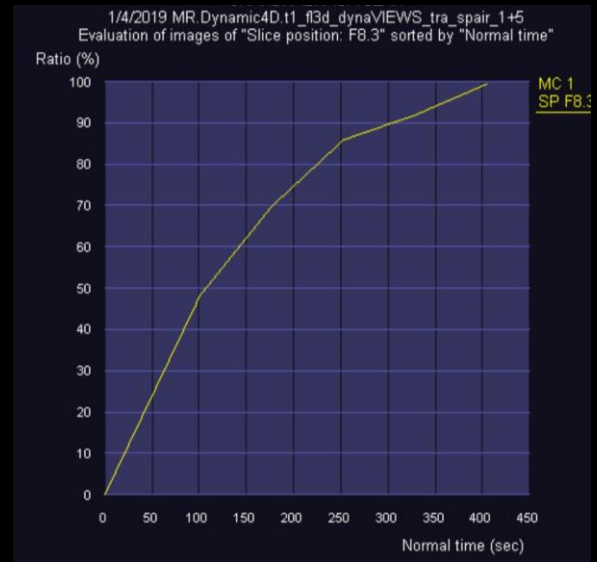
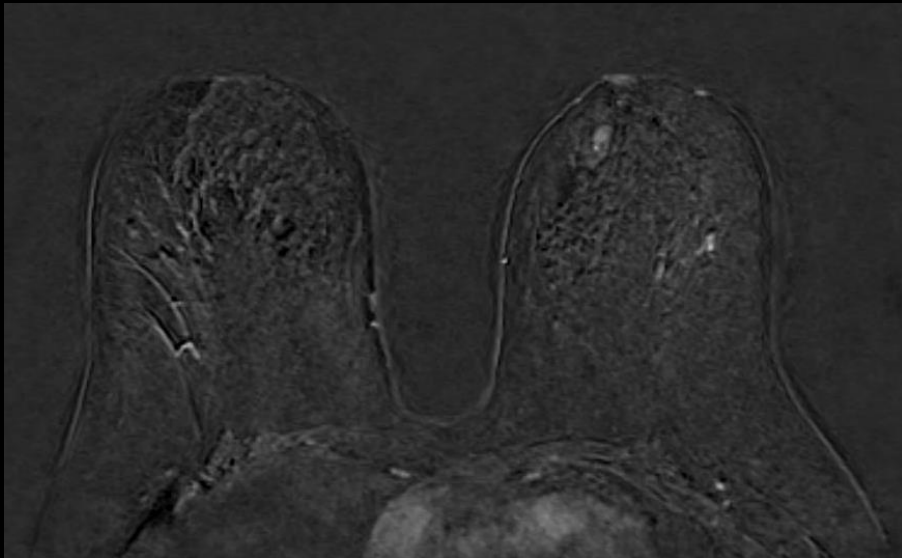
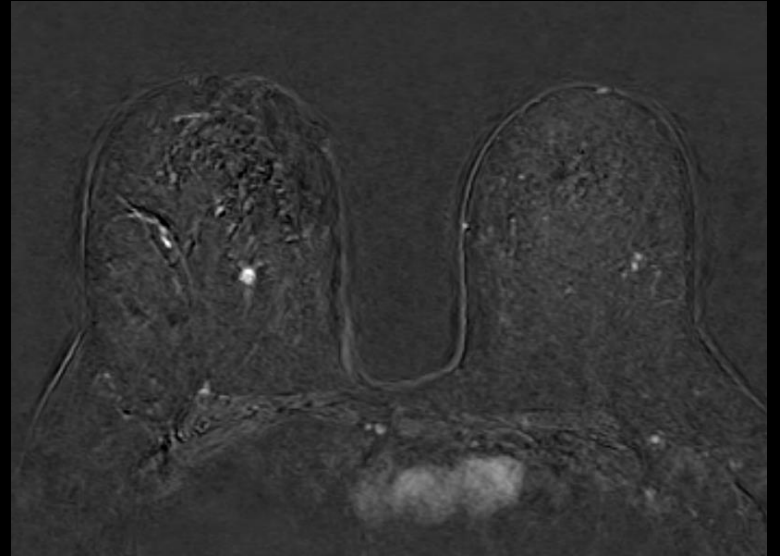
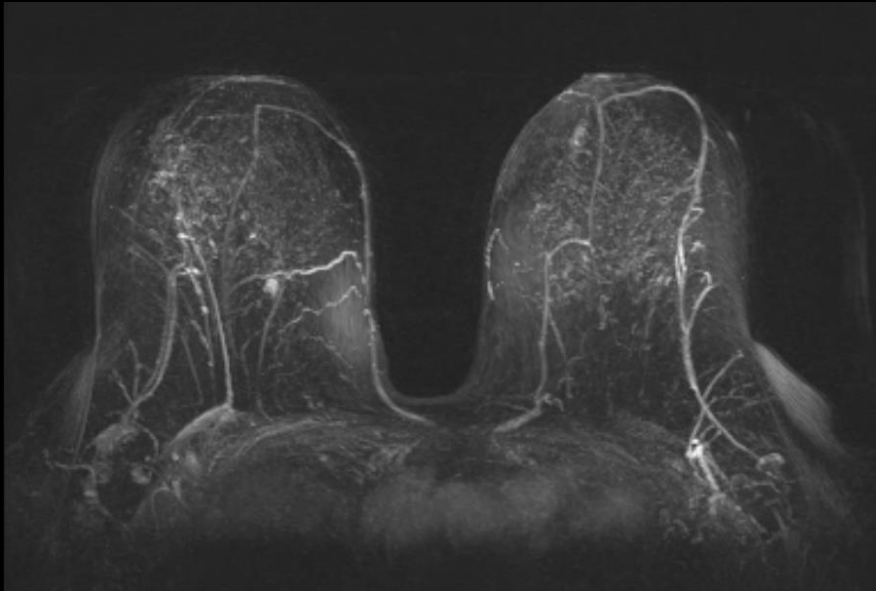
Indications

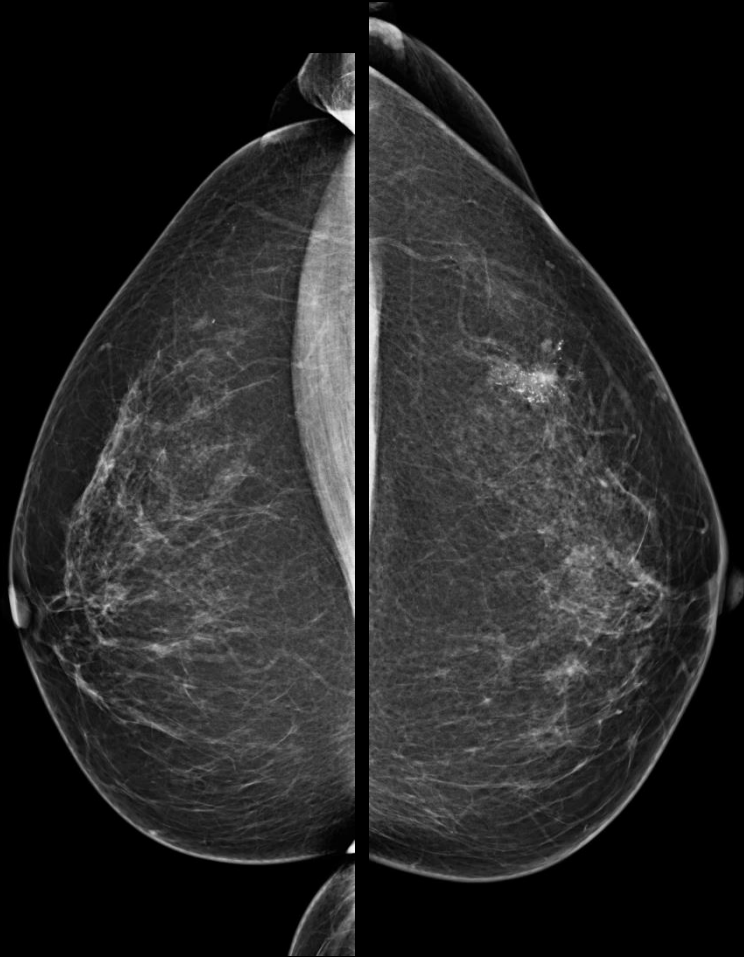
- Preoperative evaluation
- Response to neoadjuvant chemotherapy
- Evaluate surgical margins, post breast conservation surgery
- Metastatic axillary lymph nodes –Unknown primary
- Breast cancer screening
- Problem solving tool
- Breast implant integrity

Case- early detection in screening

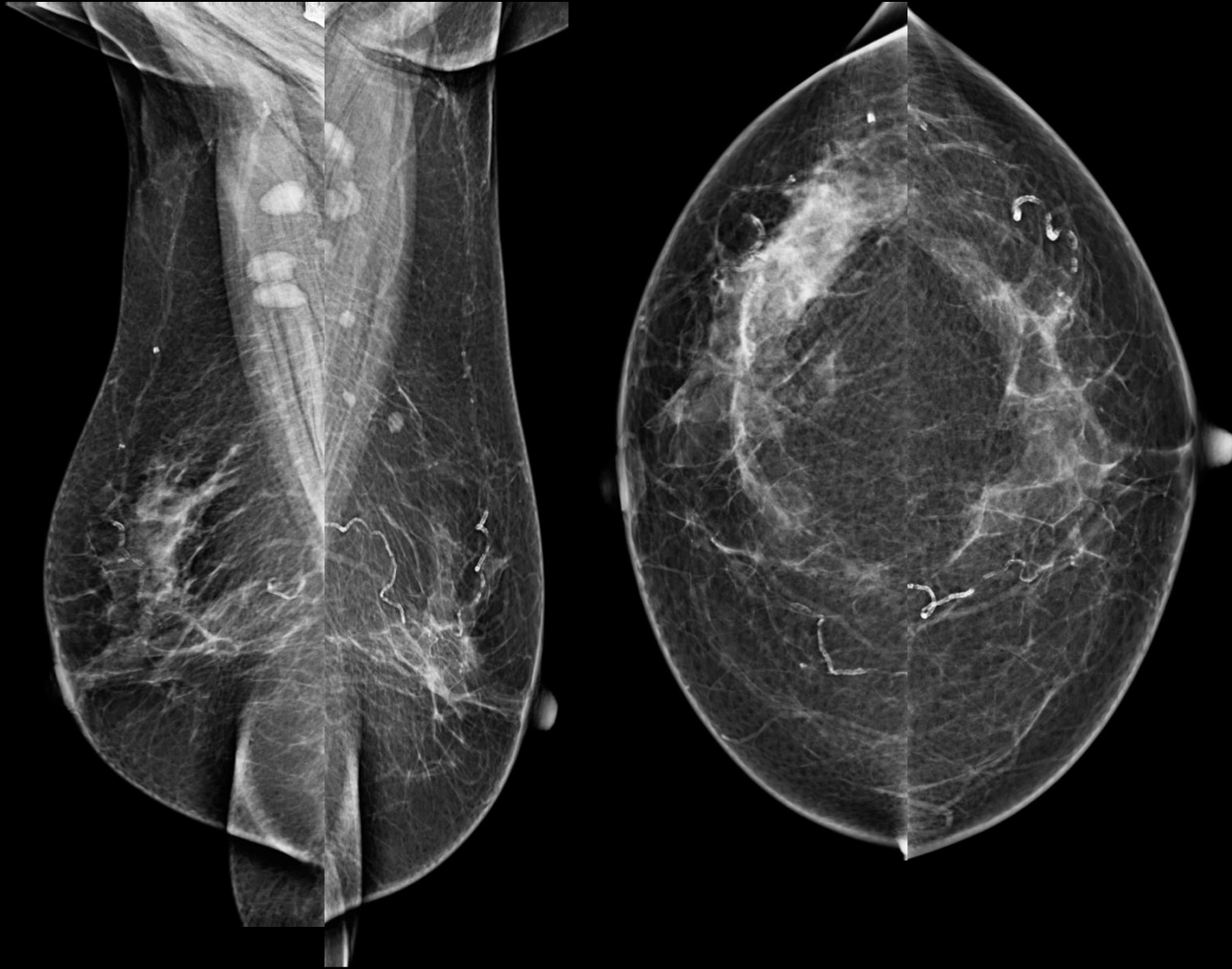


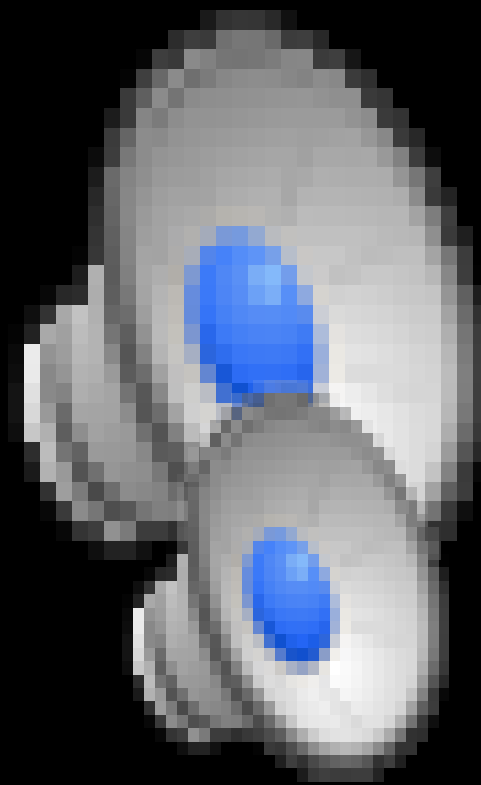
63 years old female came for screening
mammogram, no family history of breast cancer



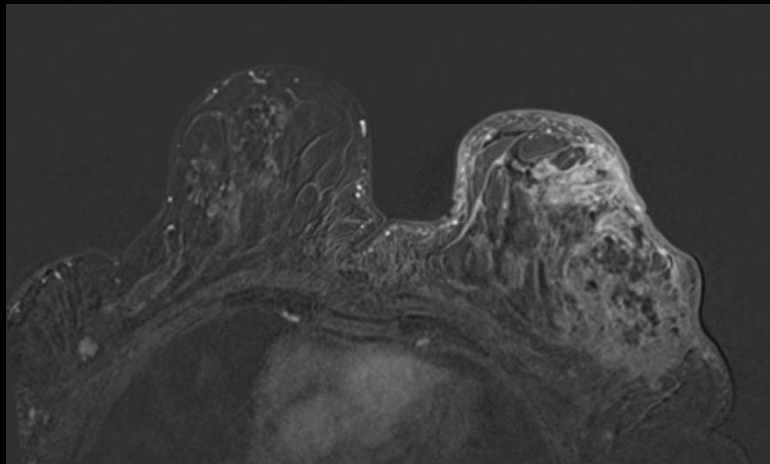
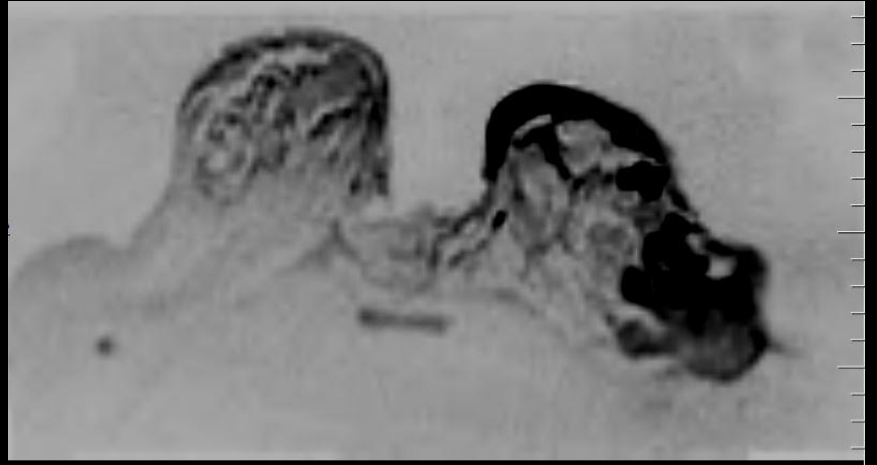


Case- non mass abnormality

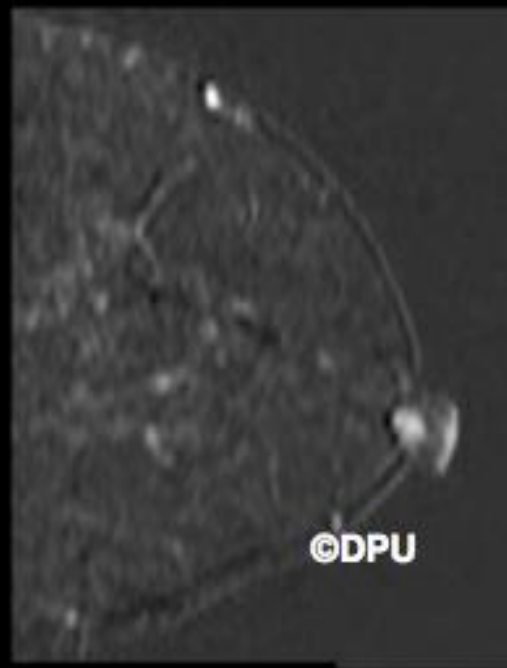
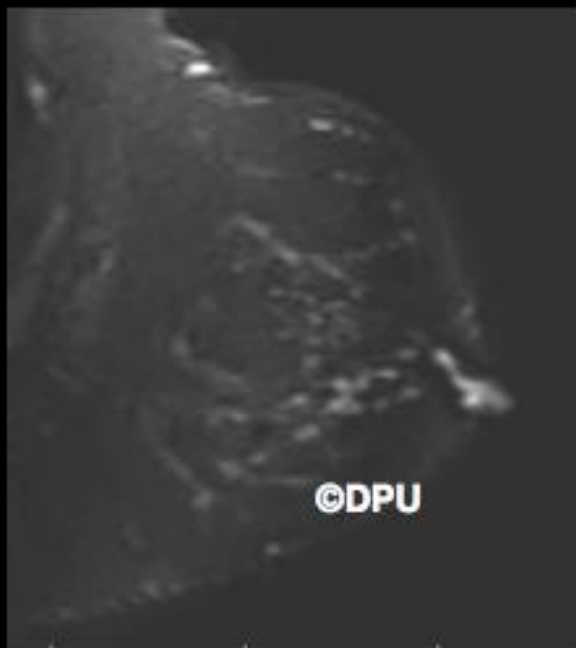
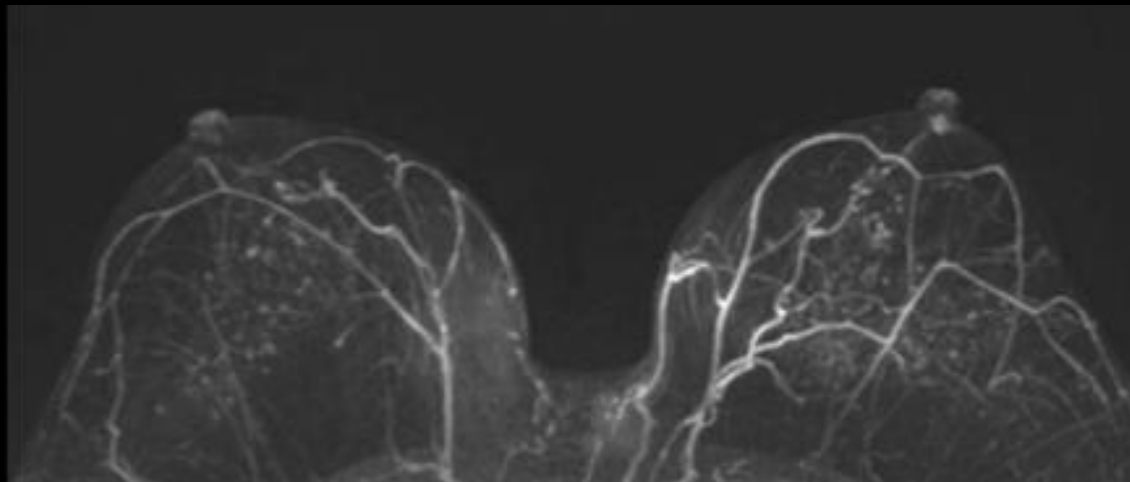




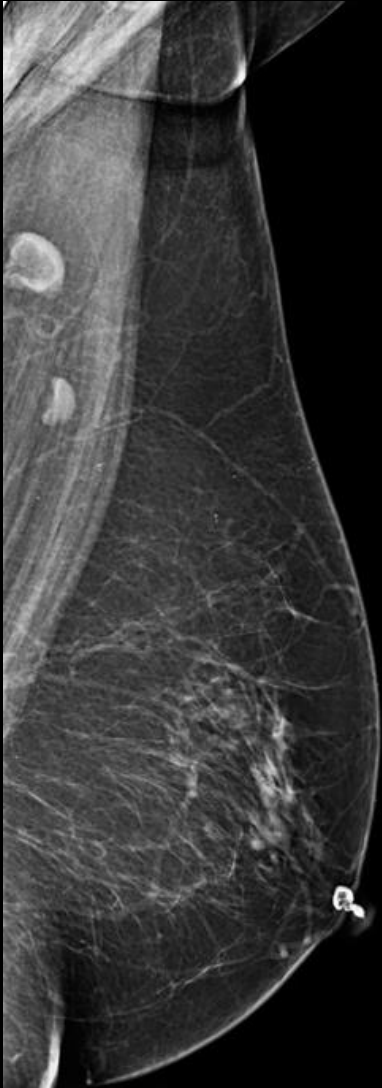
Case : LABC (IDC)



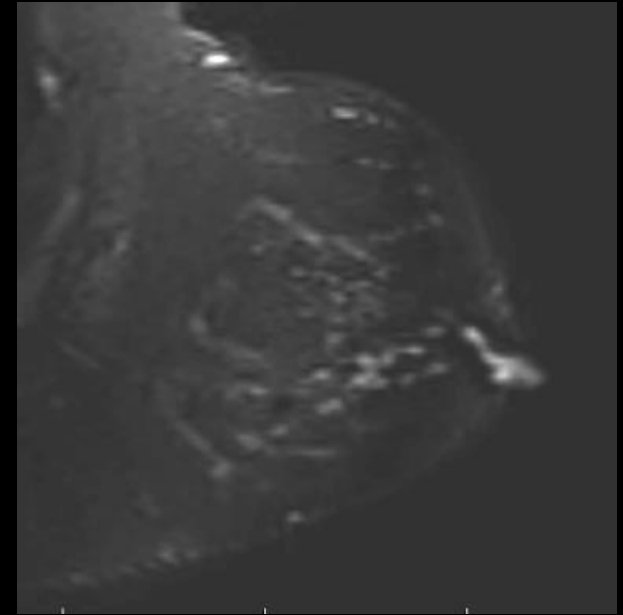
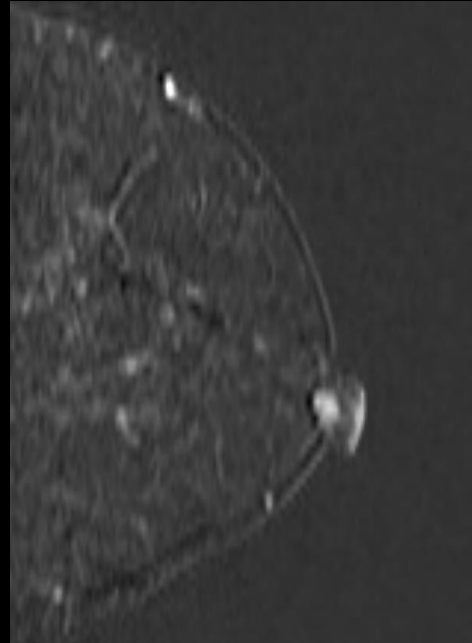
MR Ductography



MRI Ductography

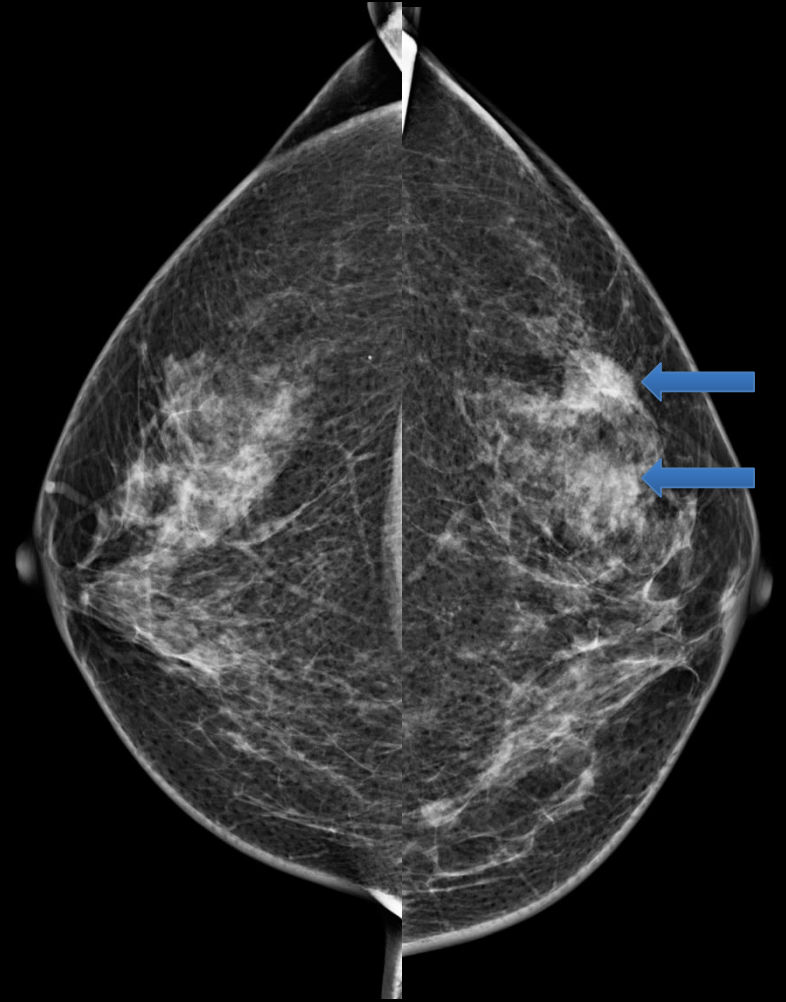


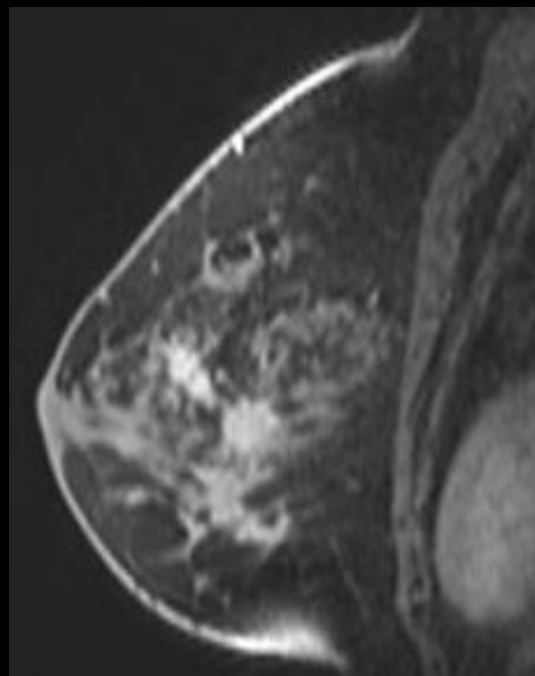
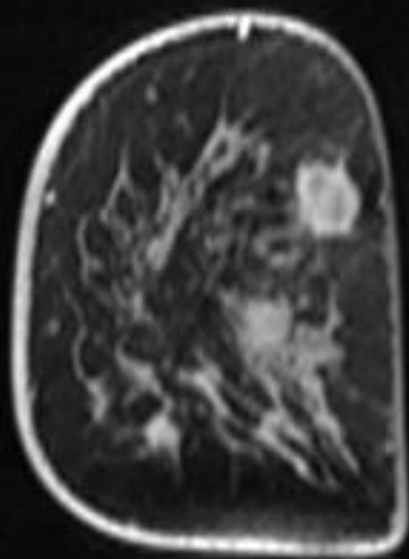
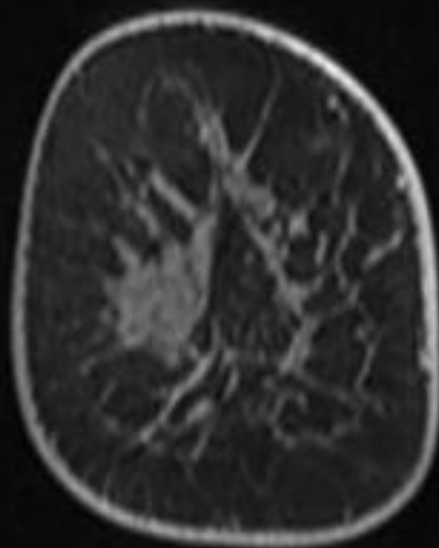
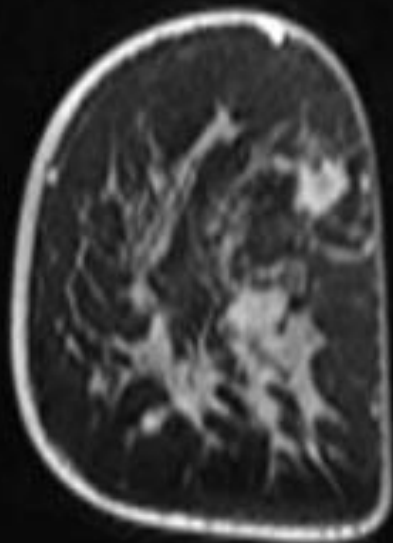
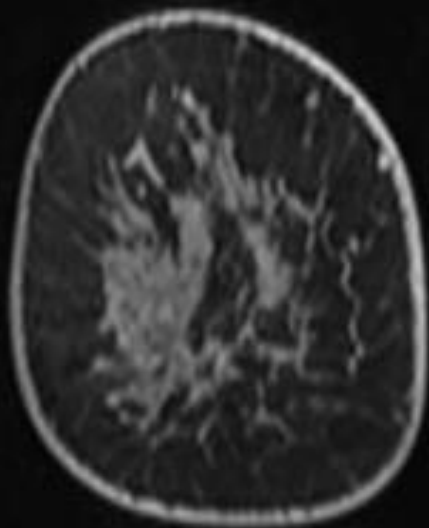
DCEMRI –showed
enhanced
intraductal mass



MR –Ductography
showing filling defect

Case of intraductal Papilloma

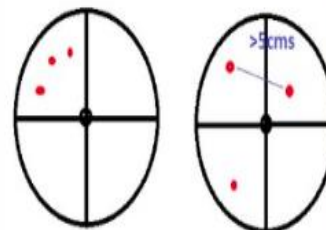




Multifocal and Multicentric Breast Ca

- **Multifocal Carcinoma**- When multiple lesions seen in the same quadrant of the breast
- **Multicentric Carcinoma**- multiple tumours in far separated areas of the breast

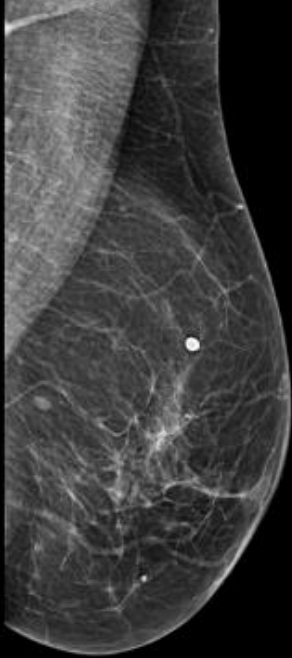
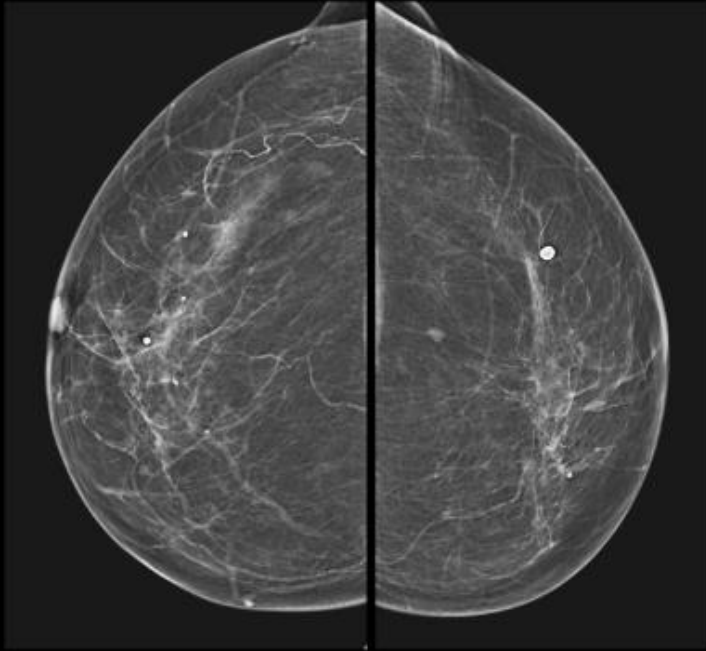
- The presence of two or more foci of cancer within the same breast quadrant is defined as multifocal, while the presence of two or more foci of cancer in different quadrants of the same breast is defined as multicentric



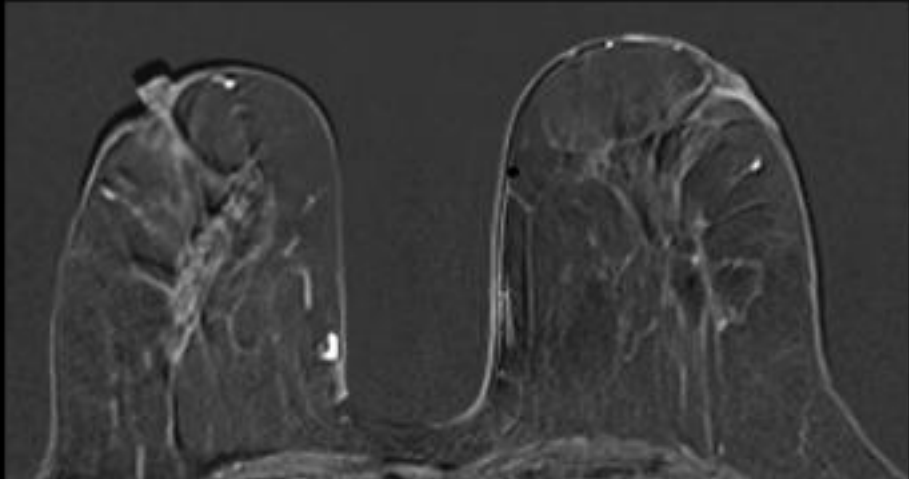
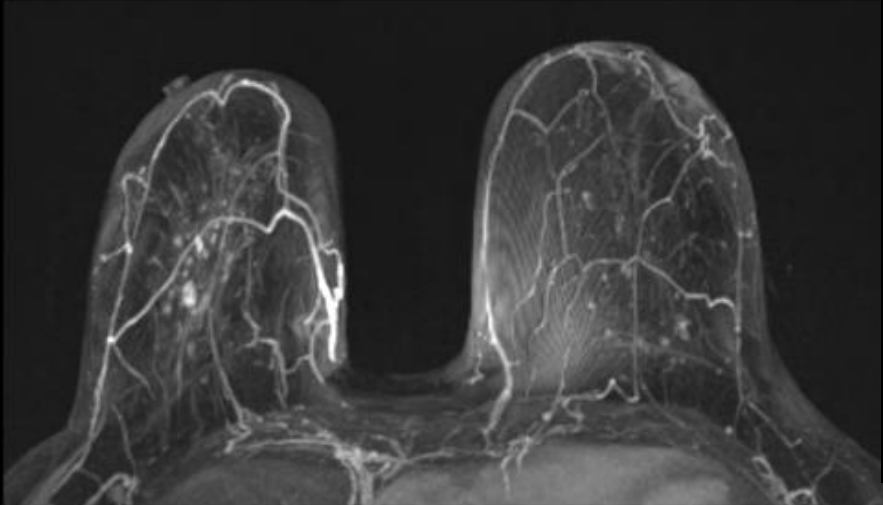
Multifocal

Multicentric

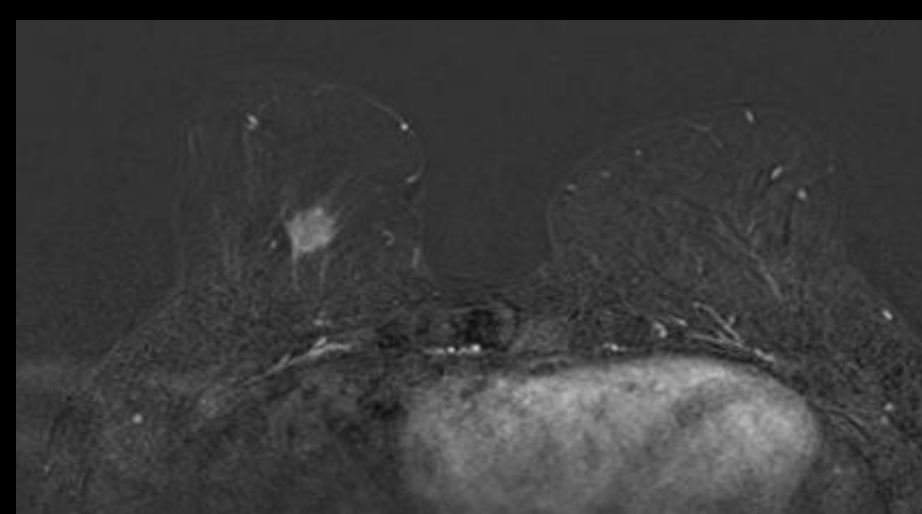




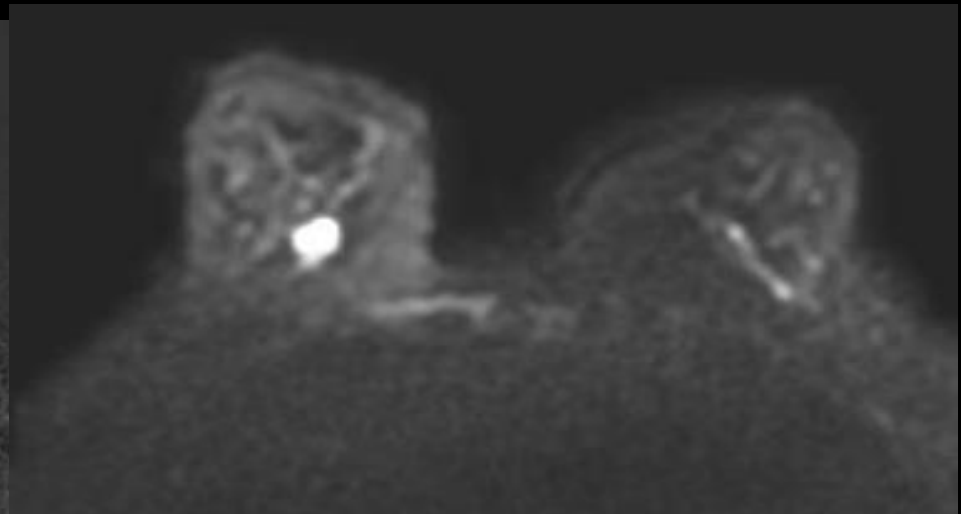
Paget Disease



Non contrast MRI Breast Techniques- DWI Functional Imaging



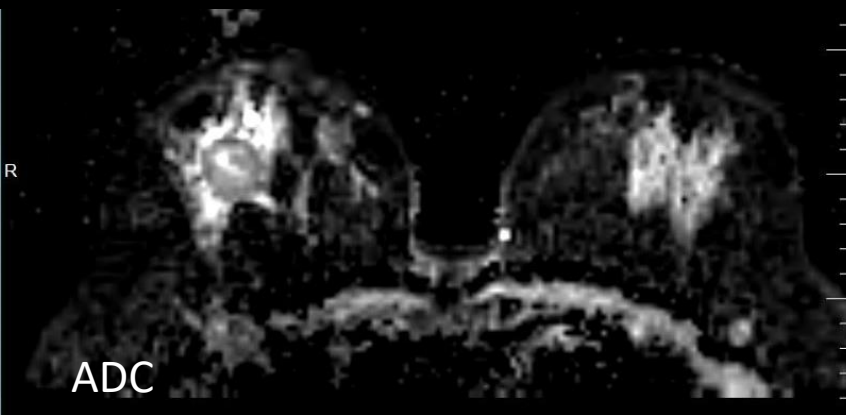
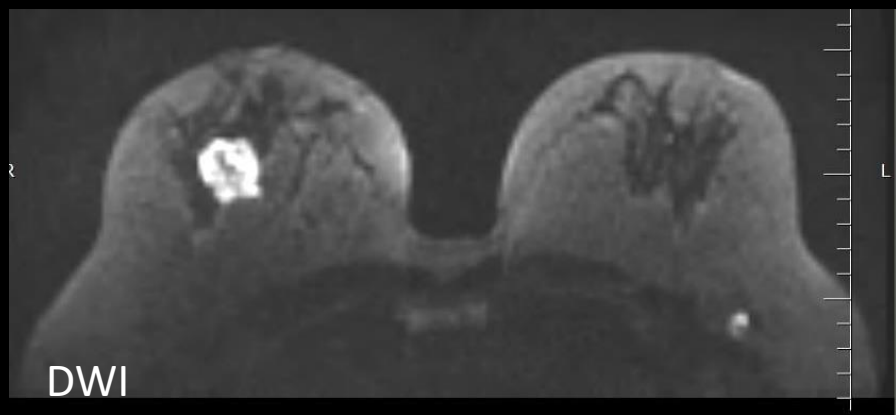
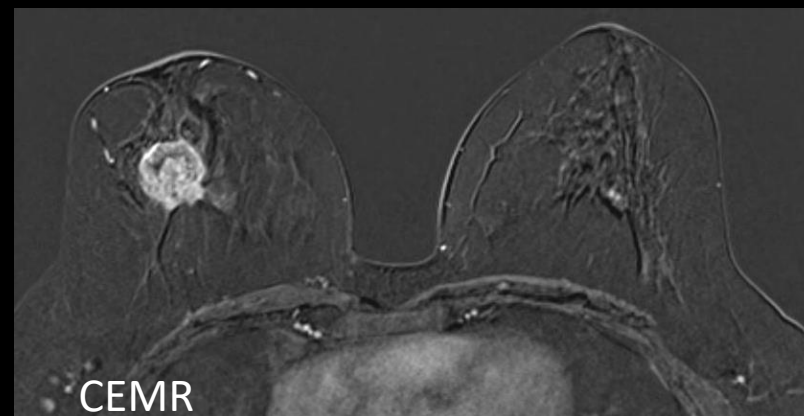
Dynamic contrast enhanced MRI



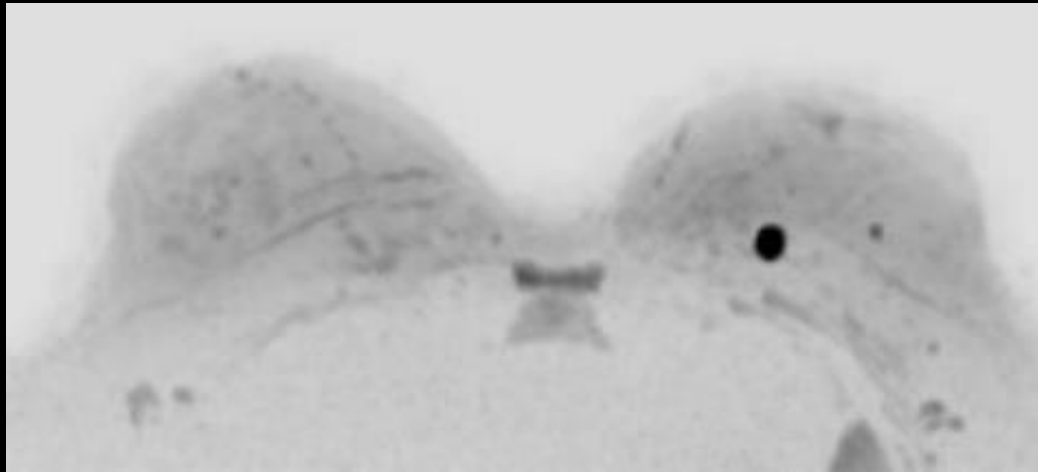
Diffusion Weighted MRI

IDC in Right Breast

Case: IDC in 40 years woman



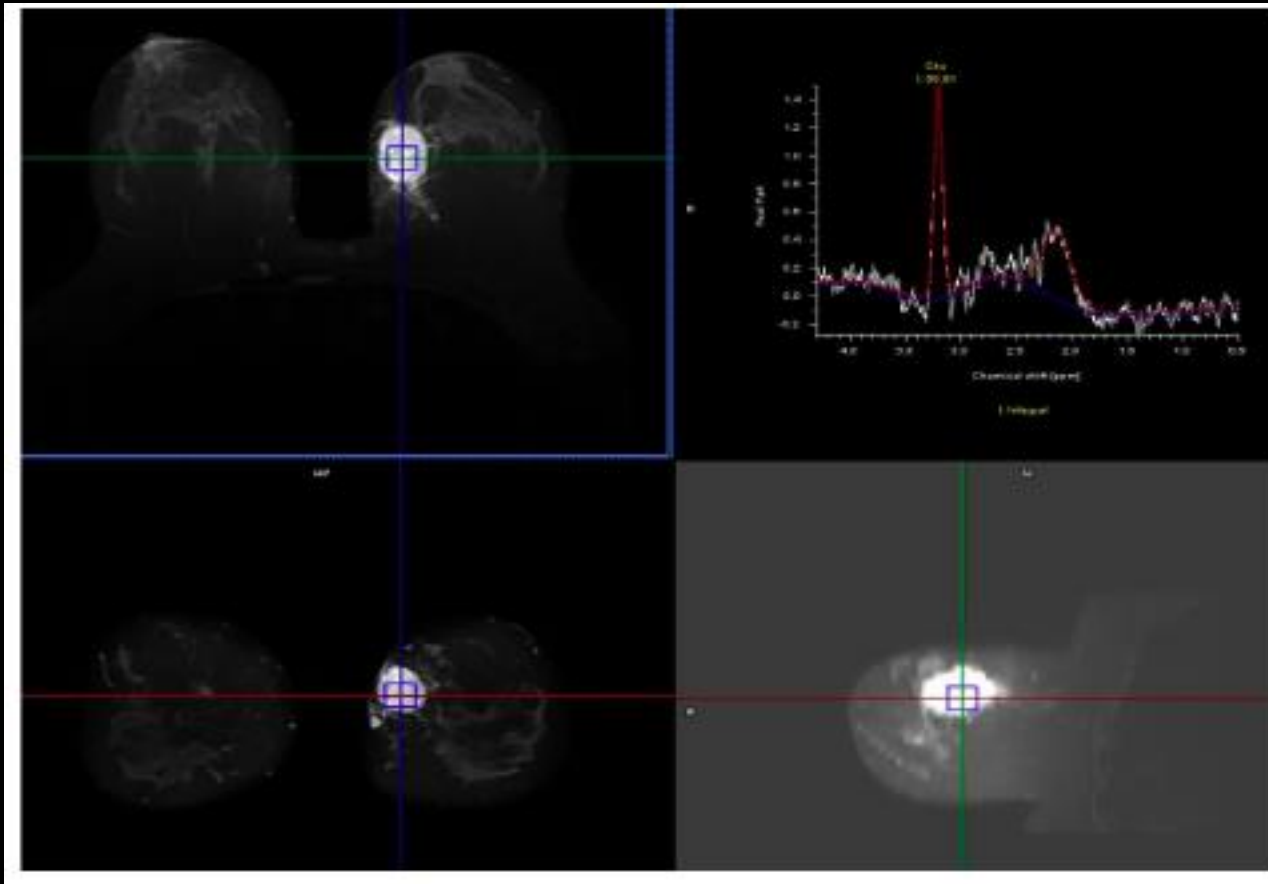
- Efficacy of 3-D Diffusion Weighted Imaging with Background Suppression (DWIBS) in Detection of Breast Carcinoma Compare to Dynamic Contrast Enhanced MRI



3-D DWIBS



Functional MRI – MR Spectroscopy



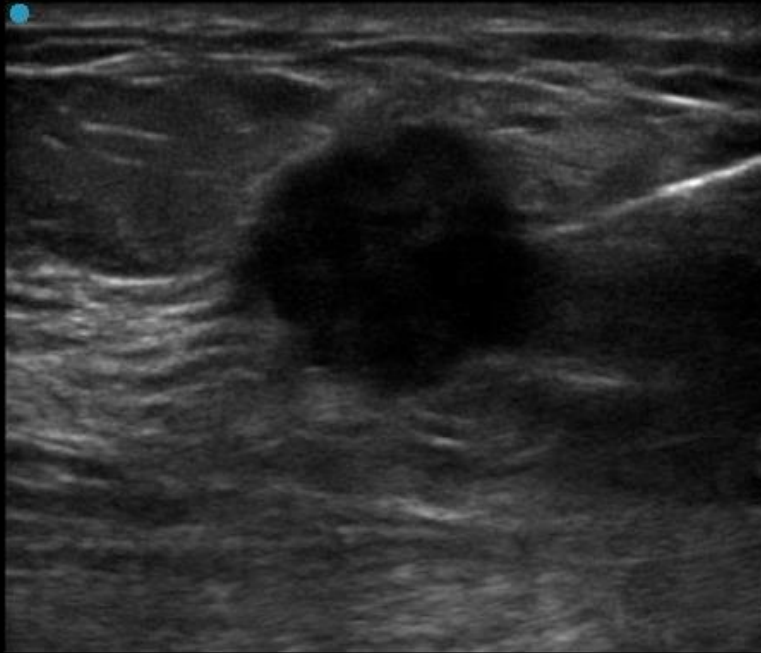
MR spectroscopy – showing Choline peak in case of malignant phyllodes in 26 years old female

Multiparametric MRI Breast

- 272 lesions in 254 women
- Multiparametric MRI showed 98.58% sensitivity, 93.13% specificity and 95.95% diagnostic accuracy

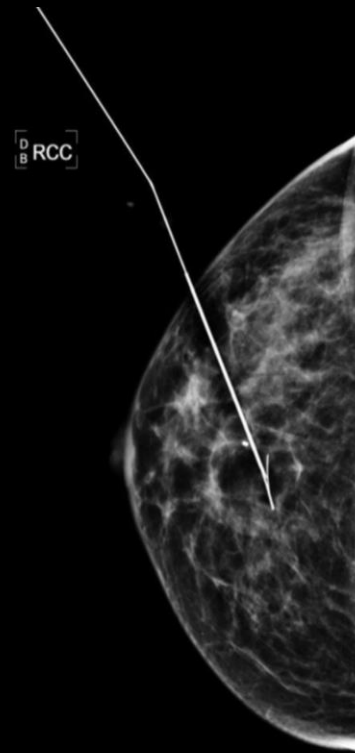
Breast Interventions

- Imaging guided breast biopsy



3.1

- Preoperative imaging guided wire needle localization for non palpable lesions



Conclusion

DBT is an excellent modality

- For early detection of breast carcinoma
- To differentiate benign from malignant imaging features of breast lesions
- Increased confidence in assigning a Breast Imaging Reporting and Data System (BI-RADS) classification.

Take home message

- MRI is a valuable tool in the diagnosis, work up and management
- It is a very sensitive modality to detect breast lesions, specially in the dense breast parenchyma
- Problem solving
- Very useful modality for Preoperative assessment of the breast mass for size, extent, pectoralis muscle and chest wall invasion
- Evaluation of contralateral breast
- High risk screening
- MRI guided biopsy

- Multidisciplinary approach and working as a team is very necessary for early detection and better management for breast cancer.

Original paper

Efficacy of high-resolution, 3-D diffusion-weighted imaging in the detection of breast cancer compared to dynamic contrast-enhanced magnetic resonance imaging

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³MR Research and Collaborations, Siemens Healthcare Private Limited, Bangalore, India

Abstract

Purpose: To evaluate the utility of high-resolution, 3-D diffusion-weighted imaging (DWI) in the detection of breast cancer and to compare the sensitivity, specificity, and area under the curves of DWI and dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI).

Material and method: Prospective IEC approved study included 131 breast lesions detected on mammography and breast ultrasound. Cases underwent MRI on a 3 Tesla scanner using a dedicated breast coil. T2WI, STIR, T1WI, and dynamic post contrast MR. DWI MRI with b value of 50, 800, and 1500 s/mm². Post-processing data with apparent diffusion coefficient (ADC) calculations and kinetic curves were obtained. Characteristics for lesions were analysed as per ACR BI-RADS descriptors. Final histopathological diagnosis was considered as the standard of reference. χ^2 test, t-test, receiver operating characteristic (ROC) curve analysis, pairwise comparison of ROC curves, sensitivity, specificity, diagnostic accuracy, and area under the curve (AUC) were calculated.

Results: Sixty-six (50.38%) malignant and 65 (59.62%) benign lesions were included in the study. The mean ADC of malignant lesions was 0.870×10^{-3} mm²/s and 1.637×10^{-3} mm²/s ($p < 0.0001$) for benign lesions. Sensitivity and specificity for DWI were 95.45% and 90.76%, respectively, and for DCE-MRI they were 96.97% and 87.69%, respectively.

International Journal of Radiology and Diagnostic Imaging

2019, Vol. 2, Issue 2, Part B

Utility of whole breast ultrasound and digital tomosynthesis as an adjunct with mammography in dense breast to detect breast lesions

Author(s)

Dr. Pratiksha Yadav and Dr. Variar Saroja Padmanabhan

Abstract

Mammography has been widely adopted as the primary screening tool in breast cancer detection and assessment. Screening in dense breast makes it difficult to detect lesions on screening and lowers its sensitivity to detect small lesions. Sensitivity and specificity improves with use of digital breast tomosynthesis and whole breast ultrasound in detecting lesions and also in differentiating benign and malignant breast lesions. Breast ultrasound and DBT have shown equivocal significance in detecting breast lesion on screening in the present study.

The aim of the study was to evaluate utility of whole breast ultrasound and digital tomosynthesis as an adjunct with mammography in dense breast to detect breast lesions.

DOI: <https://doi.org/10.33545/26644436.2019.v2.i2b.48>



Analysing the Insights and Assessing the Impact of a Digital Mammography and Tomosynthesis Based 2-year Long Prospective Breast Screening Programme Organised in Western India

Document Type : Research Articles

Authors

Pranav Ajmera¹, Pratiksha Yadav^{2,3}, Udayan Dosi⁴, Shreeya Goyal⁵

Department of Radiology, Dr. D.Y. Patil Medical College, Hospital and Research Center, Dr. D.Y. Patil Vidyapeeth, Pune, Maharashtra, India.

DOI: 10.31557/APJCP.2022.23.1.327

Abstract

Background: While the past decades have seen a rise in the number of cases diagnosed with cancer, breast cancer in particular has become the most frequently diagnosed cancer in women over the past decade. The figures for associated mortality are on a decline in most Western and developed nations, but in contrast they continue to remain high in transitional nations like India. **Materials and Methods:** After receiving approval by IEC and IRB, we set-up a prospective 2-year long screening programme combined with outreach camps to ensure representation of the larger population and include urban, rural and tribal population. Strict screening criteria were enforced and trained female paramedical staff were assigned to the camp for patient counselling and breast cancer awareness. Investigation was performed at the tertiary care institute utilising both full-field digital breast mammography and tomosynthesis. Biopsy was advised for highly suspicious lesions. **Results:** The study encompassed n=1017 Indian women and revealed that 39% (n=397) of them belonged to 41-50 years age group. BIRADS categorisation of the lesions revealed that while majority (57%; n=580) women had no detectable abnormality, nearly 22% (n=224) had lesions suspected to be benign while 10% (n=99) of them had lesions with a suspicion of high index of malignancy. 43% (n=437) of the populace had dense breasts (type-C). Most of the BIRADS-5 lesions (36/38) were confirmed as malignant on histopathology. **Conclusion:** We



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Original paper

Effectivity of combined diffusion-weighted imaging and contrast-enhanced MRI in malignant and benign breast lesions

Pratiksha Yadav, Surbhi Chauhan

Department of Radiology and Imaging, Dr. D.Y. Patil Medical College, Hospital and Research Centre, Dr. D.Y. Patil Vidyapeeth, Pune, India

Abstract

Purpose: Mammography is the most commonly used diagnostic test for breast lesion detection and evaluation, but in dense breast parenchyma it lowers its sensitivity to detect small lesions. Sensitivity and specificity improves with combined use of contrast-enhanced magnetic resonance imaging (CE-MRI) and diffusion-weighted imaging (DWI) in differentiating benign and malignant breast lesions. The aim of the study was to evaluate the effectivity of combined dynamic CE-MRI and DWI in differentiating benign and malignant lesions, and to calculate the apparent diffusion coefficient (ADC) values of malignant and benign lesions of the breast.

Material and methods: Fifty-seven patients with 68 lesions were included in the study. MRI of breast using diffusion sequences was acquired on 1.5 Tesla Machine with dedicated breast coils. Dynamic CE-MRI along with DWI was acquired for each patient. Histopathological reports were accepted as the standard of reference.

Results: Out of 68 lesions, 37 were malignant on biopsy (54.4%) and 31 were benign (45.5%). The sensitivity of CE-MRI was 92%, specificity 84.21%, positive predictive values (PPV) 88.46 %, and negative predictive values (NPP) 88.89%. The sensitivity of DWI-MRI was 91.6%, specificity was 90.6%, PPV 91.6%, and NPP 90.6%. The sensitivity of combined DWI-MRI and CE-MRI was 95.0%, specificity was 96.43%, PPV 97.44%, and NPP 93.10%. Mean ADCs of benign lesions ($b = 800$) was $1.905 \pm 0.59 \times 10^{-3}$ mm (2)/s, which was significantly higher than those of malignant lesions ($b = 800$) $1.014 \pm 0.47 \times 10^{-3}$ mm (2)/s.

Conclusion: Multi-parametric MRI is an excellent non-invasive modality with high sensitivity and specificity to differentiate malignant from benign breast lesions.



Thank you

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