Regional Cancer Centre
Trivandrum

Breast Imaging

Search for better screening tools

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- In Kerala breast cancer is the most common cancer affecting a single organ system in the female (RCC statistics-29% in 2008)
- Second leading cause of cancer death in women worldwide (second to lung cancer).
- Leading cause of cancer death in women of 40 to 59 yrs age group.

- Early diagnosis offers the only hope of cure in Ca breast.

- Survival depends on the stage at diagnosis

- Conservation of the breast is the rule rather than the exception now.

- Mammogram helps to plan treatment in many ways.

Screening in breast cancer

- reduces mortality by 25 to 30%.
- most useful when combined with clinical examination.
- screen detected cancers tend to be small, node negative,
- about 50 % of those are in the good prognostic group (Grade 0 or 1), whereas only 19 % of clinically detected cancers are in the good prognostic group.
- Treatment options are many in early breast cancer- lumpectomy followed by radiation to breast and axilla. (breast conservation treatment)
- Late cases need mastectomy, chemotherapy and radiation.

Methods of screening

- Breast self examination
- Clinical examination
- Radiology

Radiological methods used for screening

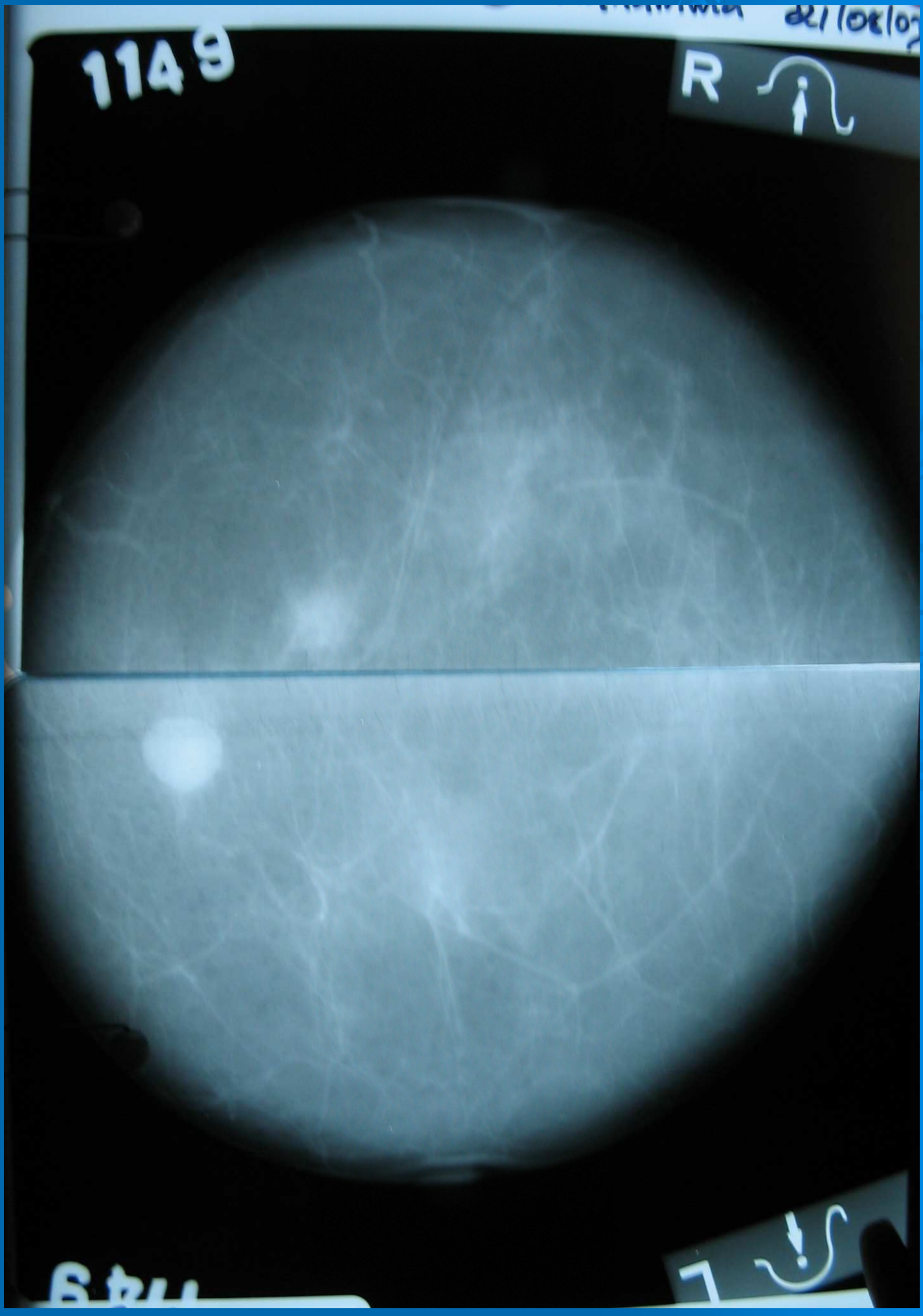
- X Ray mammography
- Ultrasound of the breast
- MRI (in exceptional circumstances)

Mammography

- Can detect cancers before they become clinically palpable and before appearance of symptoms.
- Only method validated for screening
- Gold standard for diagnosis of breast cancers.
- Guided procedures are also possible

Mammogram in breast cancers helps us to

- detect the lesion
- assess the size, shape, contour and borders
- assess the size of the lesion in relation to the breast size
- determine the quadrant/s of involvement, multifocality and multicentricity
- detect calcifications , characterize them
- assess skin changes and also provides some idea about axillary lymph node involvement.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- High frequency ultrasound is a useful adjunct to Mammography.

- MRI and PET have been used as problem solving modalities.

- Now recognized superior to Mammography in some situations.

- Mammography is X-ray examination of the breasts carried out with dedicated equipment designed to produce low kilo voltage X-rays in the range of 24 to 28 KVp, which demonstrate soft tissues of the breast to advantage.

- The main aim of Mammography is to detect breast cancer, at a stage when the disease is curable.

- Albert Salomon performed the first ever Mammogram on mastectomy specimens. Egan 1960- Mammography


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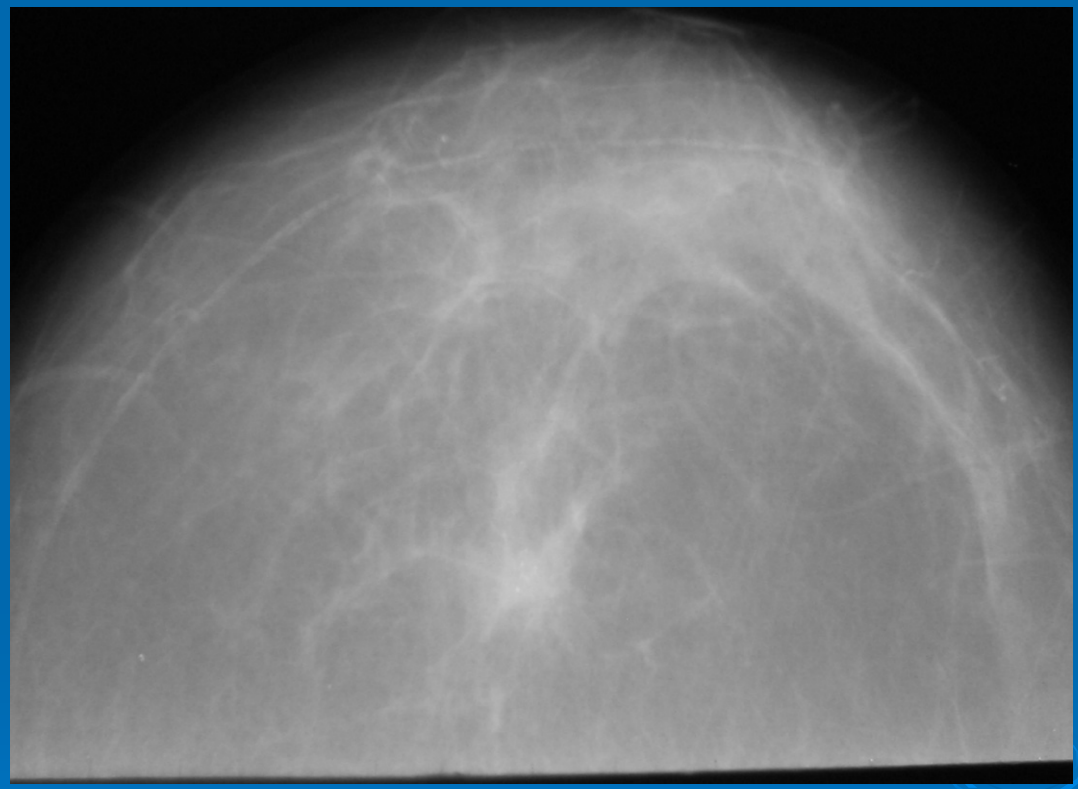


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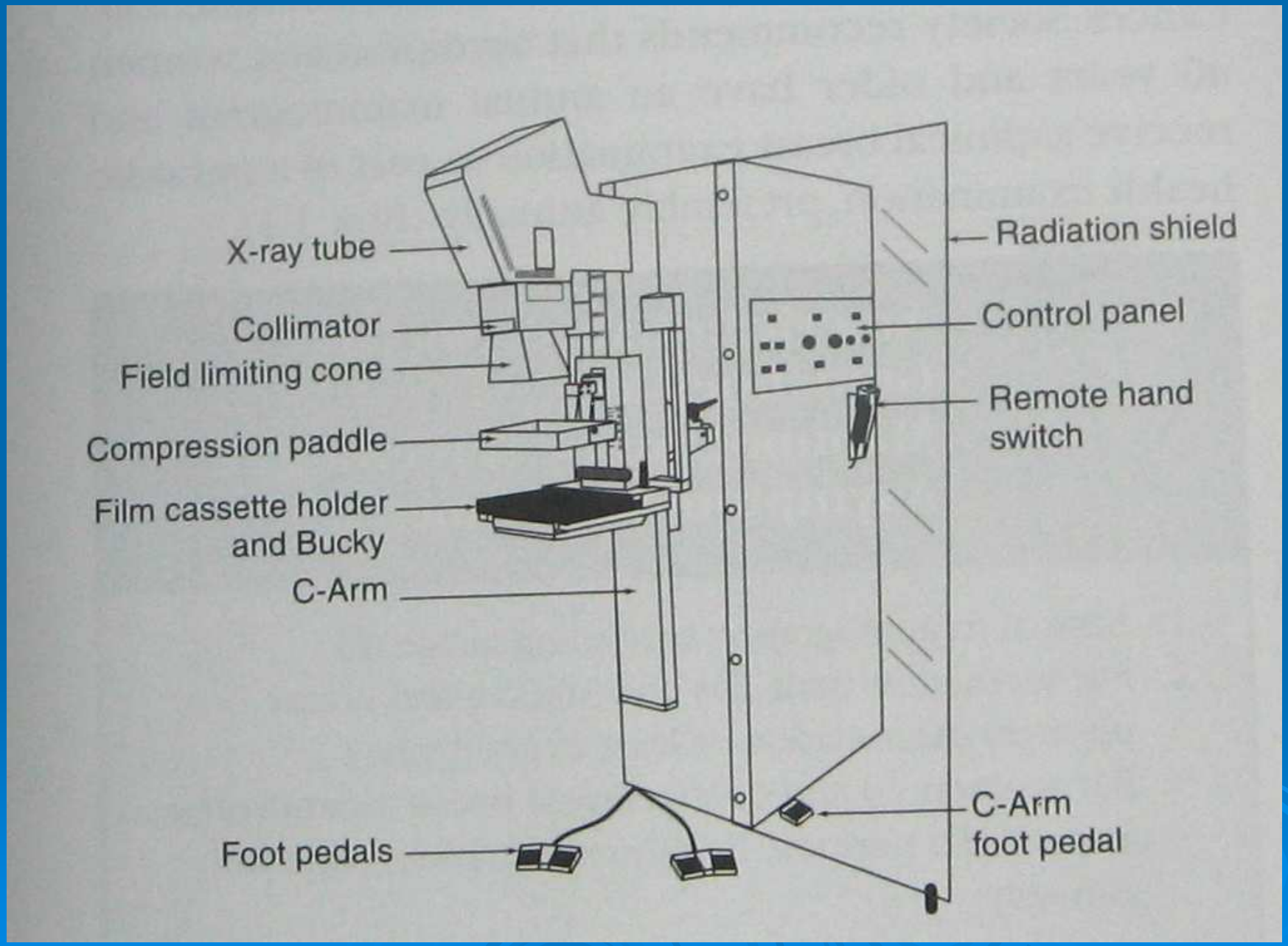

X-ray tube
Collimator
Field limiting cone
Compression paddle
Film cassette holder and Bucky
C-Arm
Foot pedals
Radiation shield
Control panel
Remote hand switch
C-Arm foot pedal

Breast Imaging - Reporting And Data System (BI RADS) Lexicon: developed by American College of Radiology to standardize mammographic reporting.

The lexicon includes terms for describing-

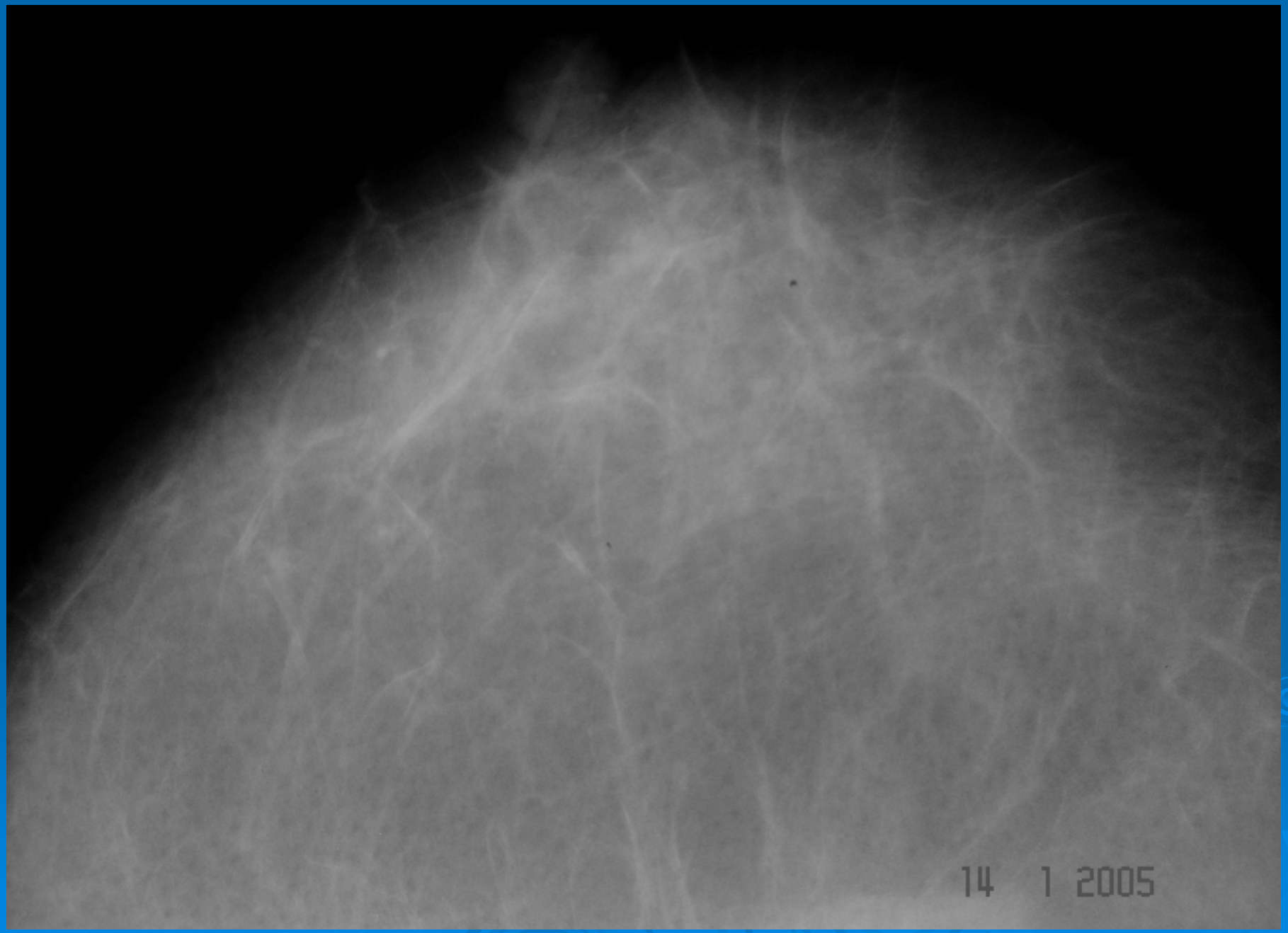
1. parenchymal pattern
2 .features of masses
3. features of calcifications
4. associated findings
5. final assessment categories.

Potential benefits-

1. Increased clarity in reporting.
2. improved communication.
3. facilities for research across different institutions.

Parenchymal density- 4 classes.

1. almost entirely fat
2. scattered fibroglandular densities.
3. heterogenously dense.
4. homogenously dense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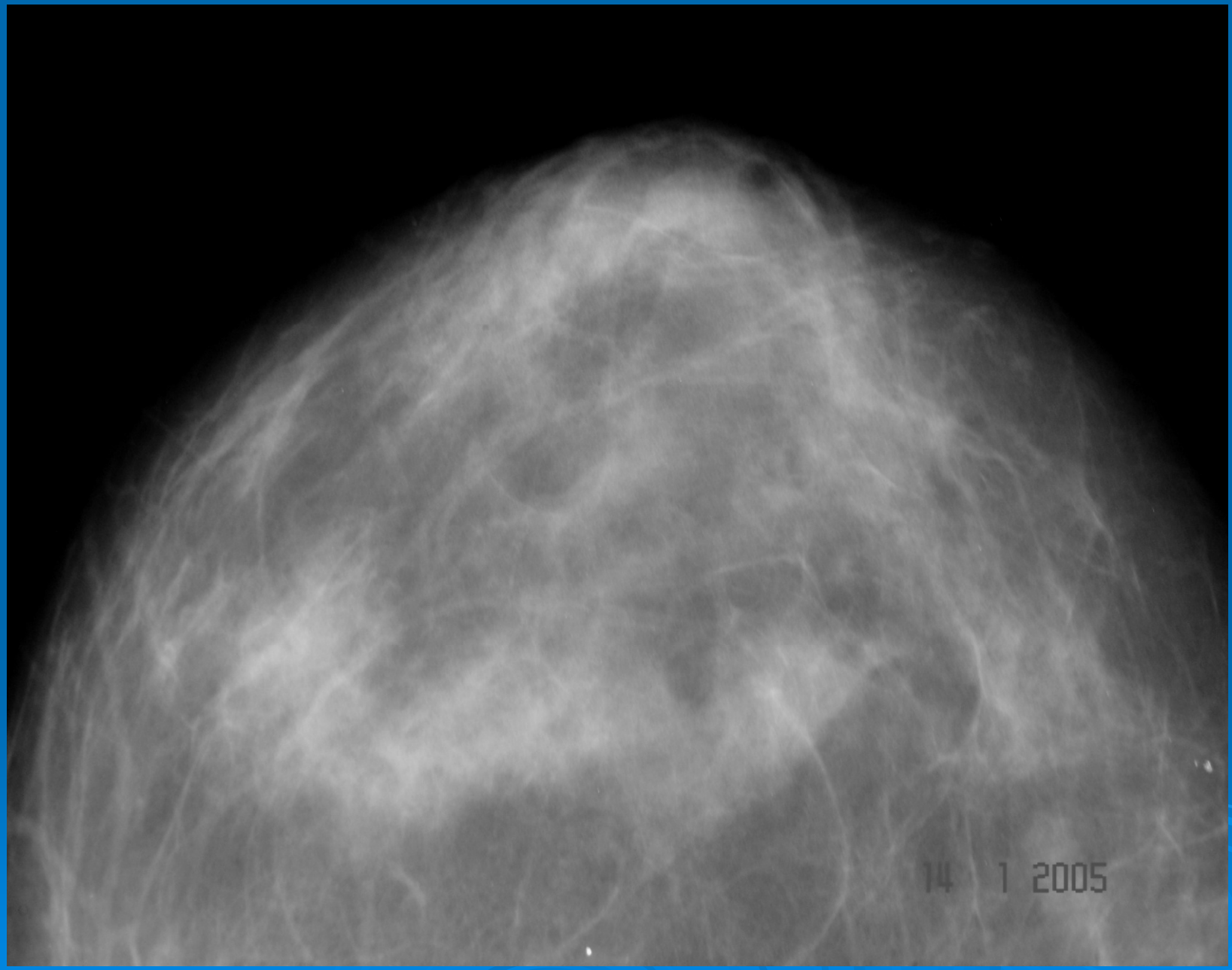
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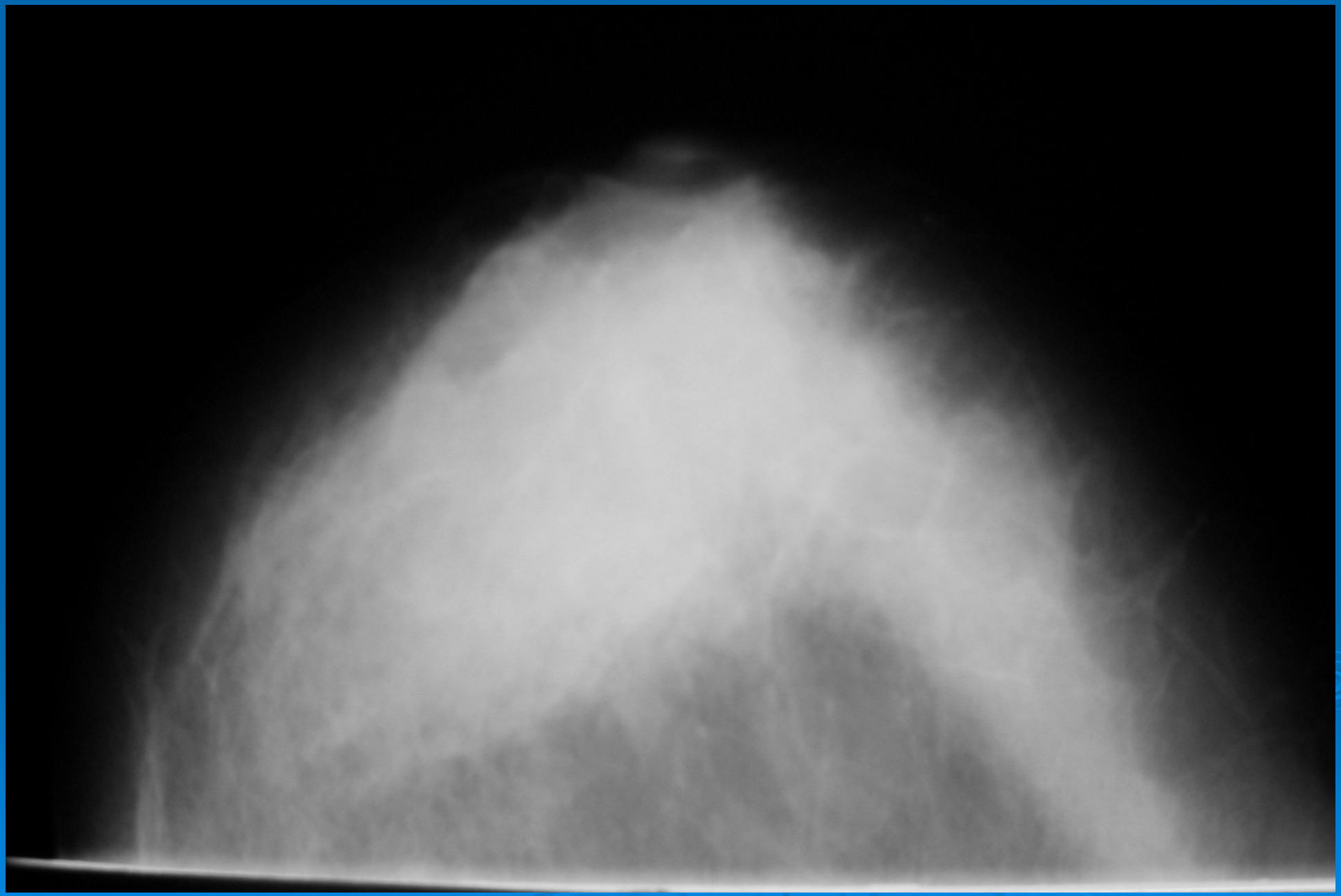

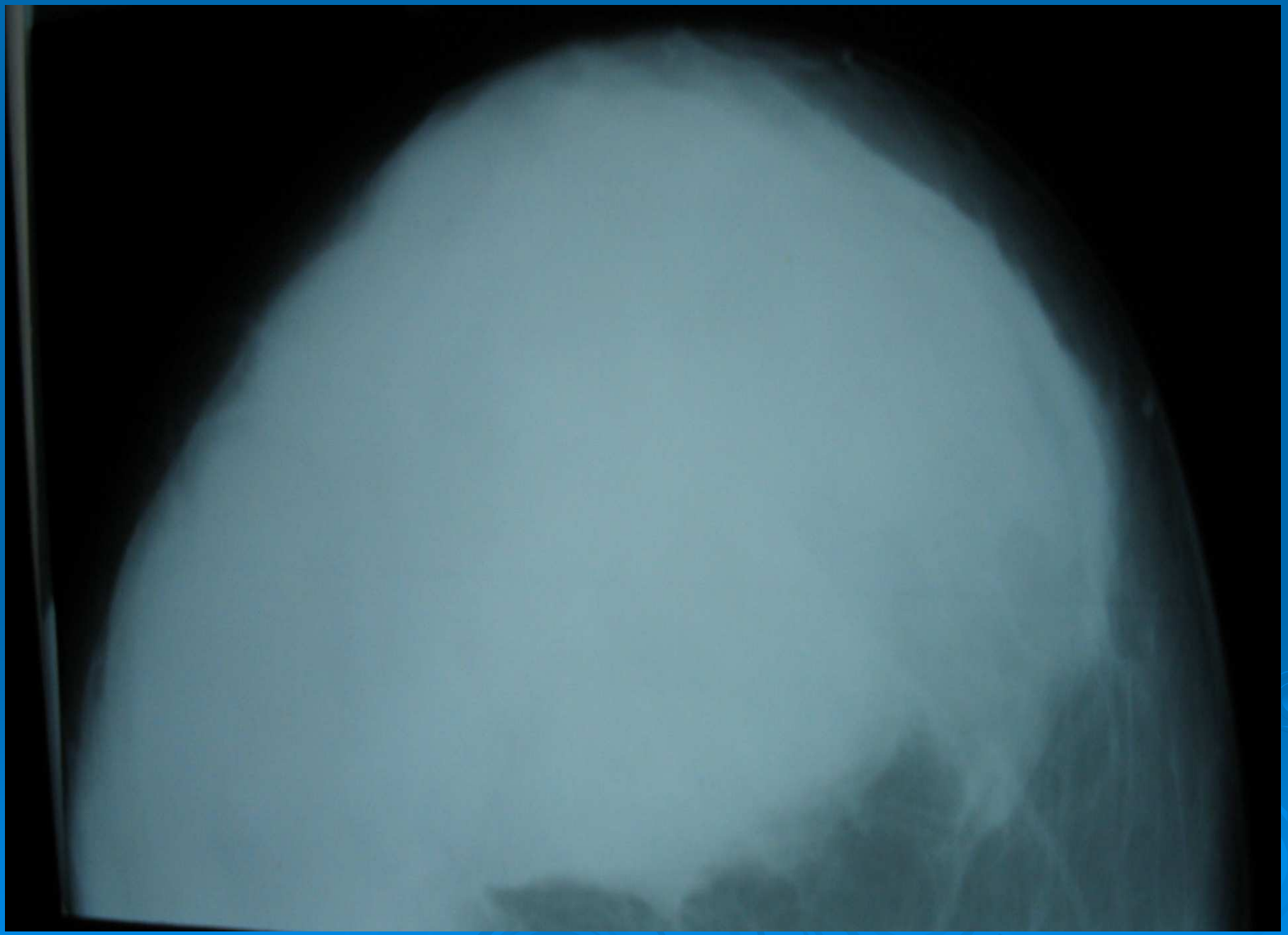

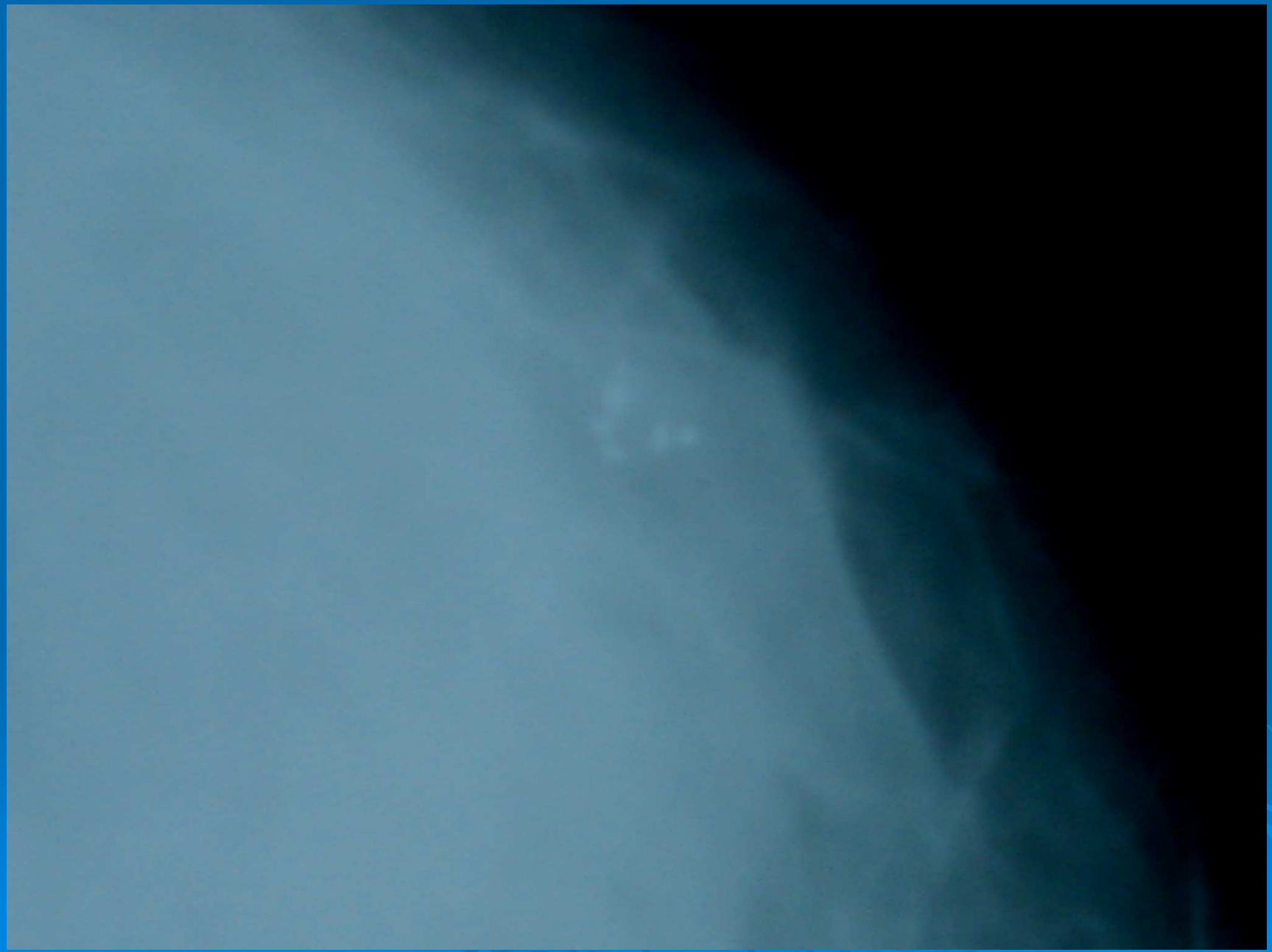

- Digitized mammograms are typically noisy
- They are also difficult to interpret because of the subtle nature of clinically significant signs.
- Several approaches for the computerized detection and segmentation of clustered micro calcifications have been developed which are based on wavelet transforms, morphological operators, machine learning algorithms, multiresolution analysis, fuzzy logic and fractals.

Need for the initiative

- It would be beneficial if an accurate CAD system existed to identify normal mammograms and thus allowing the radiologist to focus on suspicious cases.
- It could reduce the radiologist's workload and improve screening performance.
- A new full-field mammogram analysis method focusing on characterizing and identifying normal mammograms were proposed

Intelligent CAD Tool for Breast Cancer Analysis

Objectives

- Enhancement of Mammogram Images
- Pectoral Muscle Suppression.
- Automatic Detection of Microcalcifications, Mass Lesions & Architectural Distortions.
- Classification of Benign & Malignant Tumors (based on BIRADS standard)

GUI of iMAS

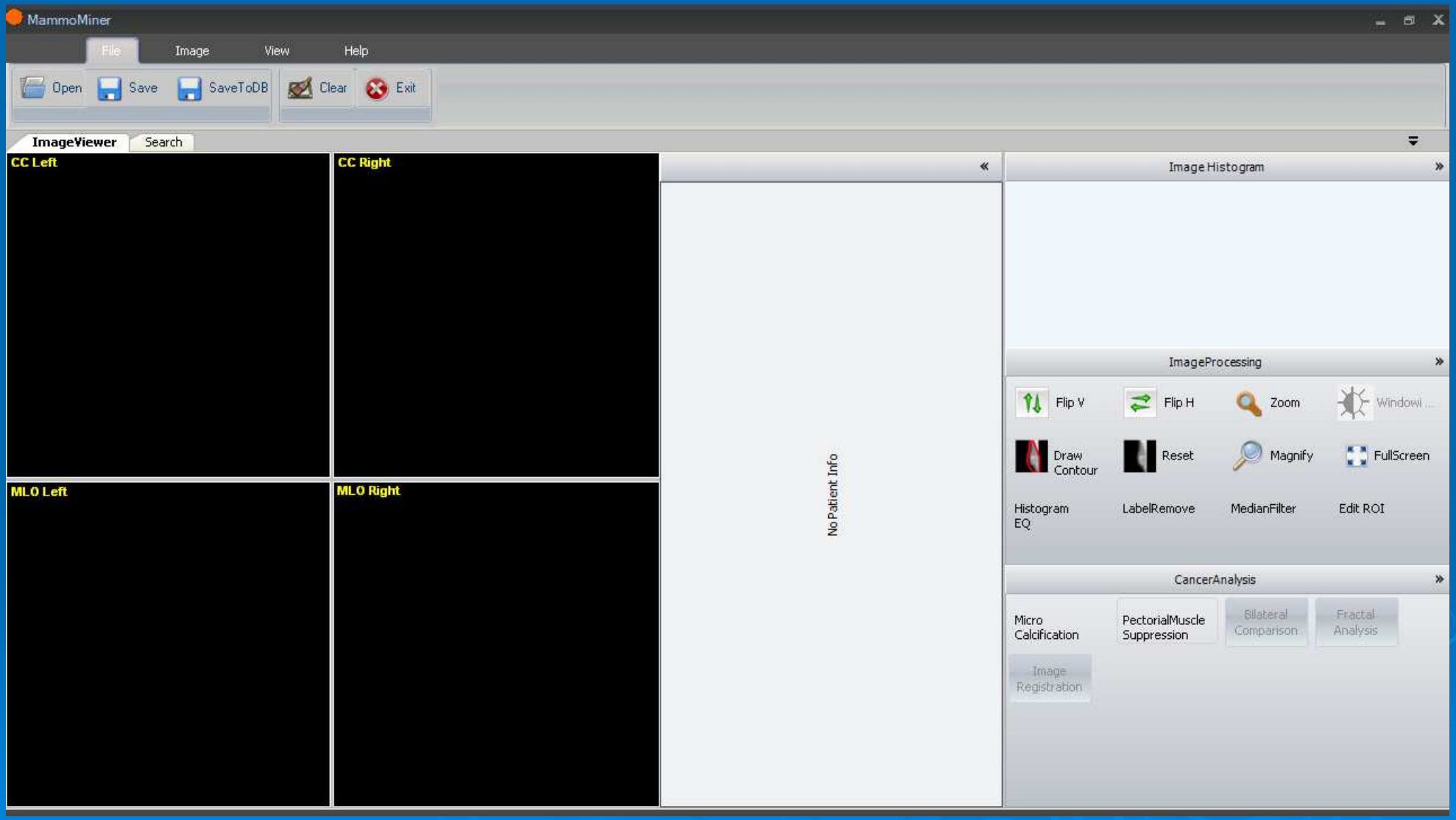
MammoMiner
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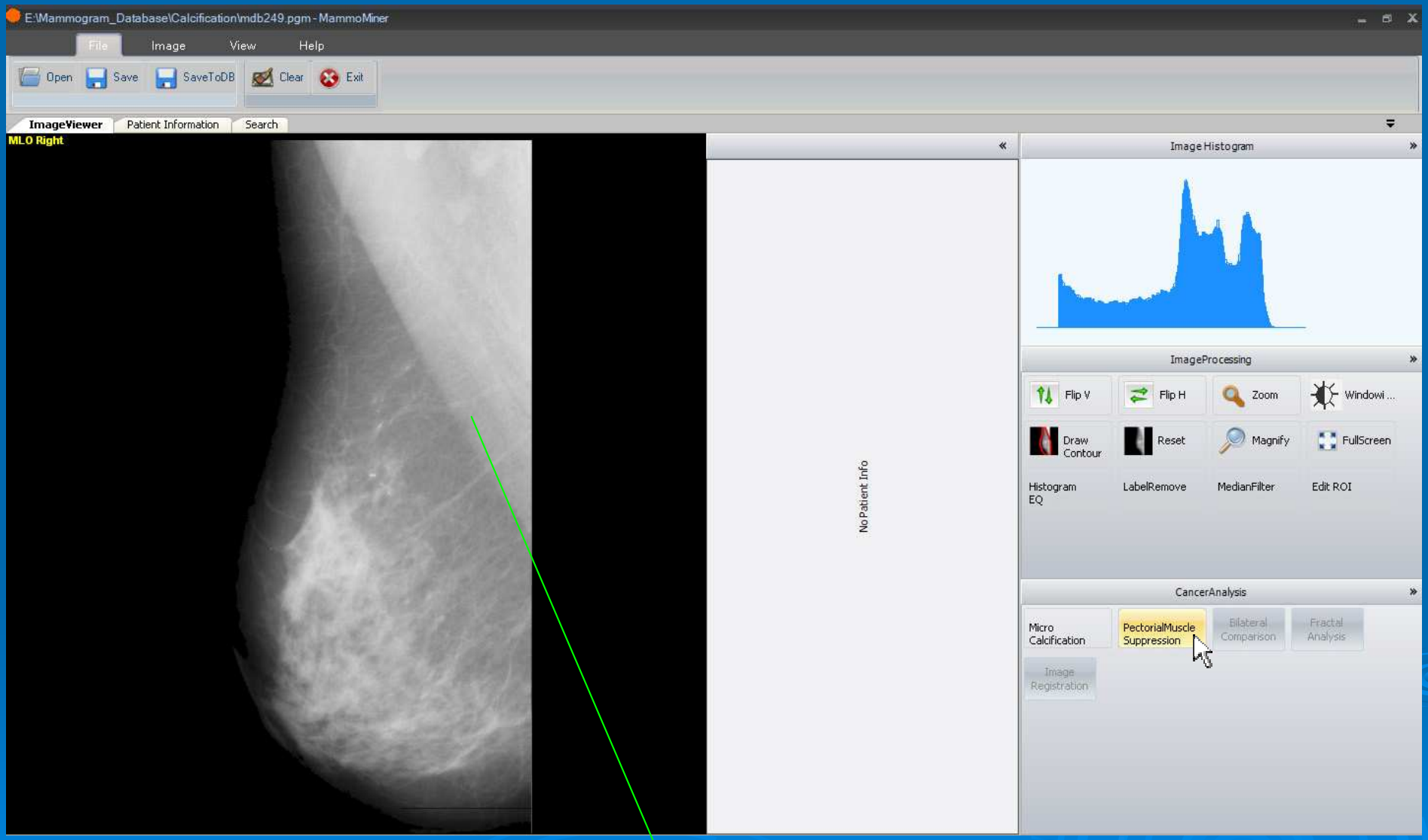
Image Histogram
ImageProcessing
Flip V
Flip H
Zoom
Draw Contour
Reset
Magnify
FullScreen
Histogram EQ
LabelRemove
MedianFilter
Edit ROI
CancerAnalysis
Micro Calcification
PectorialMuscle Suppression
Bilateral Comparison
Fractal Analysis
Image Registration

Pectoral Muscle Suppression



Original mammogram with pectoral muscle

Micro calcification Enhancement

- Micro calcifications have some resemblance with impulsive type noise
- Because of this property, a good spot detector could be useful in the extraction of micro calcifications (with false positive
- A dual stage median filter was used to filter out the areas showing impulsive noise type behavior in the images).
- The working of a dual window median filter is as follows: it has two bounds

Micro calcification Enhancement

- A lower bound (α) and an upper bound (β), defines two sub list inside the windows [M(i, j)](α,β), which contains the gray levels that we assume to be good enough not to be filtered.
- An absolute difference image is then created by subtracting the filtered image from the original mammogram. To further improve the contrast between micro calcifications and other areas, the difference image is multiplied with the original mammogram image.

Where $E_{i,j}$ is the micro calcification enhanced image

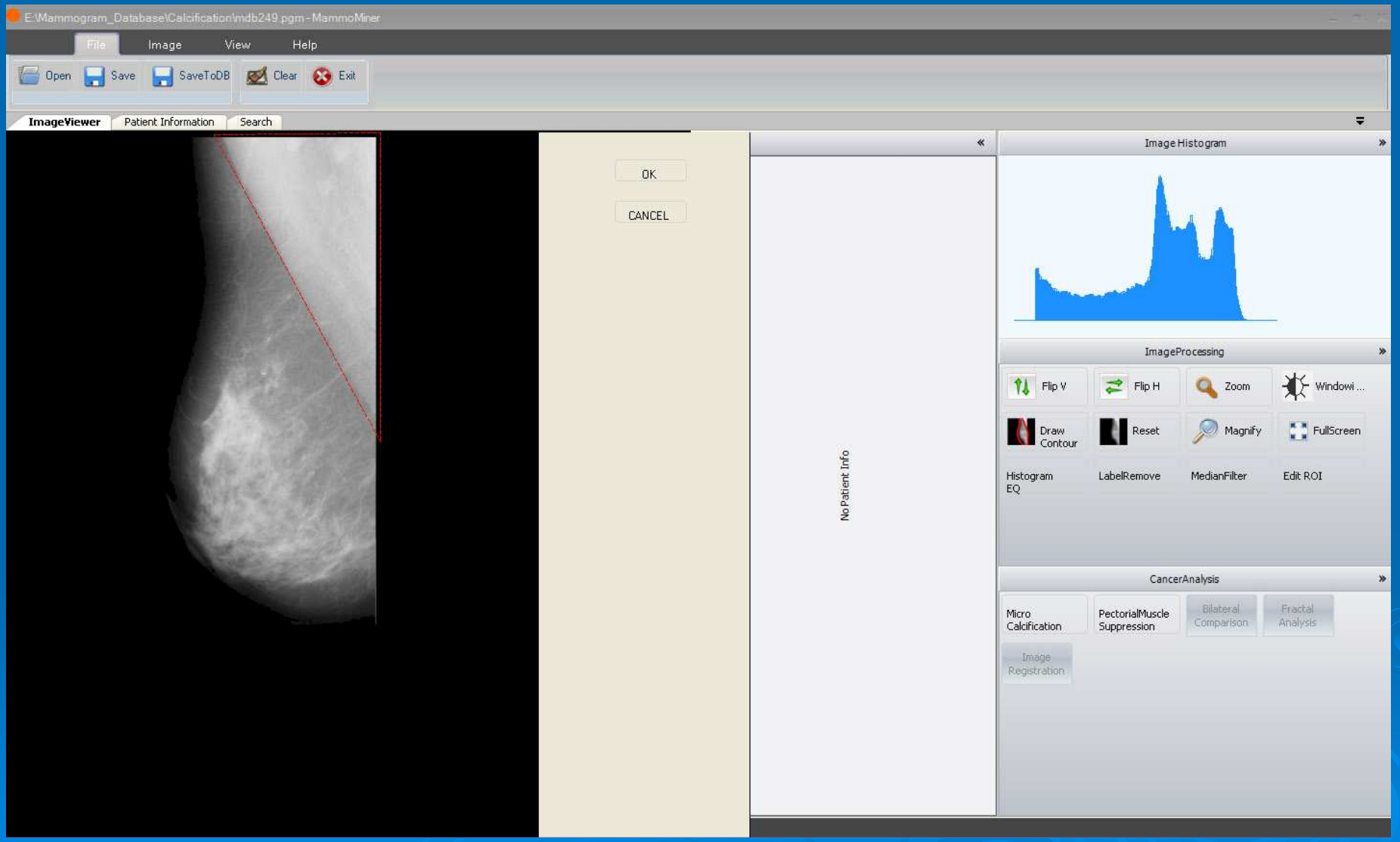
Micro calcification Extraction

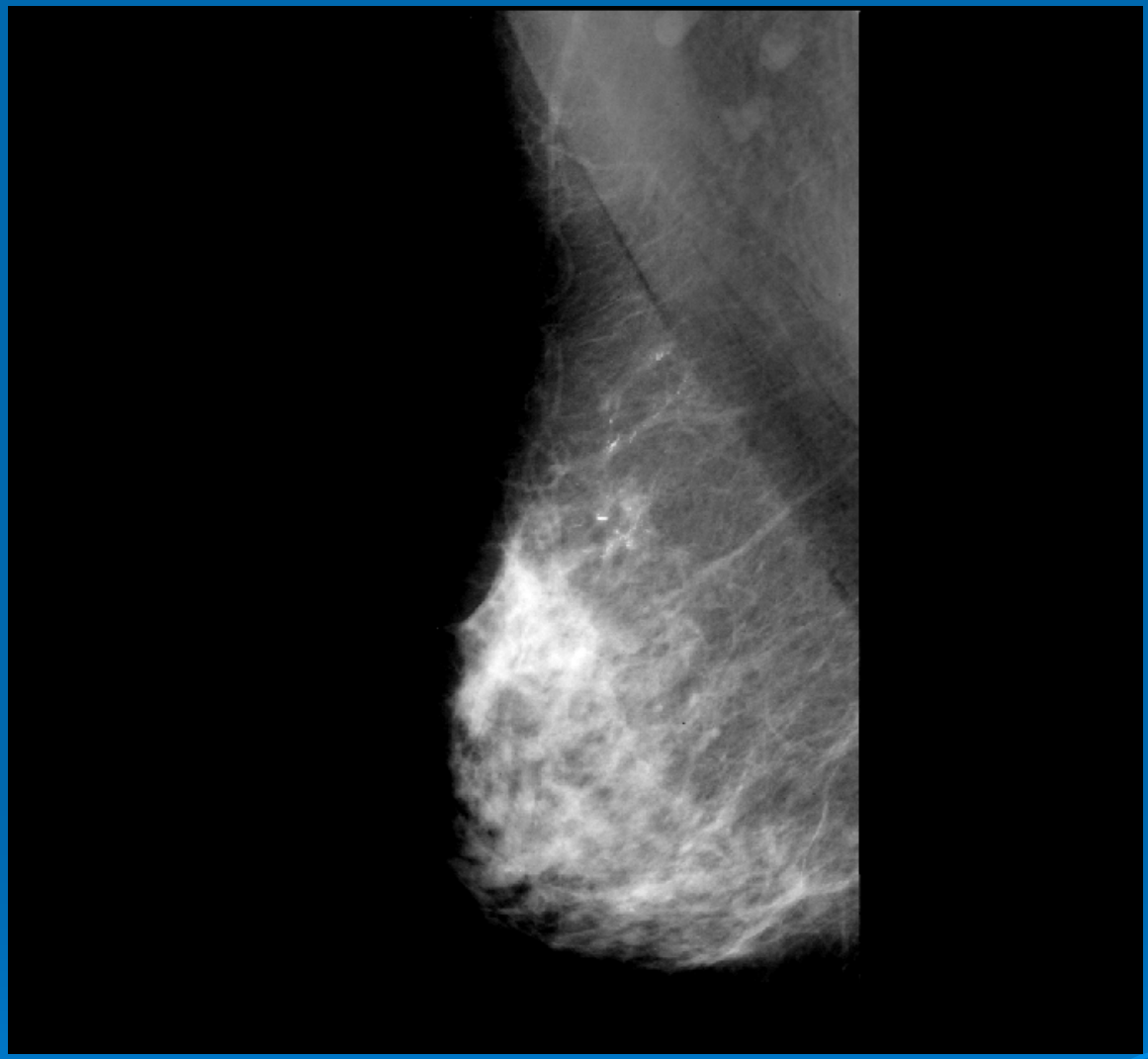
- Extraction of micro calcification is achieved through the technique of complex diffusion (complex diffusion is a partial differential equation used for smoothing images).
- After the enhancement process, non-linear complex diffusion is applied on the absolute difference image E.
- The non-linear complex diffusion process generates the Gaussian and Laplacian pyramids (scale-spaces) simultaneously, depicted in the real and imaginary parts, respectively.
- The imaginary part consists of high frequency components and the real part contains low frequency components

Micro calcification Extraction

- Micro calcification belongs to high frequency components. So the imaginary area alone is sufficient for further analysis
- A global thresholding is applied on the imaginary part of the image.
- This process retains the dot like structures and eliminates the blood vessels and nodes.
- Finally, morphological clean operation is performed using 3x3 structuring elements for eliminating isolated pixels.

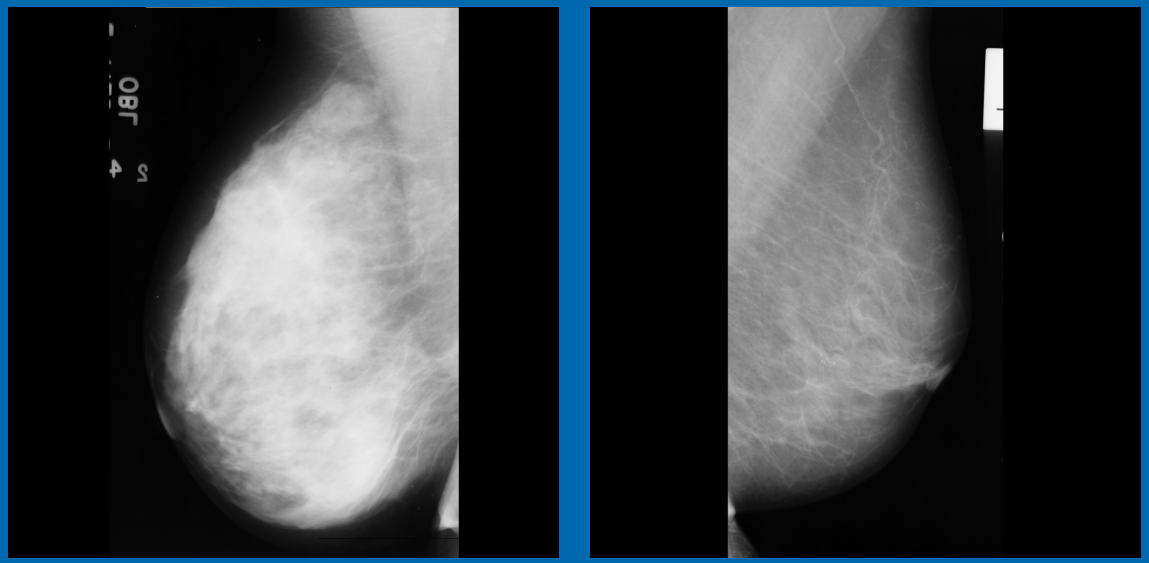
ROI Selection



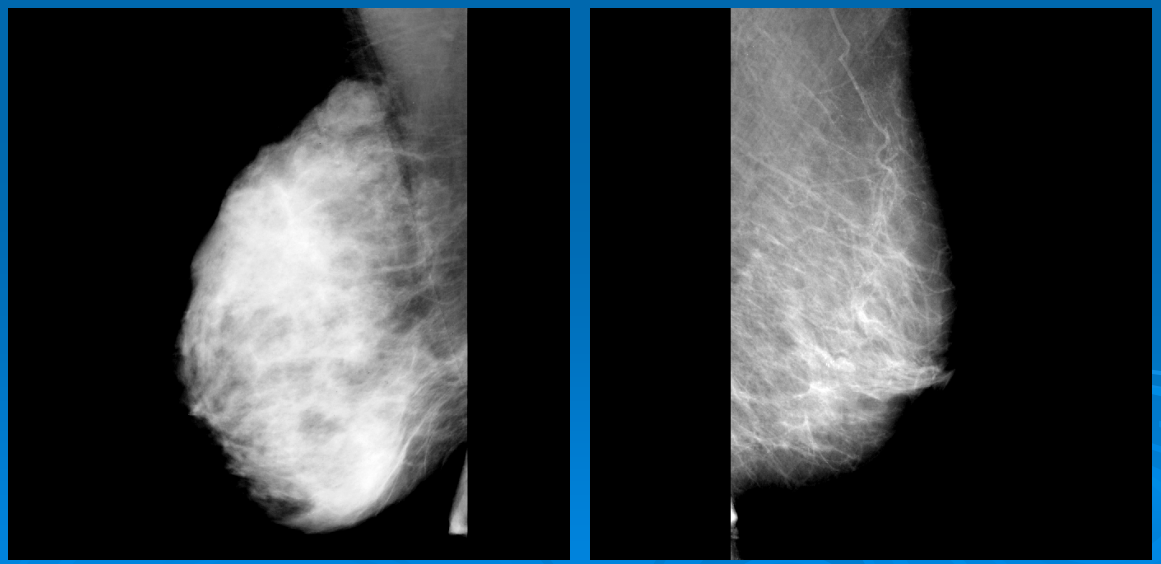


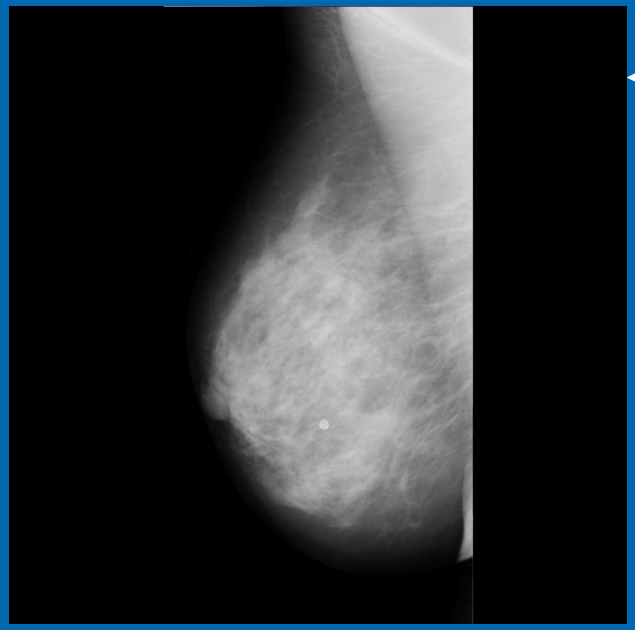
Pectoral Muscle Suppressed image

Original Image



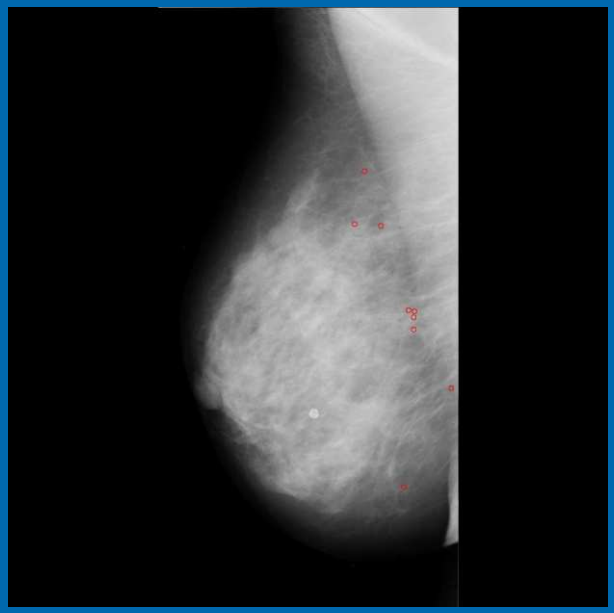
Pectoral Muscle Suppressed image

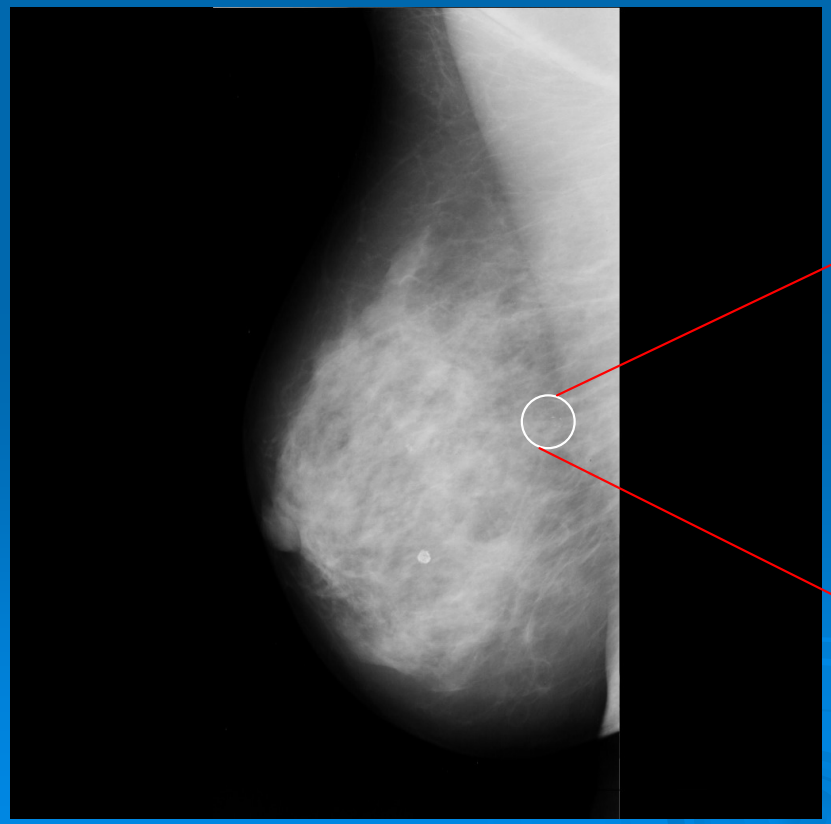




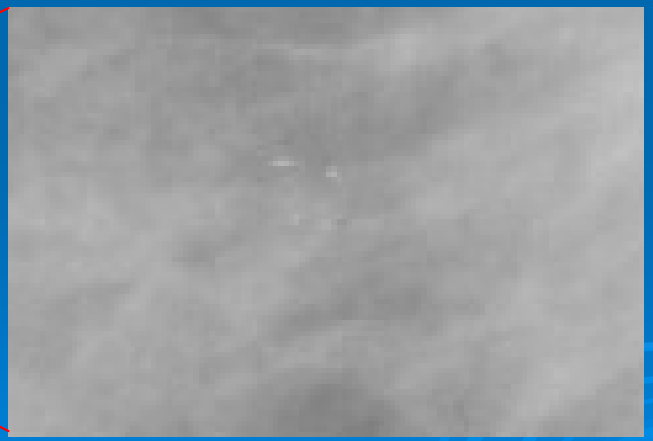
Original Image

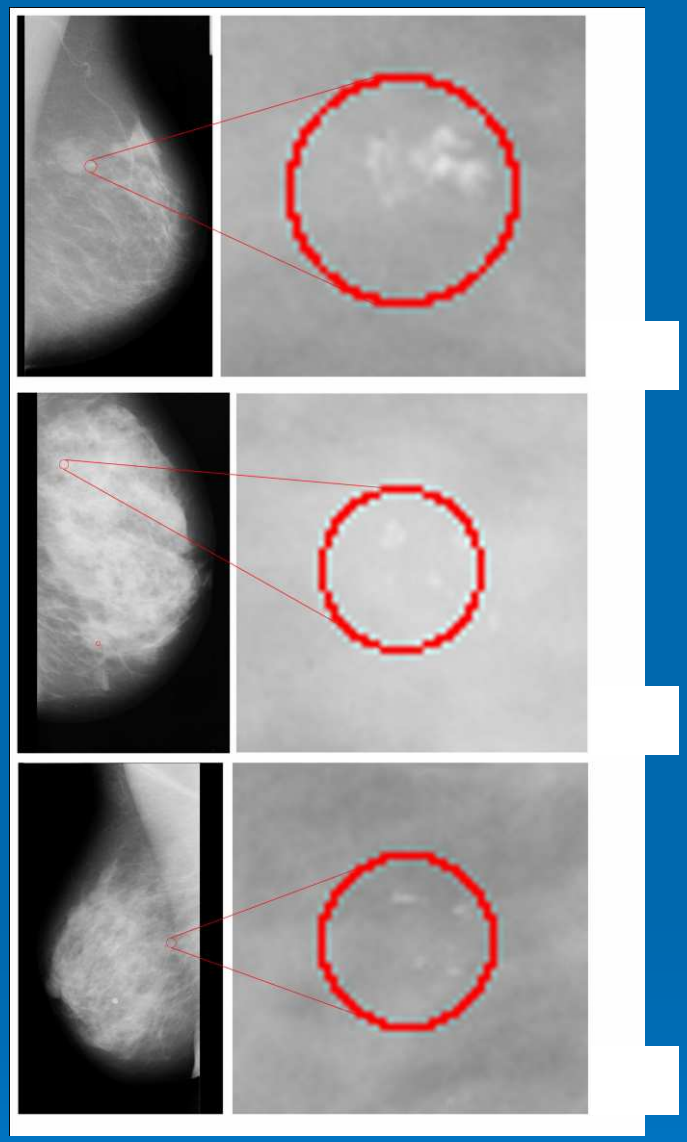
Processed Image





Zoom view of a tumor area





Automatic Micro calcification Detection using proposed method. (a) Fatty tissue (b) Dense-glandular tissue and (c) Fatty-glandular tissue

		TP	FP	TN	FN
Normal Mammogram	Dense Glandular	-	2	8	-
	Fatty Glandular	-	1	8	-
	Fatty Tissue	-	1	4	-
Mammogram with Tumor	Dense Glandular	8	2	-	1
	Fatty Glandular	8	1	-	-
	Fatty Tissue	5	1	-	-

Results

- While many techniques are being developed for micro calcification detection and classification, this method demonstrates a new and reliable approach for micro calcification detection from mammograms.
- Experimental results show that this hybrid approach is a good candidate for micro calcification detection for all type of breast tissues.
- Statistical analysis shows a sensitivity of x% and specificity of y%. This is considerably good when compared with the previously reported techniques.

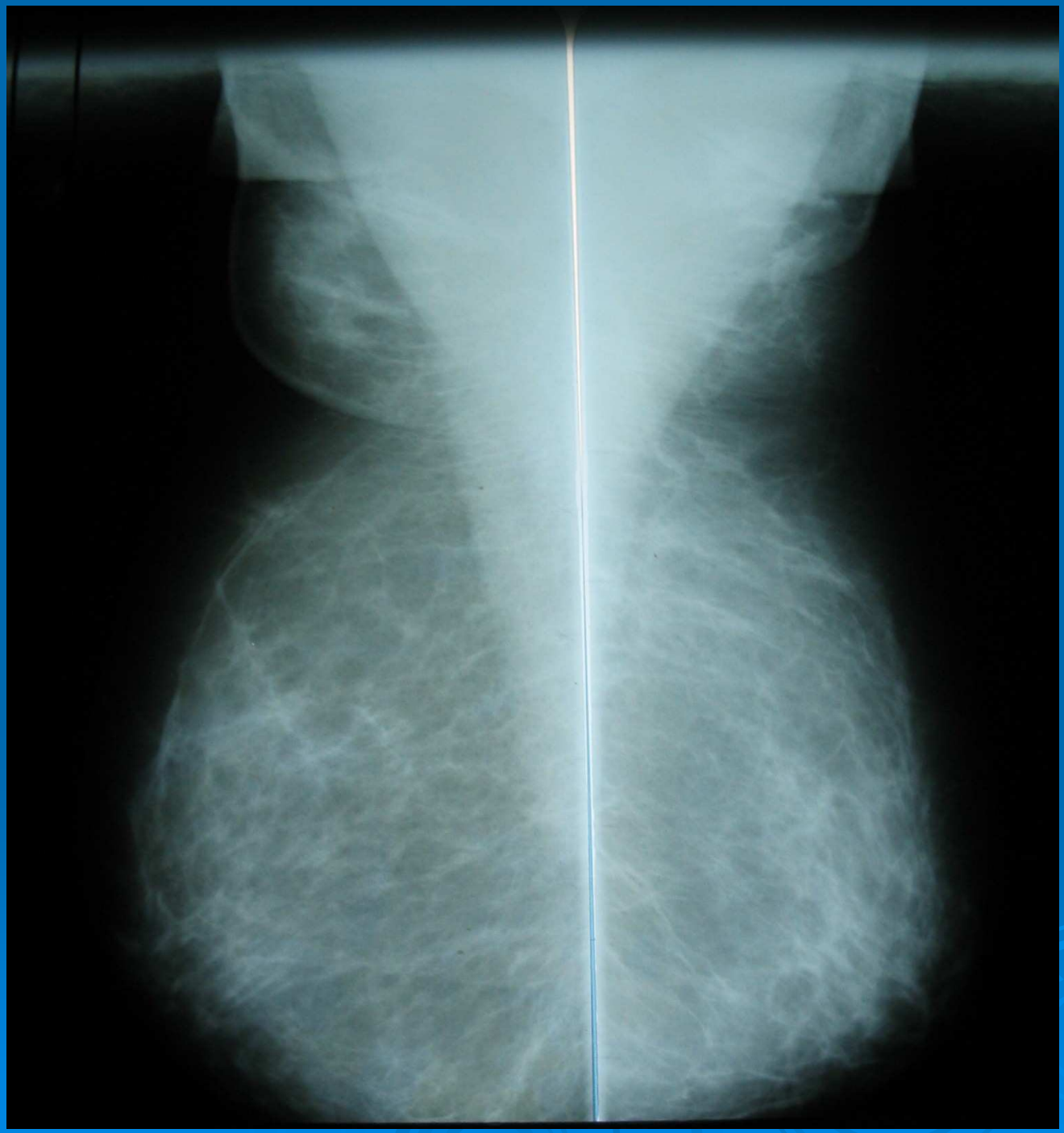
Abnormal Mammogram may show :

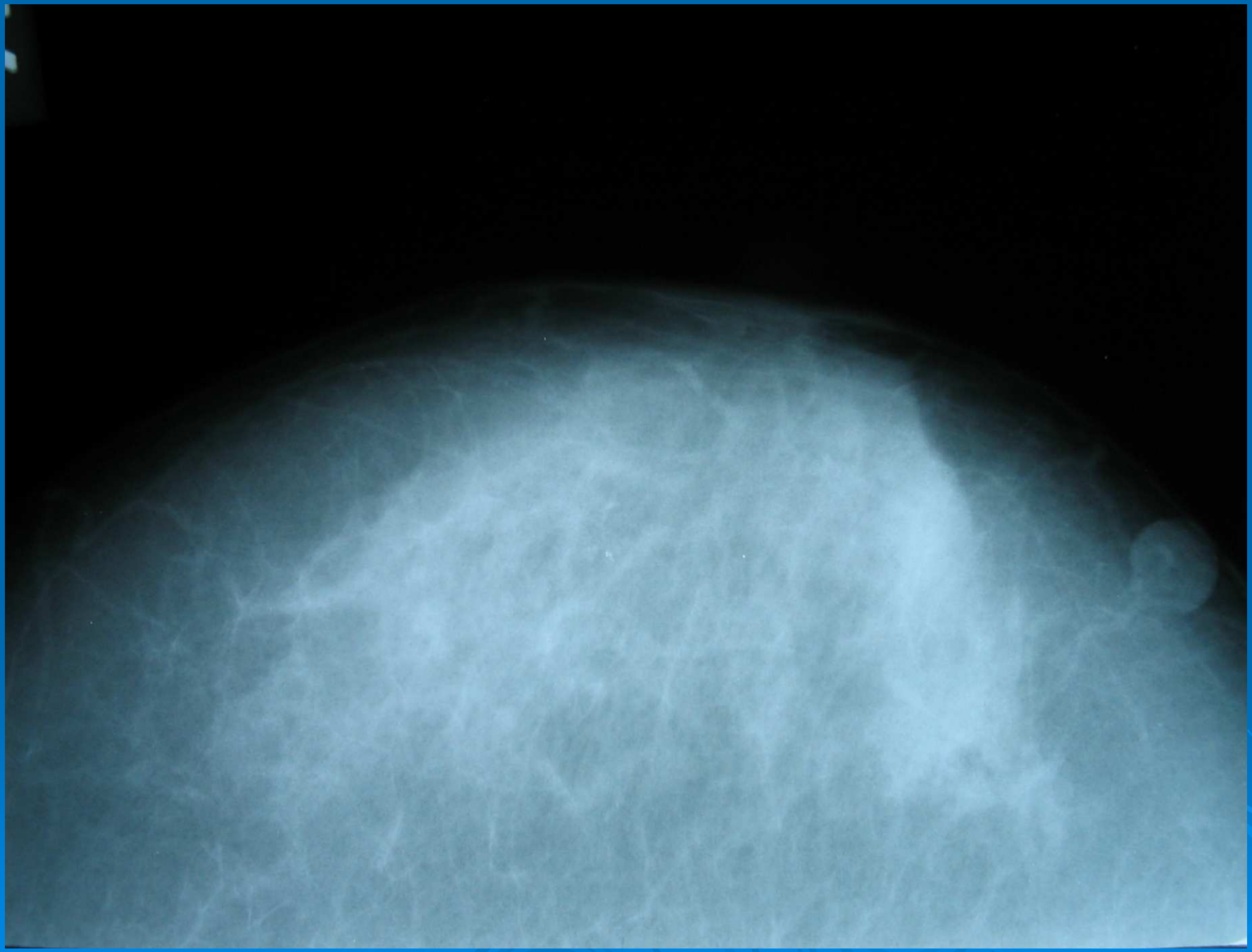
1. a mass
2. calcifications
3. architectural irregularity
4. nipple retraction
5. skin thickening, irregularity, puckering, etc.
6. only a density difference between the two breasts.
7. chest wall changes
8. enlarged lymph nodes in the axilla

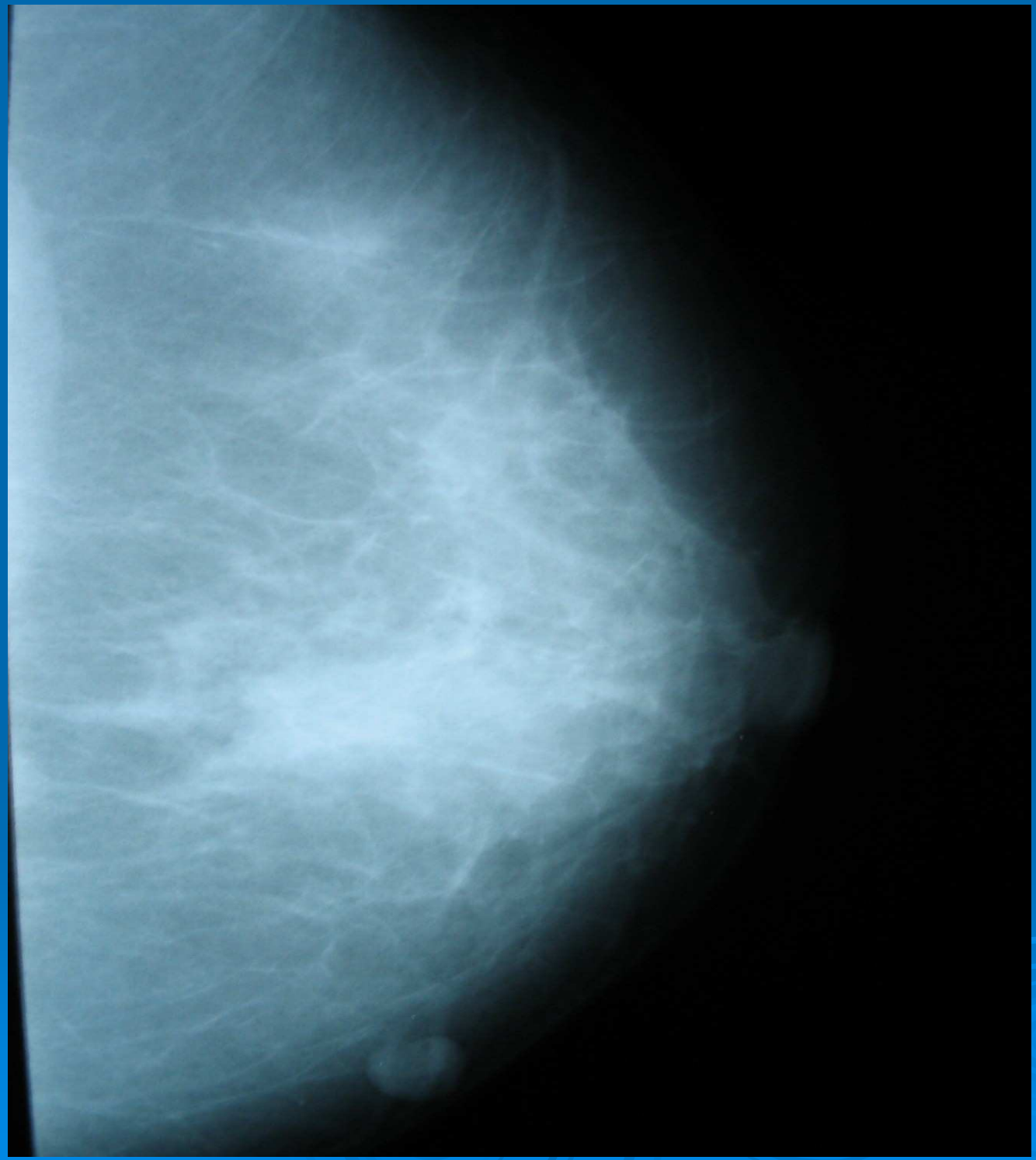
These findings may suggest a benign or malignant aetiology

- NORMAL VARIANTS:
- (ACCESSORY NIPPLE,ACCESSORY BREAST TISSUE IN THE AXILLAE)
- LOOK FOR SKIN LESIONS
- AXILLARY LYMPH NODES
- INTRA-MAMMARY LYMPH NODES

H/O MINOR SURGERY IN CHILDHOOD

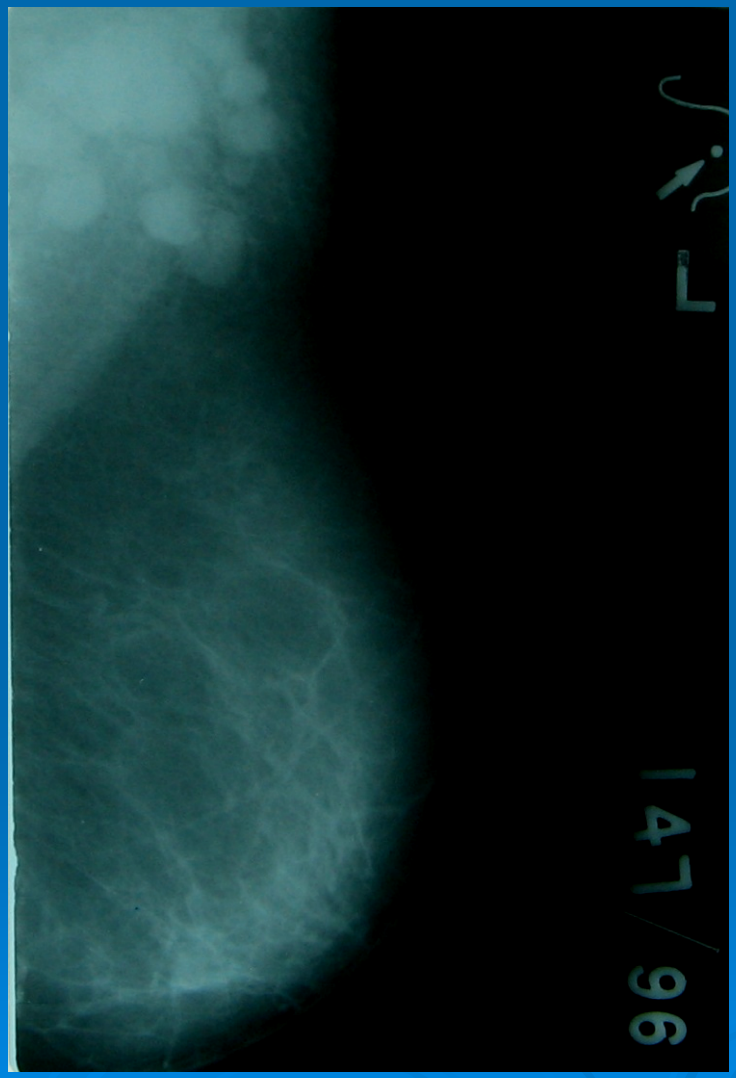






SKIN FOLDS

AXILLARY LYMPHADENOPATHY



The signs of a malignant lesion include:

1. High density, non-uniform, irregular opacity with perifocal haziness. The shape may be knobby, lobulated, or round.
2. Spiculated margins-These spicules represent fibrosis which is related to the desmoplastic reaction that cancer elicits in surrounding tissues.
3. Microcalcifications

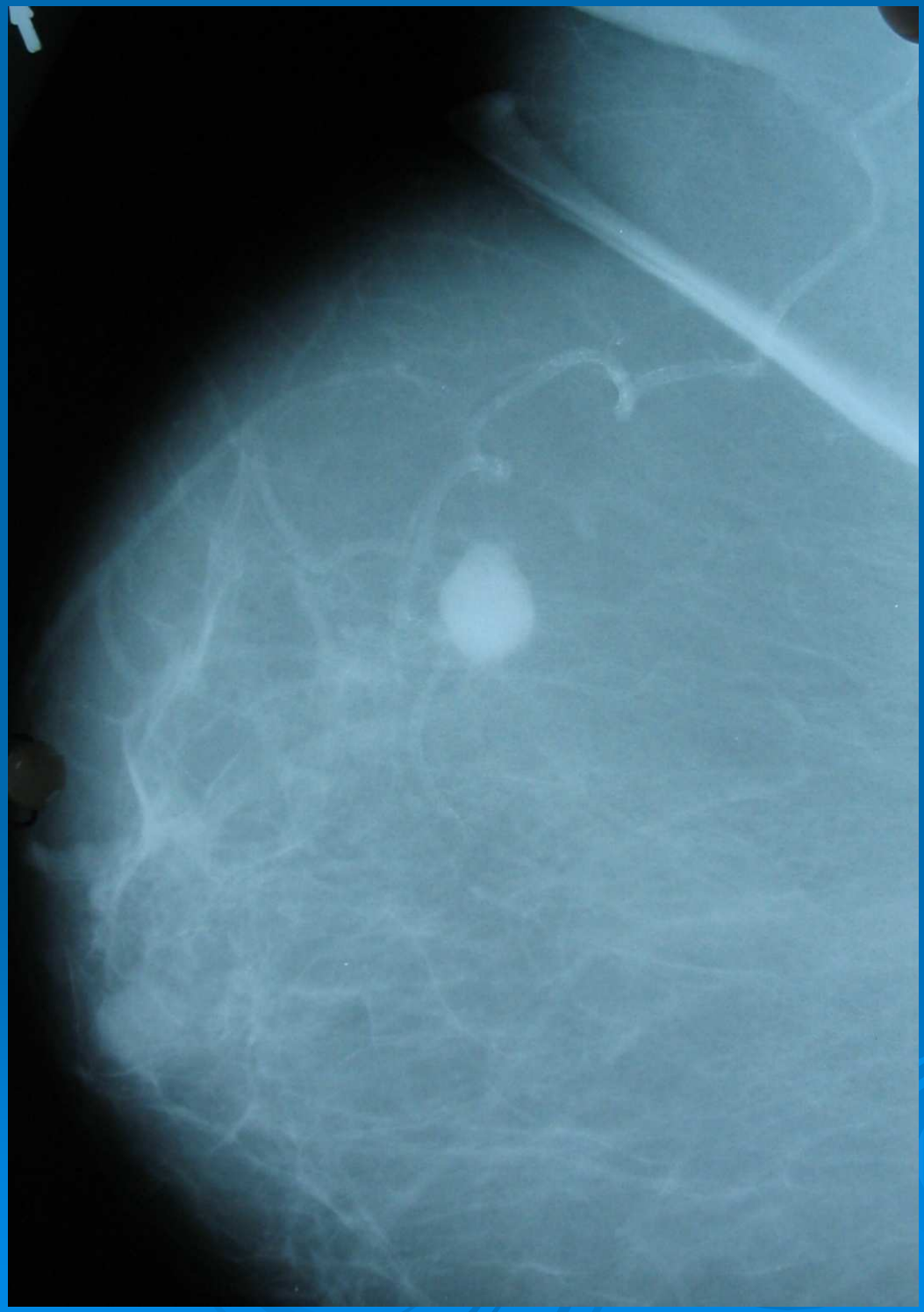
[Contd…]

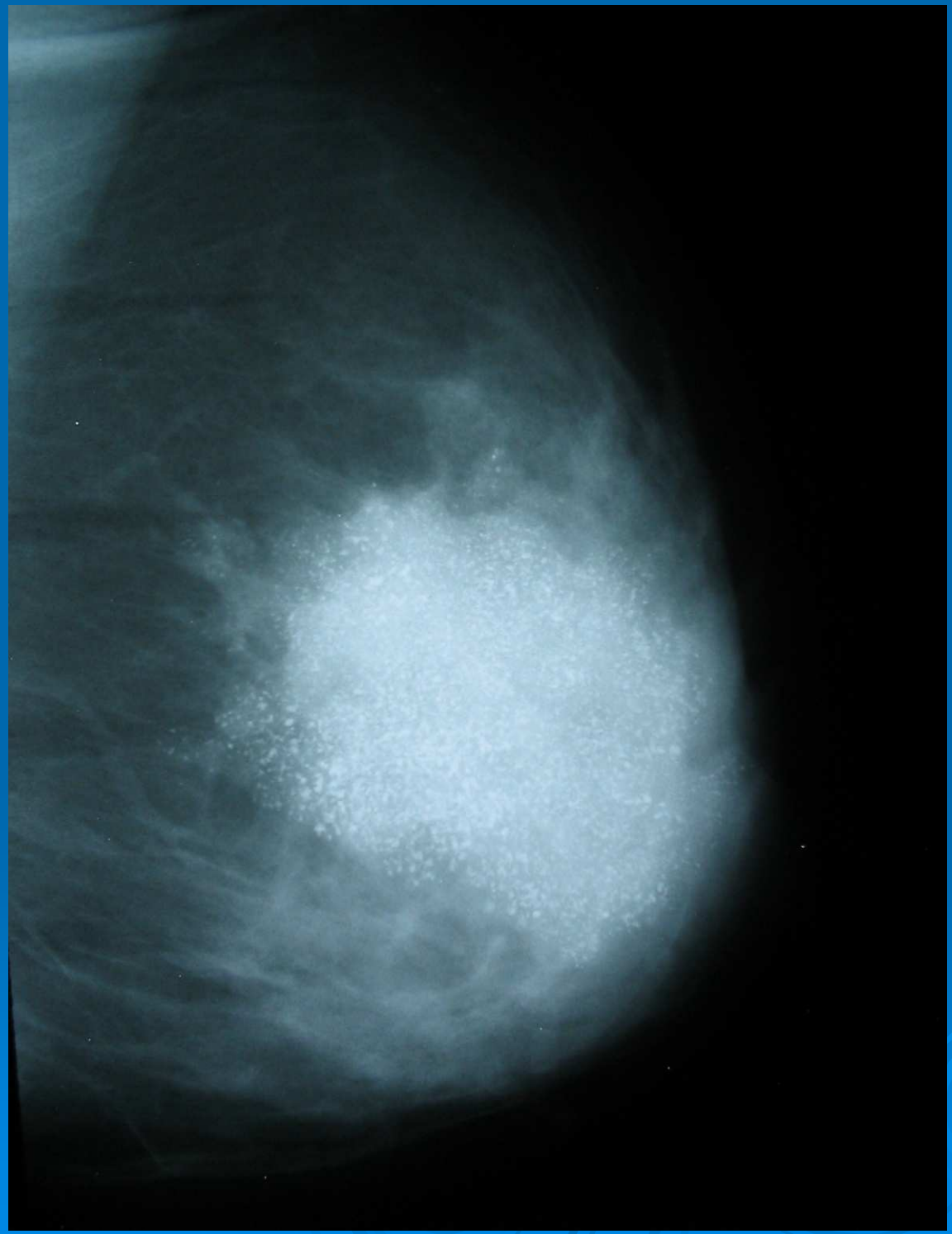
4. Pathological lymph nodes in the axilla.

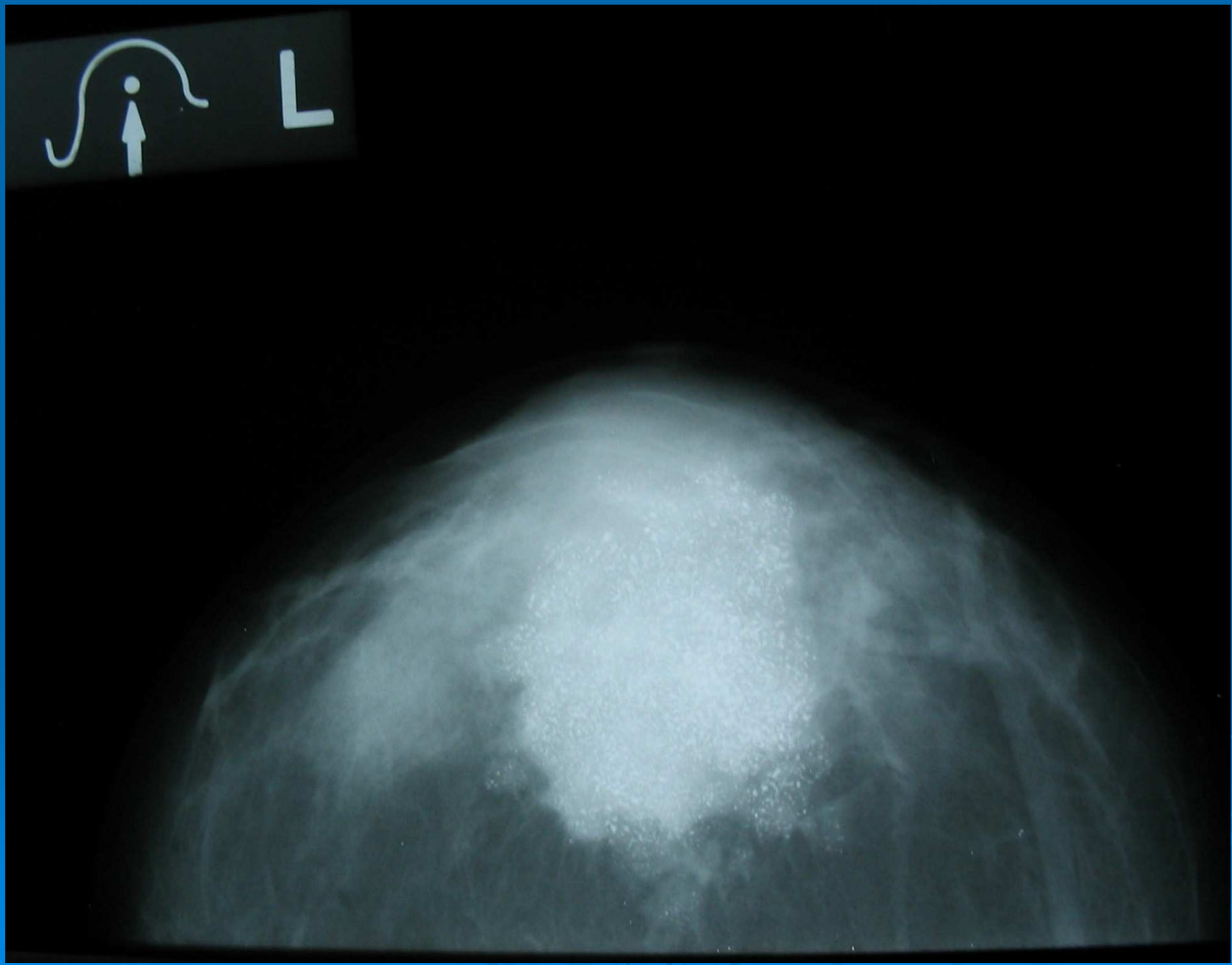
5. Nipple retraction

6. Skin thickening, oedema, puckering.

7. Radiological size of the lesion smaller than the clinical size



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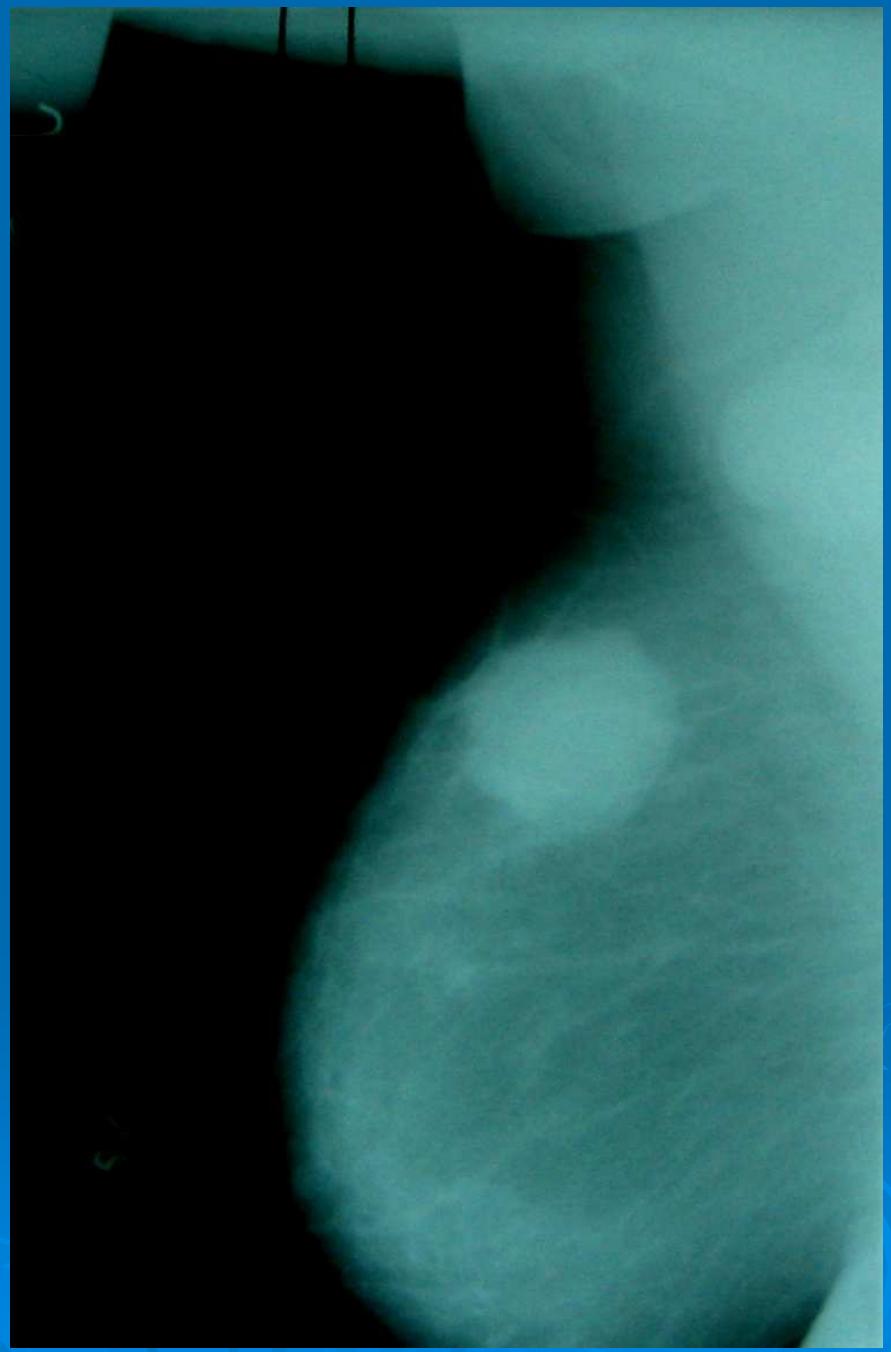
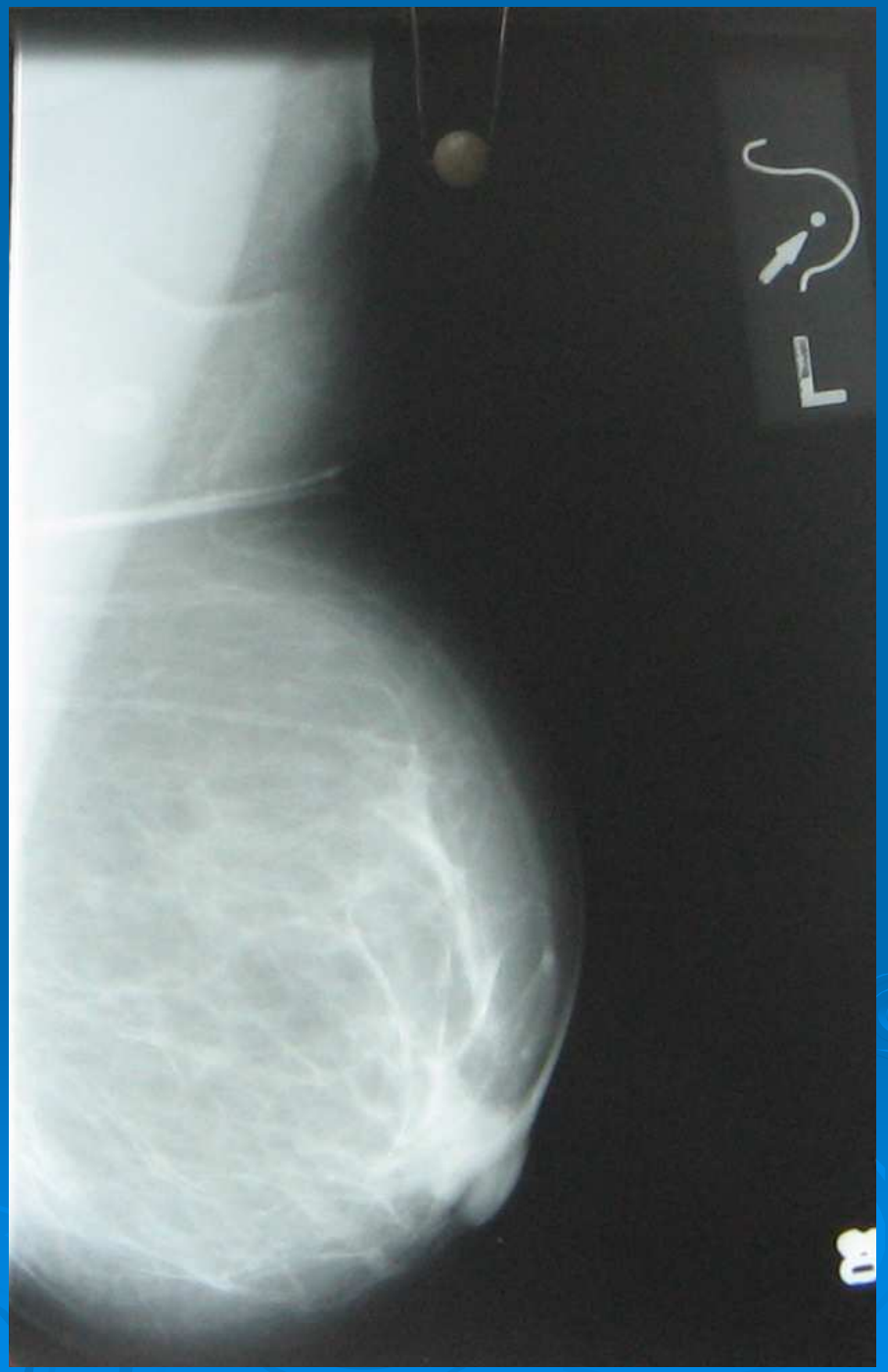
MASS WITH AXILLARY LYMPHADENOPATHY



SUBAREOLAR MASS

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Microcalcifications

- Histologically 80% of breast carcinomas have calcifications.

- Radiographically visible calcifications are present in 55 % of breast cancers.

- Malignant calcifications are generally smaller than typical benign calcifications.

- They range in size from 0.08 mm to 5mm,but are usually less than 0.2 mm.

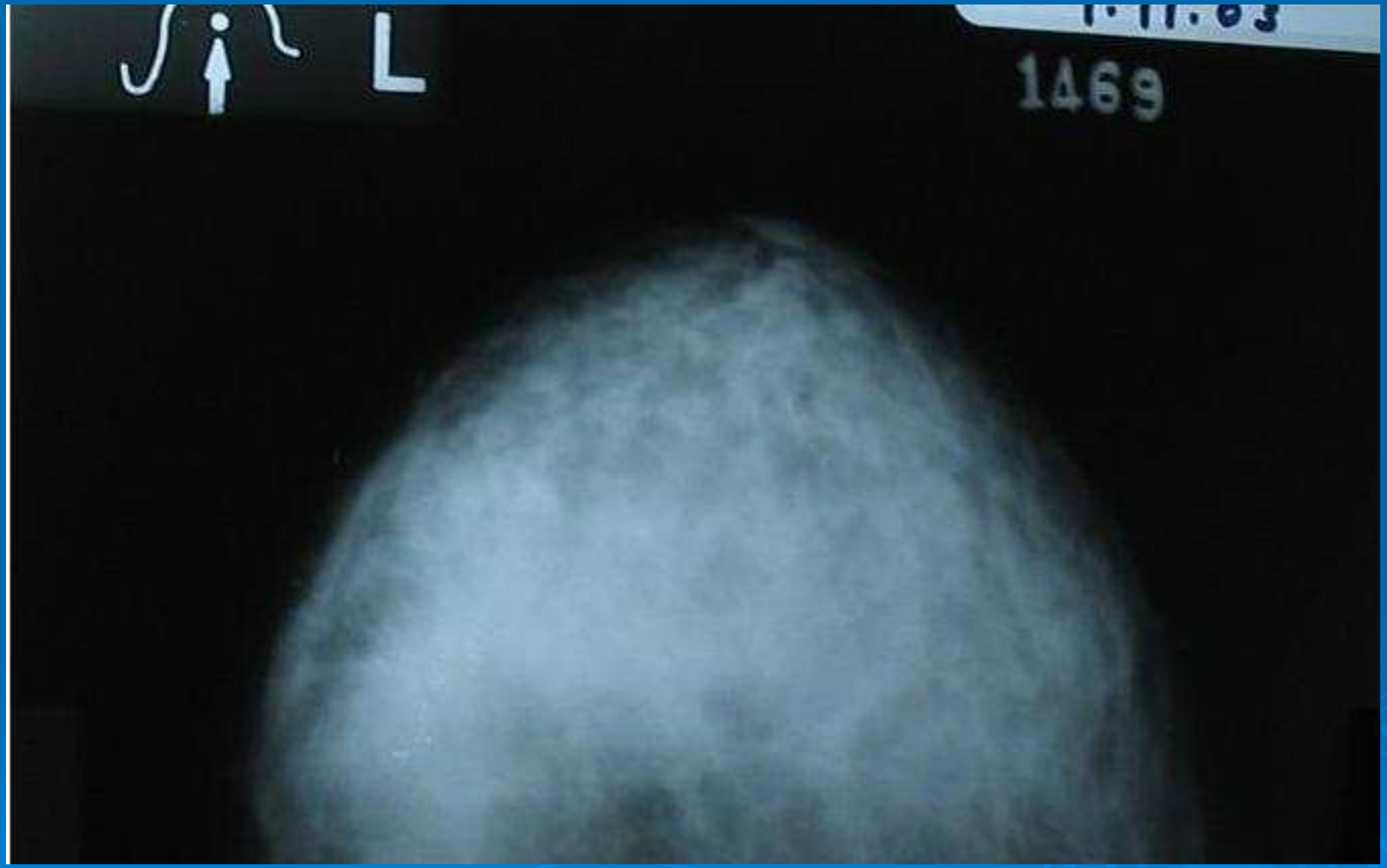
- Variability is the hallmark. They vary in distribution, size, form, density and number.

- They tend to be in clusters. Number varies in each cluster. Multiple clusters may be found.

- They may be present alone or found with in a mass.

- The shape may be linear, round, branching, angular, punctuate or granular.

- D/D- calcification in early fibroadenoma, early vascular calcification, etc.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Multicentricity in Breast cancer

- is defined as presence of foci in other quadrants than primary carcinomas.

- also defined as presence of foci that are 4 to 5 cms distant from primary carcinomas.

- suggests foci in more than one duct system

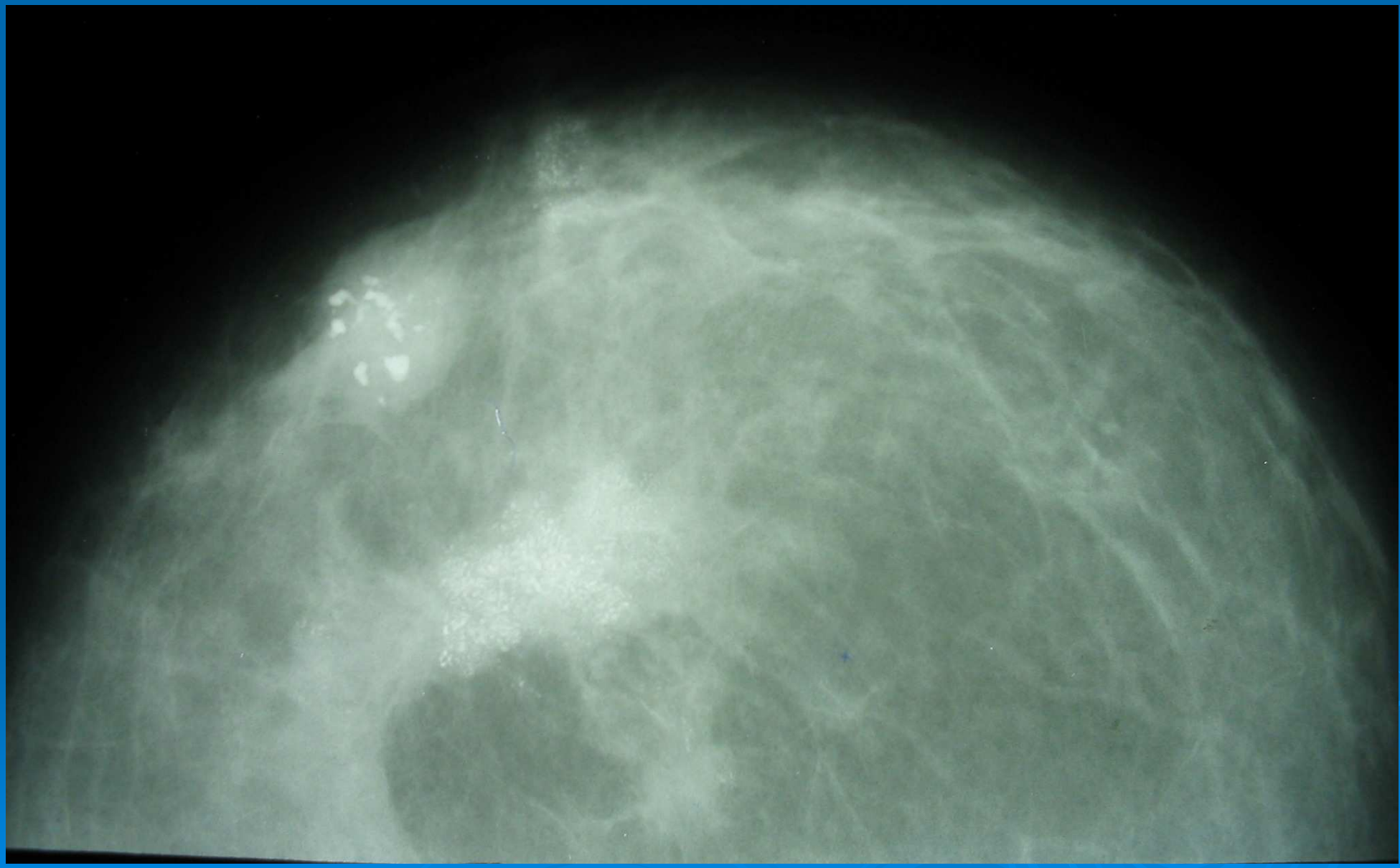
- precludes breast conservation

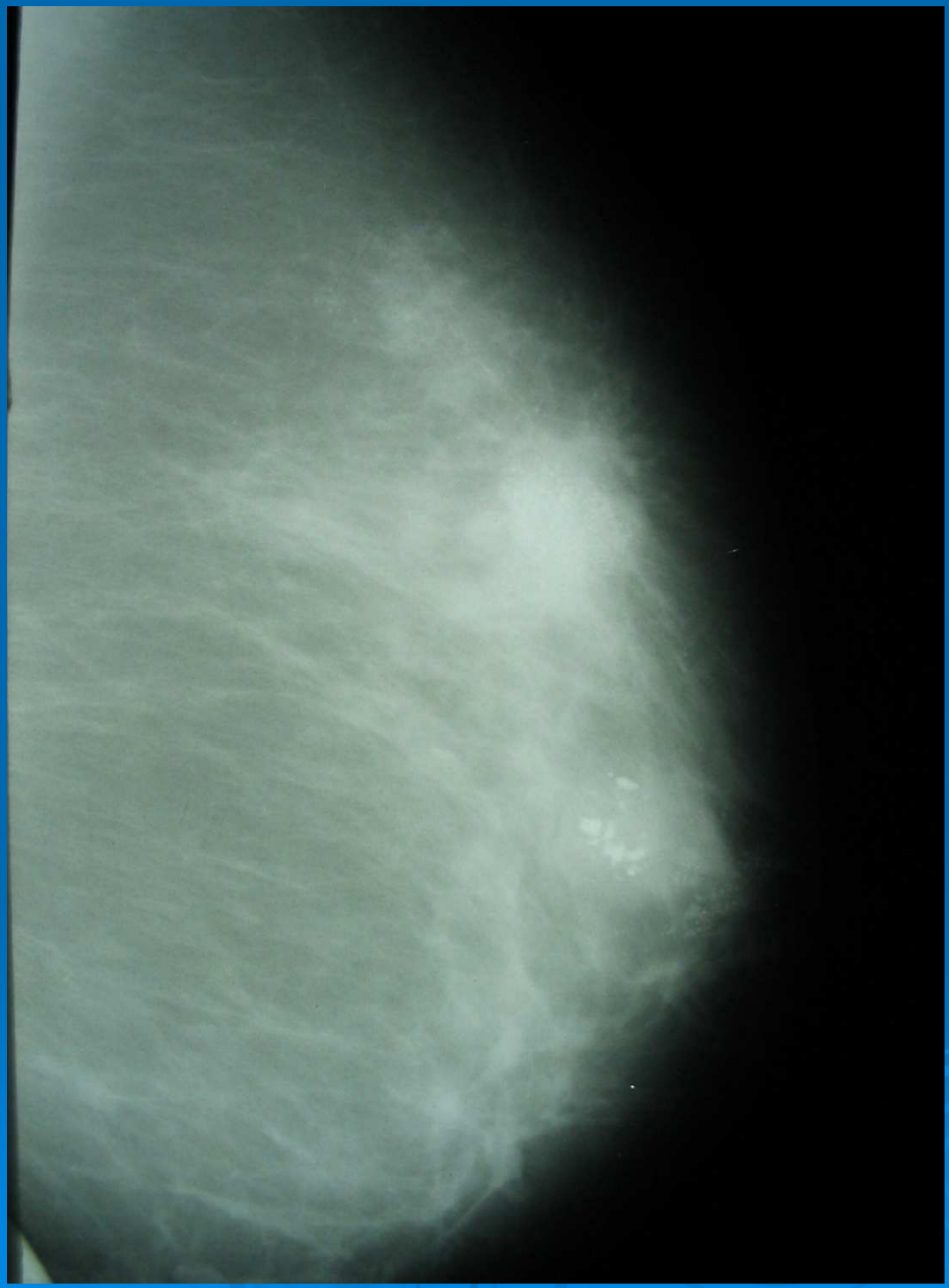
Multifocality in Breast cancer

suggests foci in one duct system

Microcalcifications in additional foci are seen in multicentric and multifocal lesions.

Contrast MRI is ideal for secondary foci without calcifications.



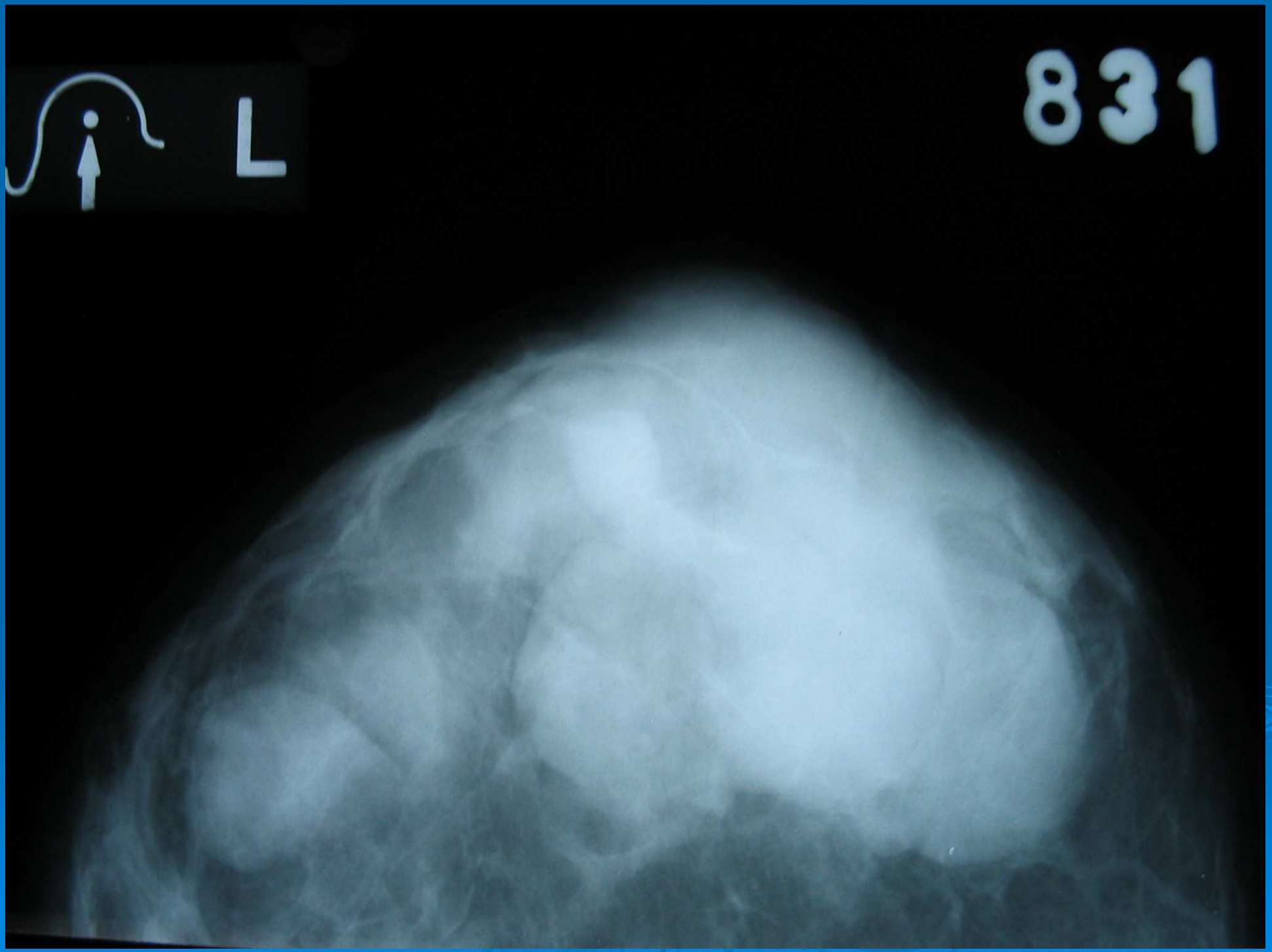


Signs of a benign lesion:

1. A relatively low-density smooth homogenous opacity.

2. Relatively coarse calcification,popcorn calcification of degenerating fibro adenoma, egg shell calcification of galactocele, milk of calcium or tea cup like calcification, large rod like calcifications, vascular calcification etc.)

3. Radiological size larger than the clinical size.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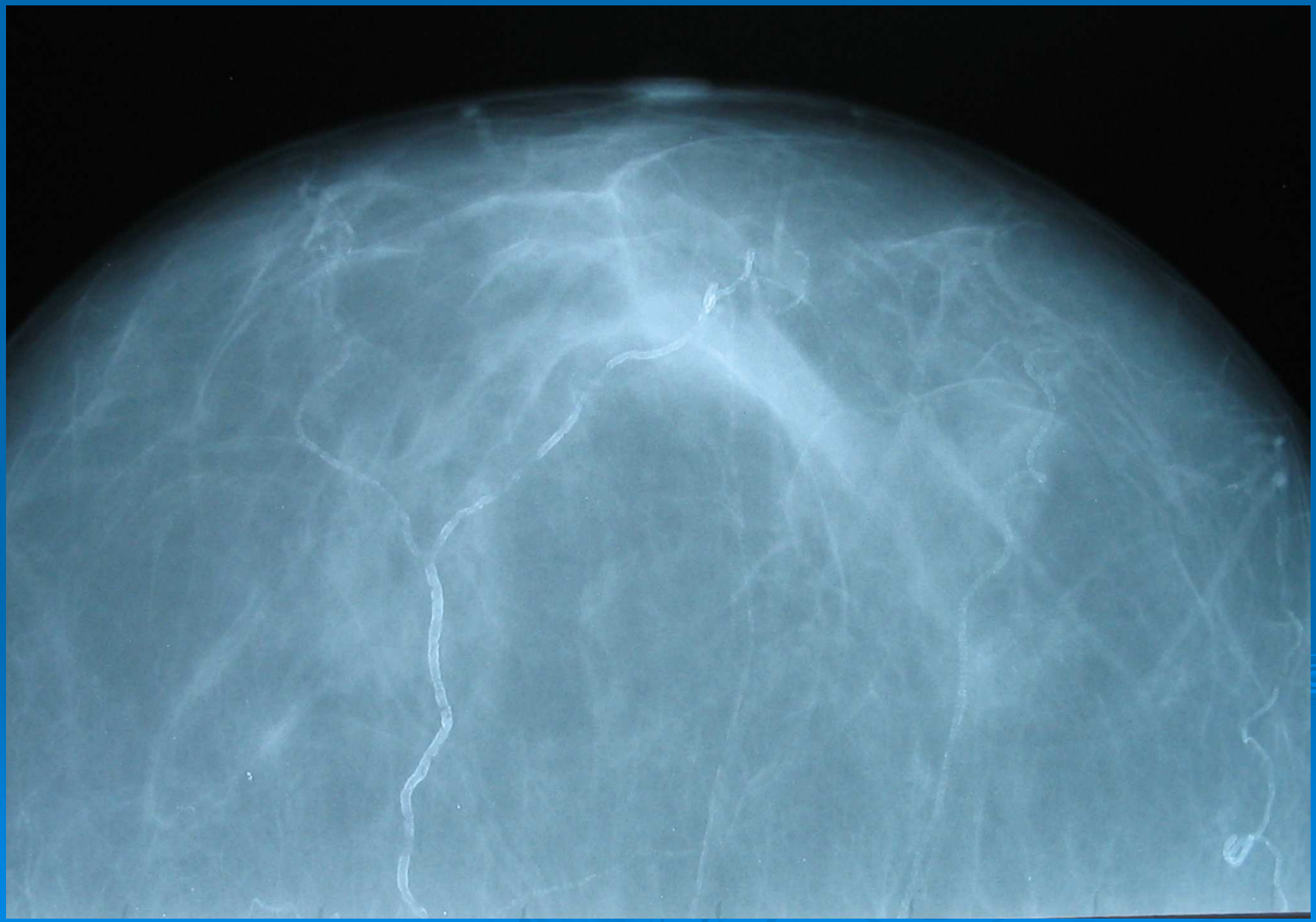

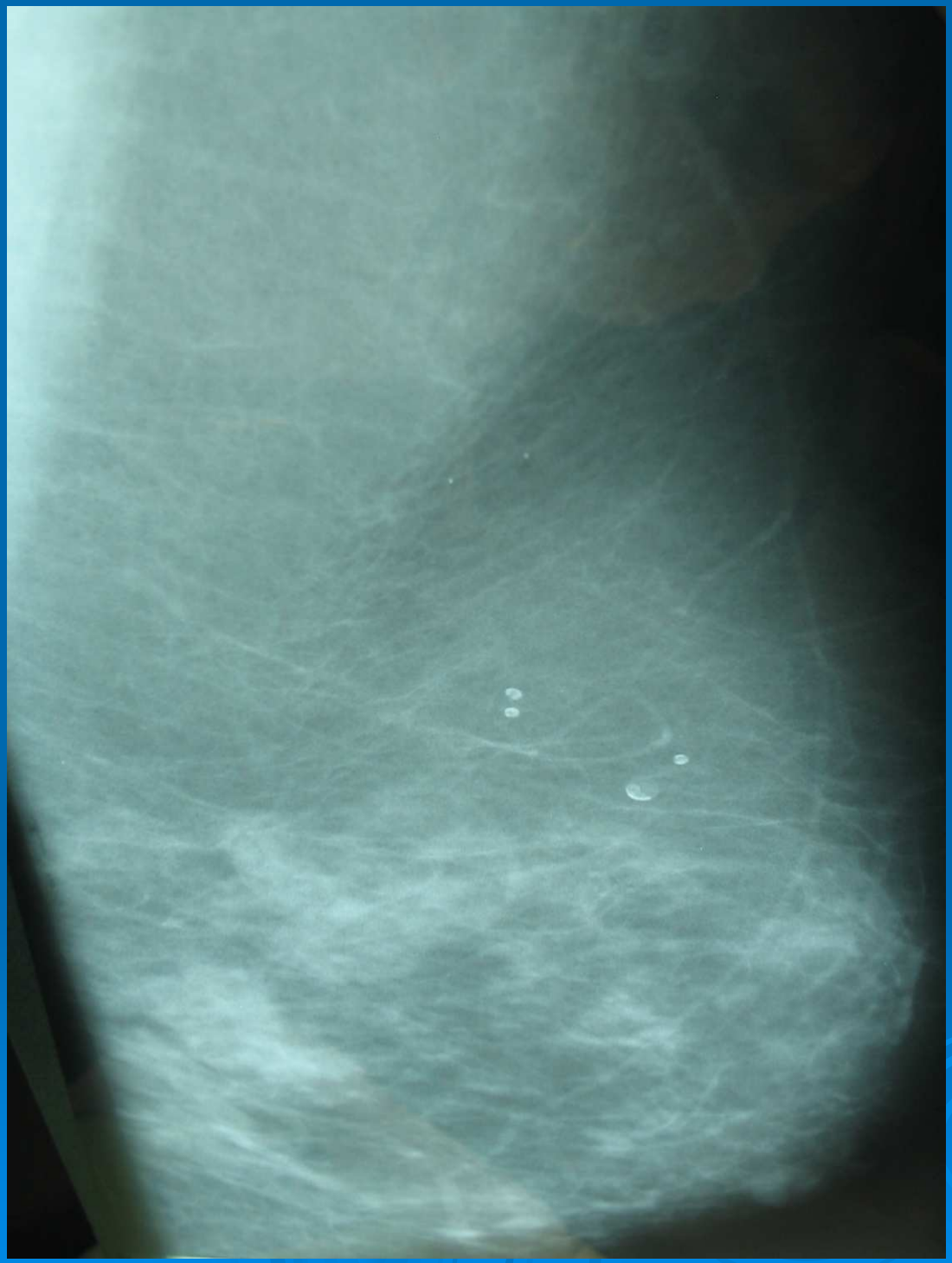

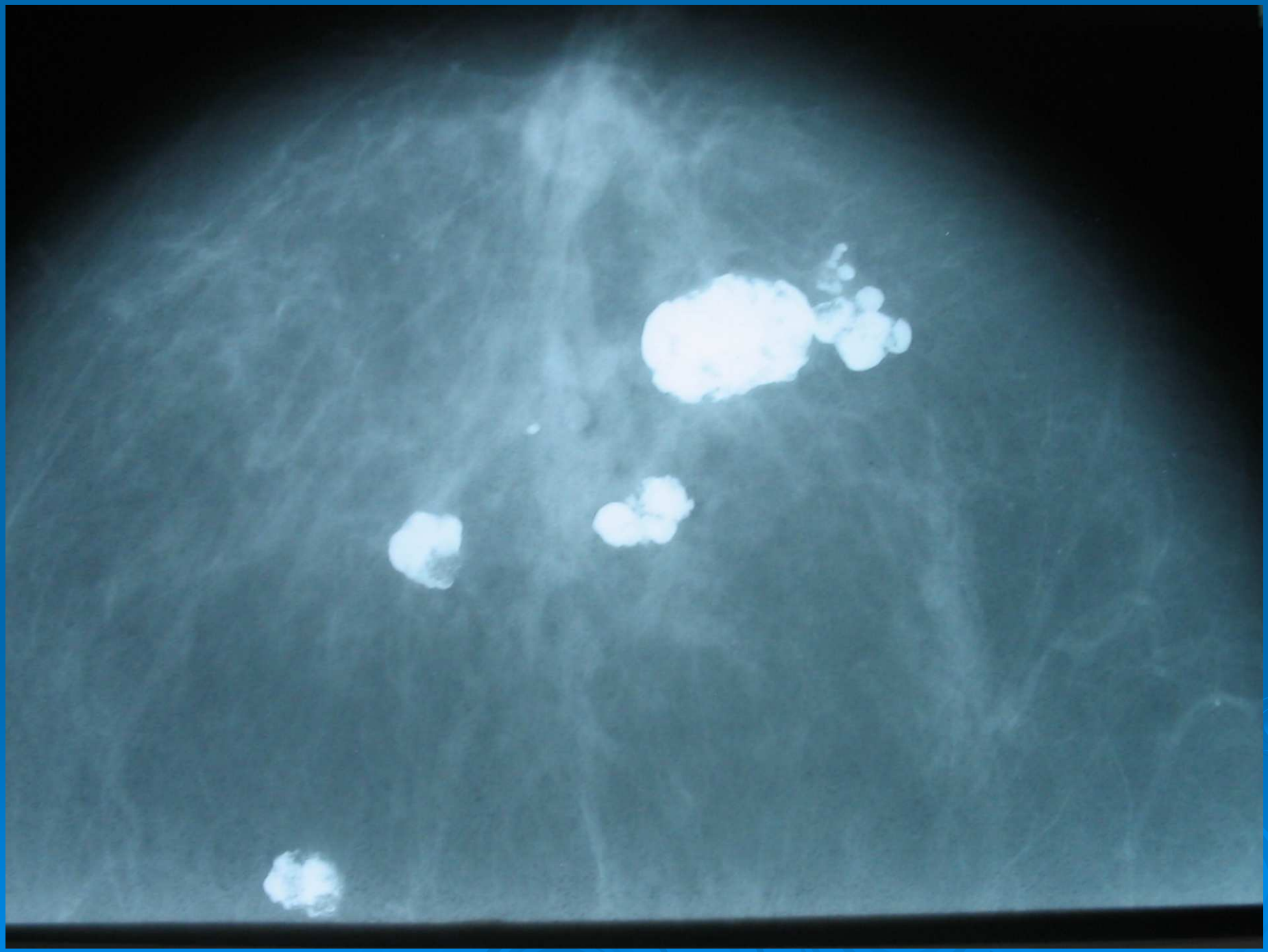

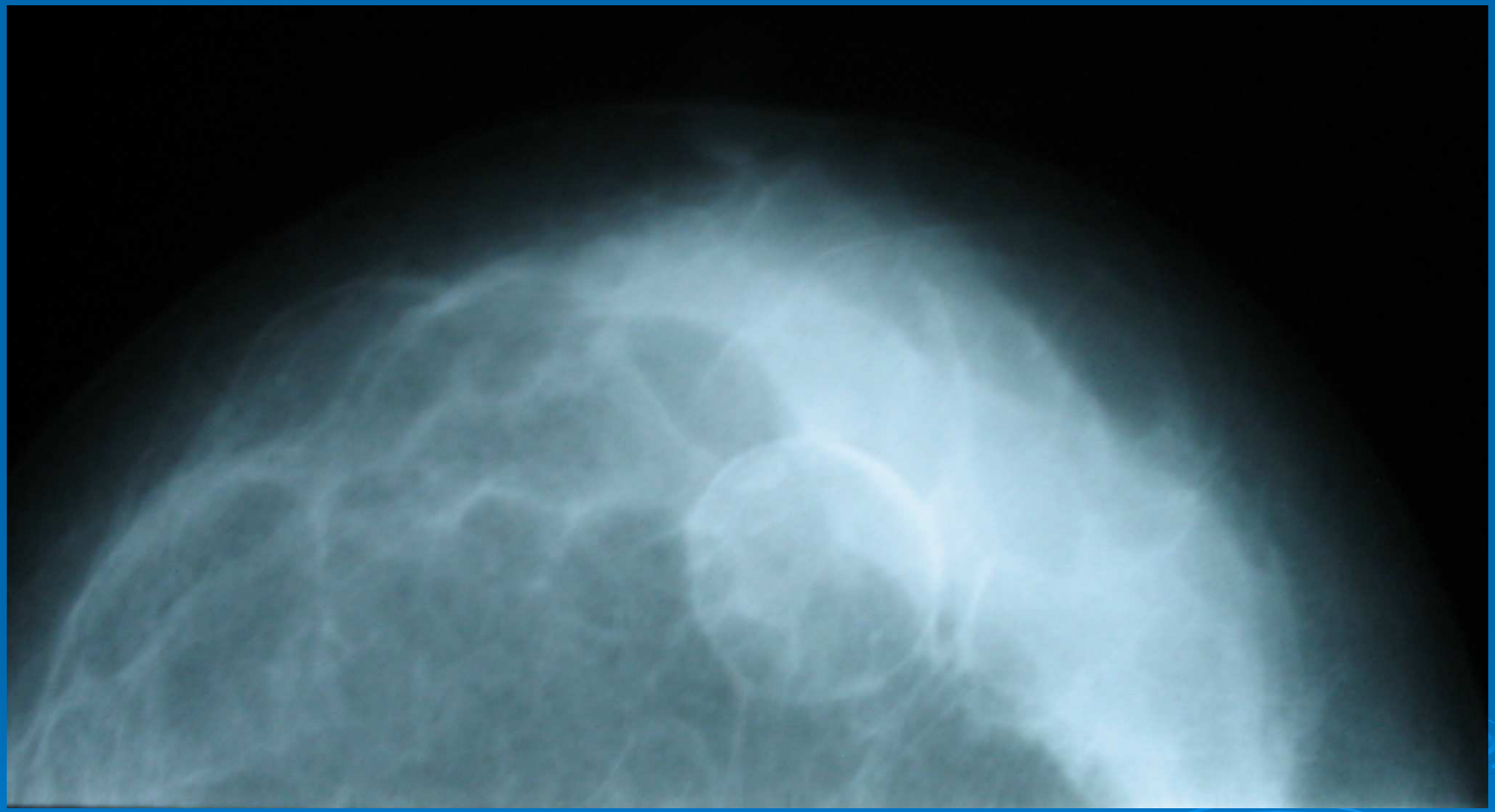

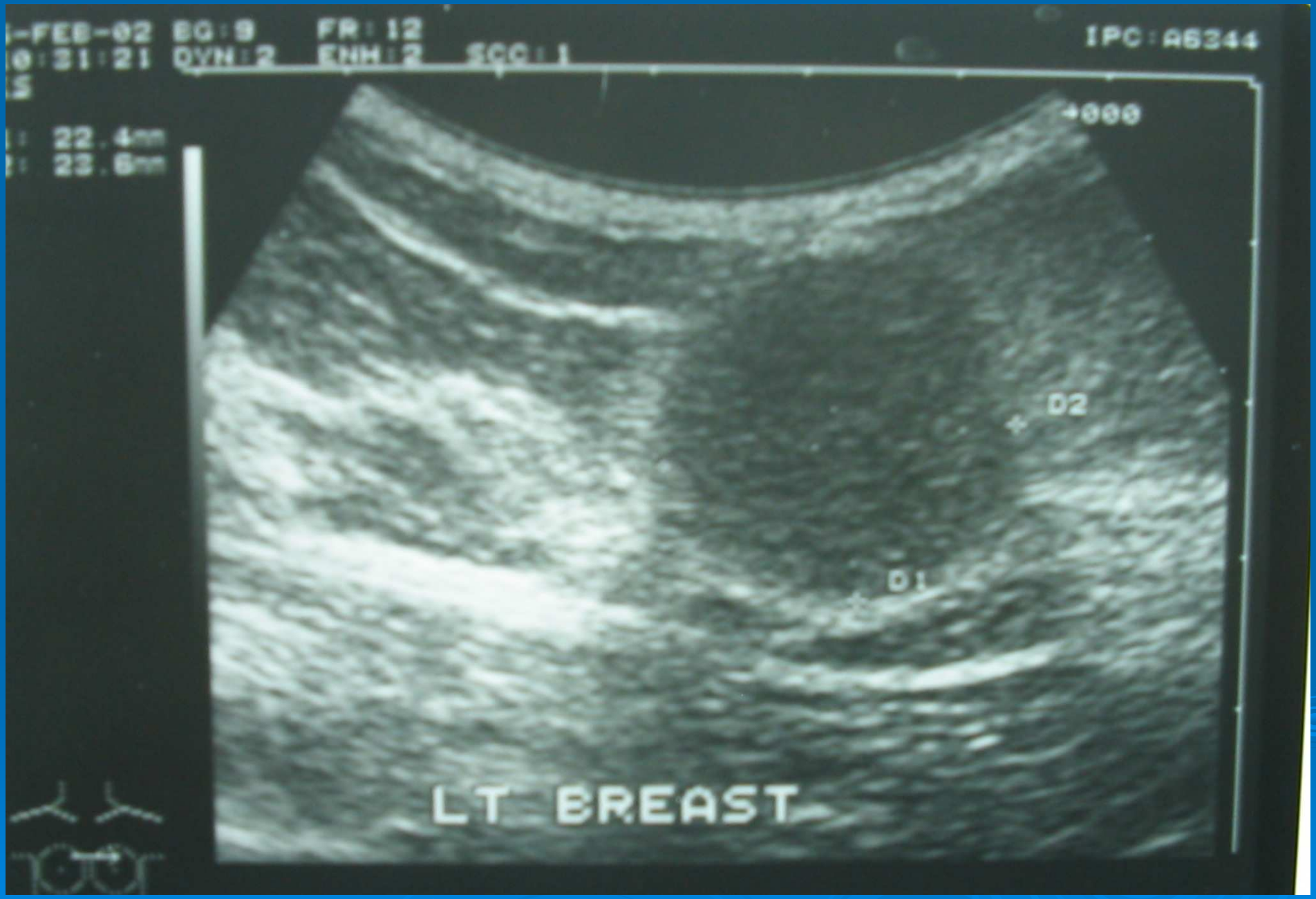
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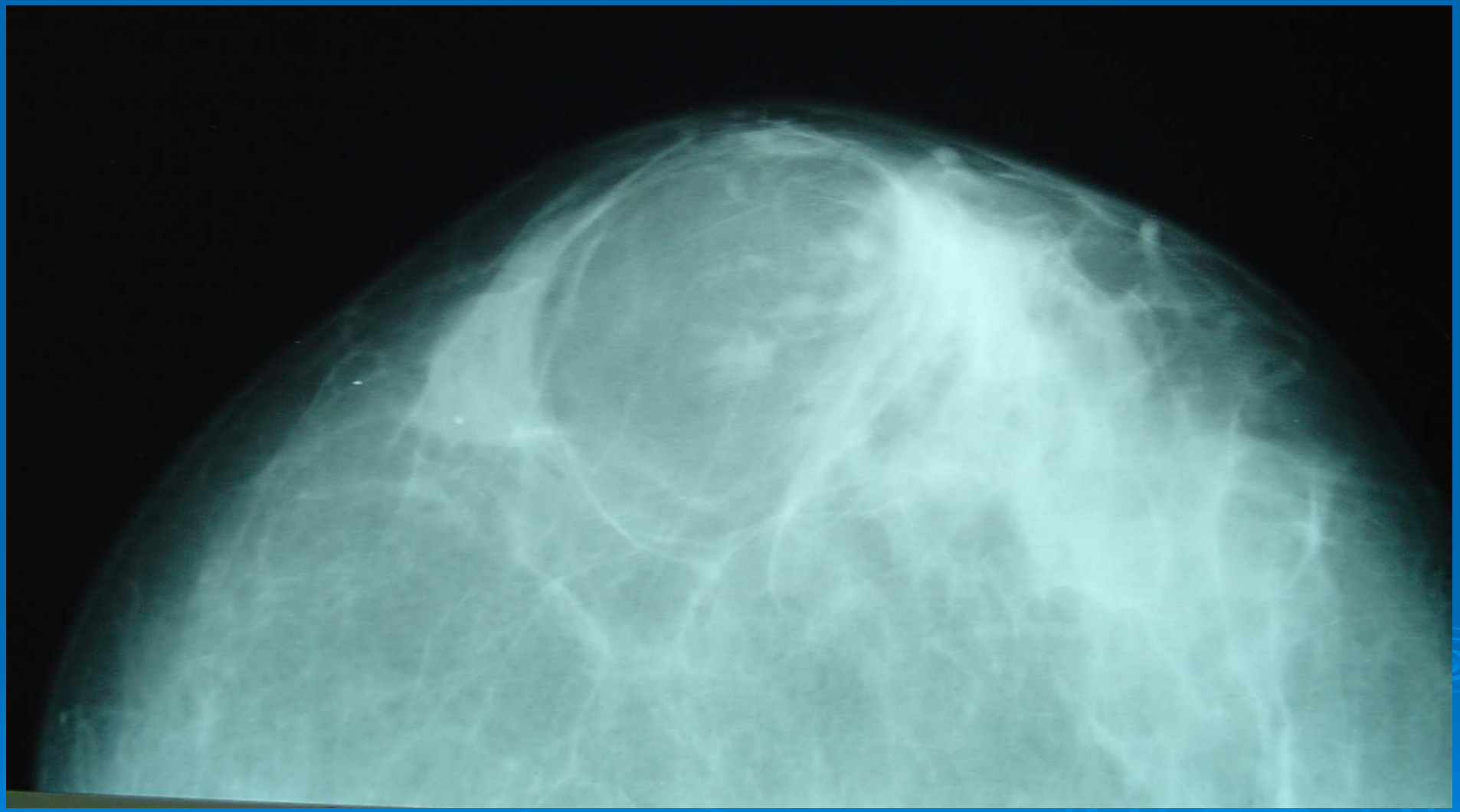
LT BREAST

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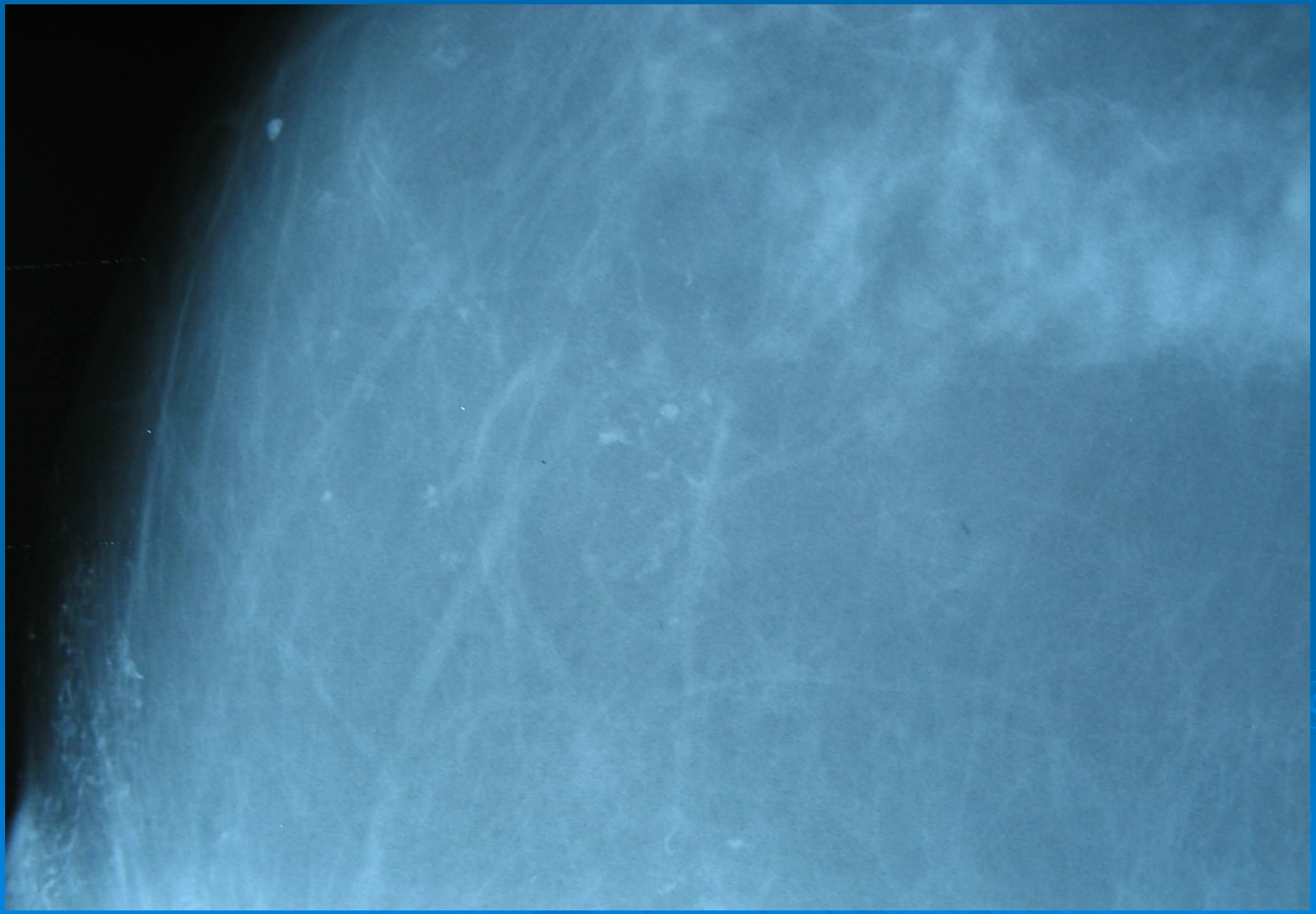
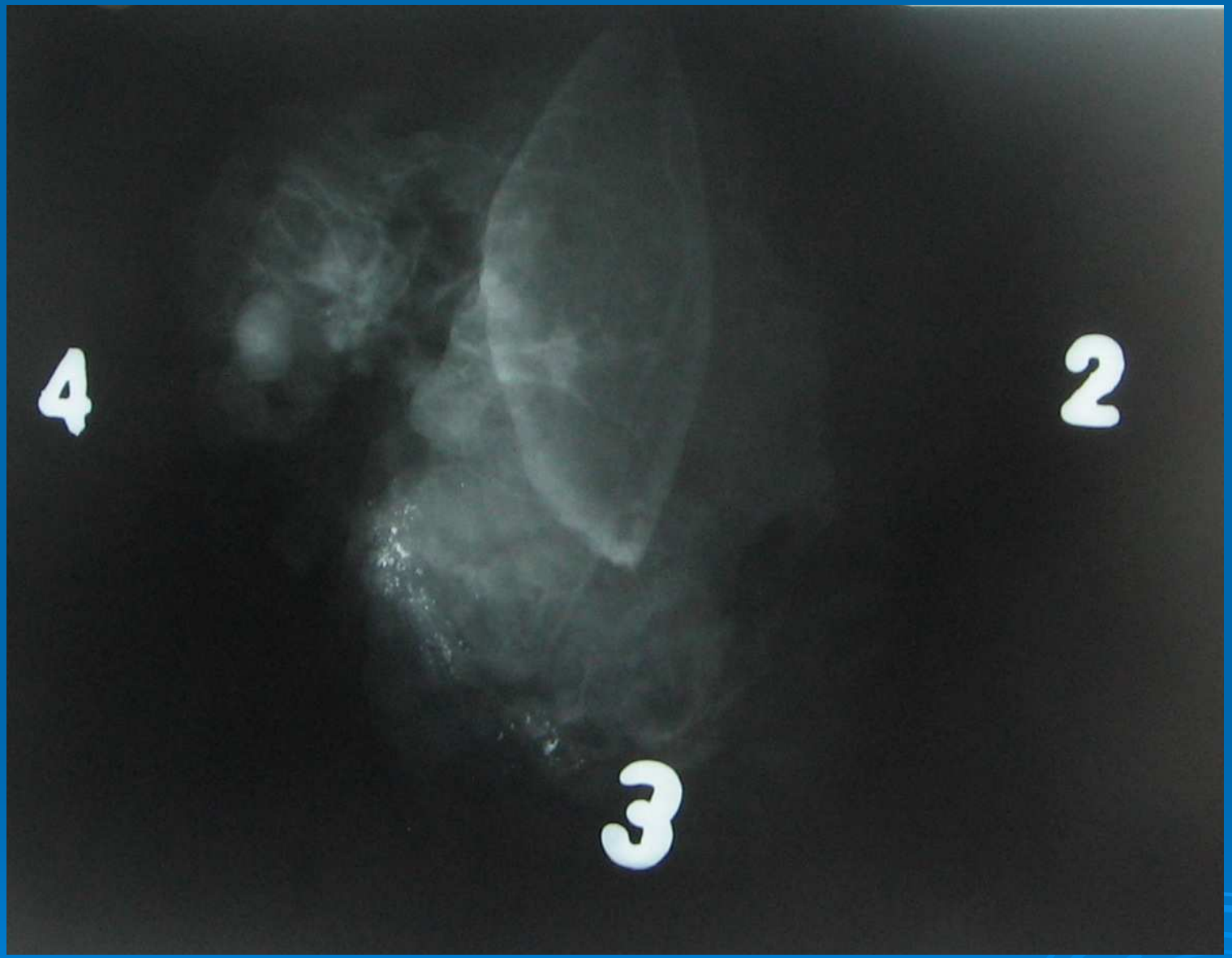




SPECIMEN RADIOGRAPH

Related techniques.

- Ductography (Galactography)
- Pneumocystography.
- Guided procedures :
  - Cyst aspiration
  - FNAC
- Stereotactic biopsy
- Wire localization

Newer Developments

Vacuum assisted biopsy

- Computer aided diagnosis
- Digital Mammography.

SONOMAMMOGRAPHY

- About 10 % are mammographically occult even after they are palpable . Most commonly used adjunct to Mammography
- High Frequency Probes 7.5-12 MHz
- Noninvasive ,Safe, easy ,economic, portable
- Supine position, water path, water bath
- Parallel and perpendicular to midclavicular line

- Lesions are described as position of the needle on the clock face.
- Malignant lesions are typically irregular, illdefined hypoechoic lesions of various sizes.
- Enlarged axillary nodes also can be picked up
- Ultrasound is operator dependent
- Guided procedures are possible

Breast MRI

- Mammography is of limited use in dense breasts, augmented breasts and breasts that have undergone conservation and irradiation.

- False negative rate for Mammography is 5-15%.

- Of the complementary imaging modalities MRI has the highest sensitivity.

- Mammographically suspicious lesions need to be biopsied regardless of a negative MRI.

Indications for Breast MRI (ACR guidelines- 2004)

- 1. Lesion characterization
- 2. Neoadjuvant chemotherapy
- 3. Infiltrating lobular carcinoma
- 4. Infiltrating ductal carcinoma
- 5. Axillary adenopathy, primary unknown
- 6. Postoperative tissue reconstruction
- 7. Silicone & non silicone augmentation.

- 8. Invasion deep to fascia
- 9. C/L breast examination in known cases
- 10. Post-lumpectomy for residual disease
- 11. Surveillance of high risk patients
- 12. Recurrence of breast cancer

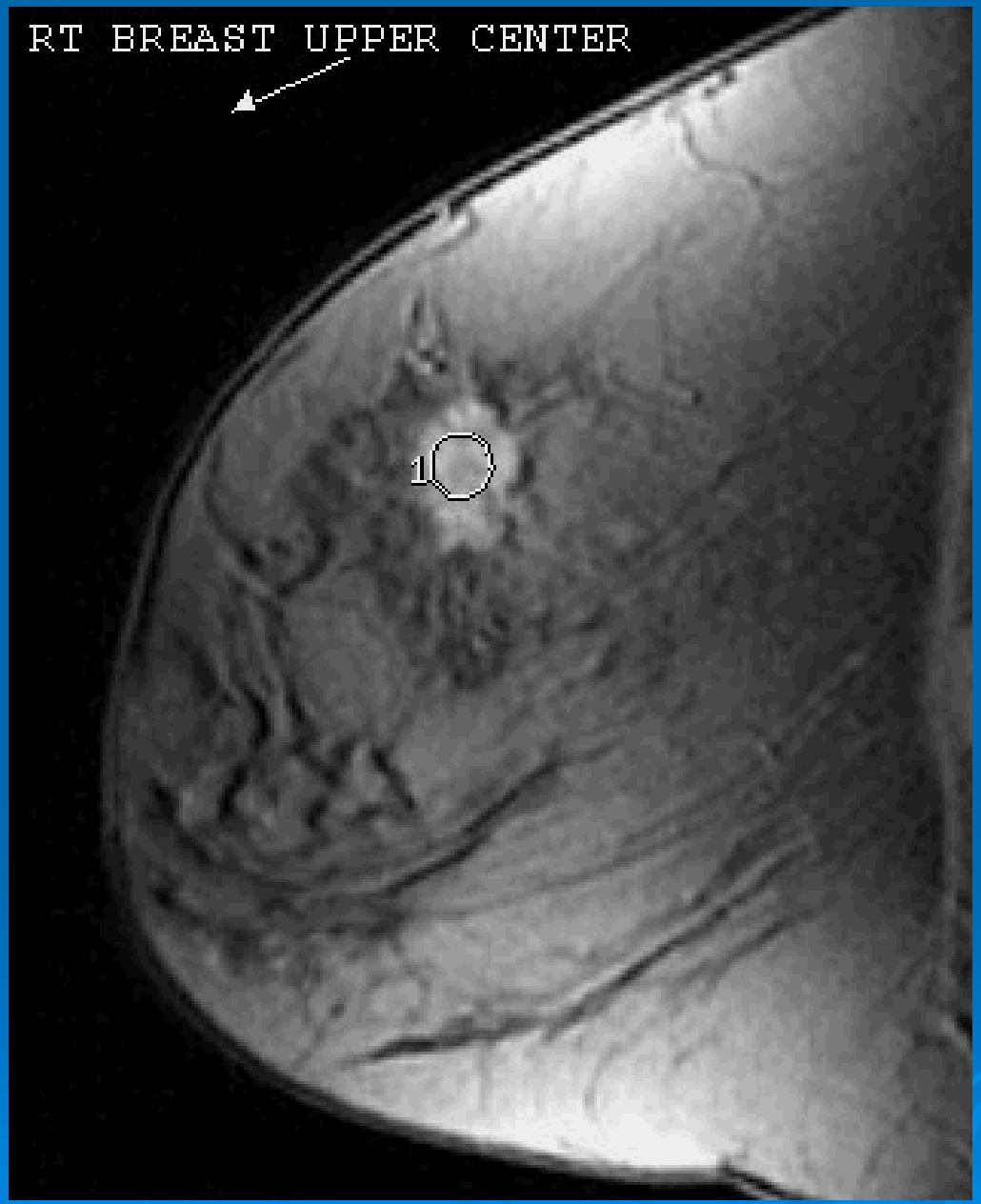
  - Indian J radiol Imaging/ may 2009

Technique of MRI:

1. Machine > 1.5 Tesla
   dedicated breast coil
   spatial resolution 1mm in all planes
   slice thickness 2mm
   dynamic contrast administration using power injector

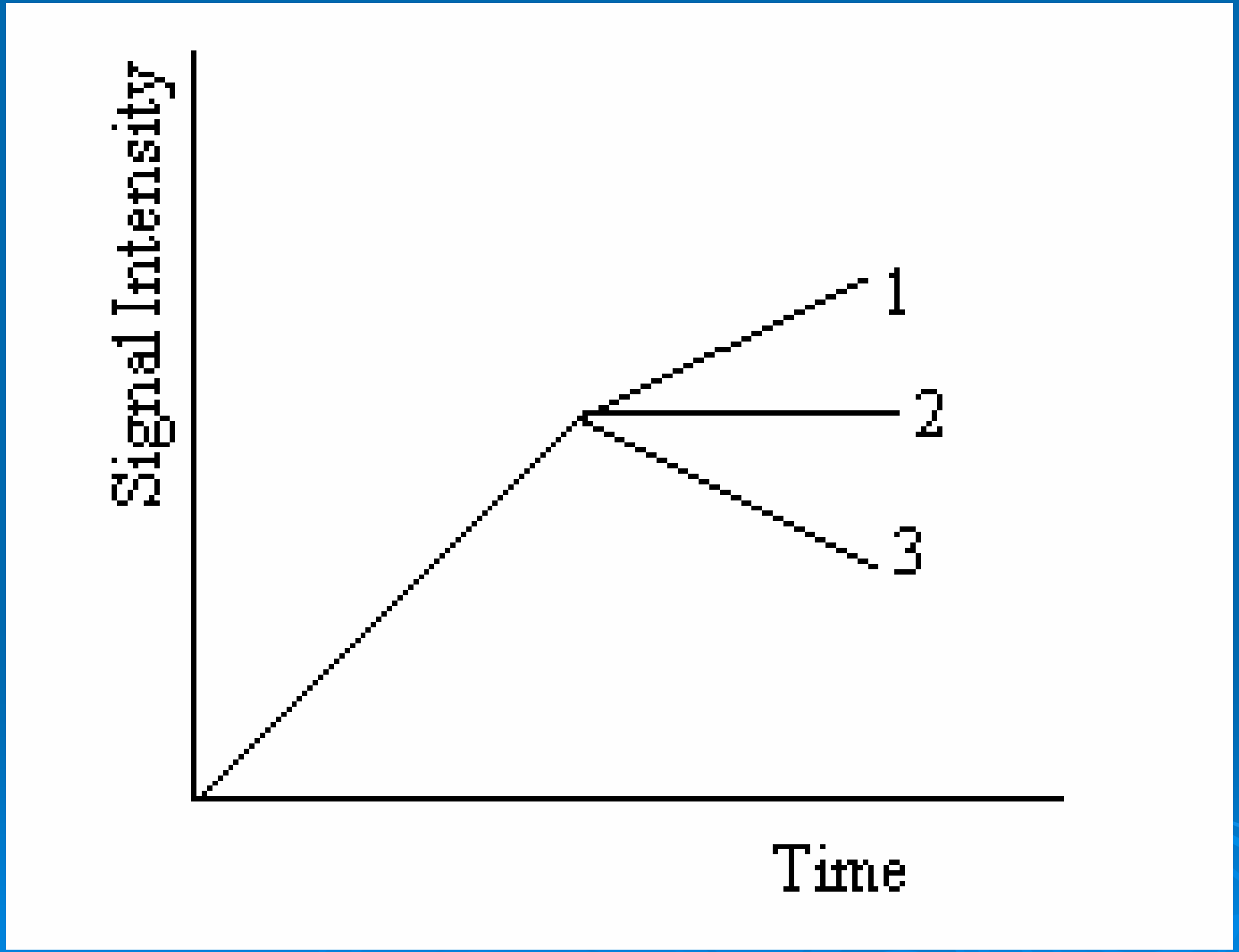
2. Procedure: Gadolinium (Gd-DTPA) enhanced T1 weighted sequences, T2 weighted sequence in axial & sag planes, Fat suppression etc. are commonly used.

Chemical selective fat suppression, subtraction from pre and post contrast, etc are used.


RT BREAST UPPER CENTER
1

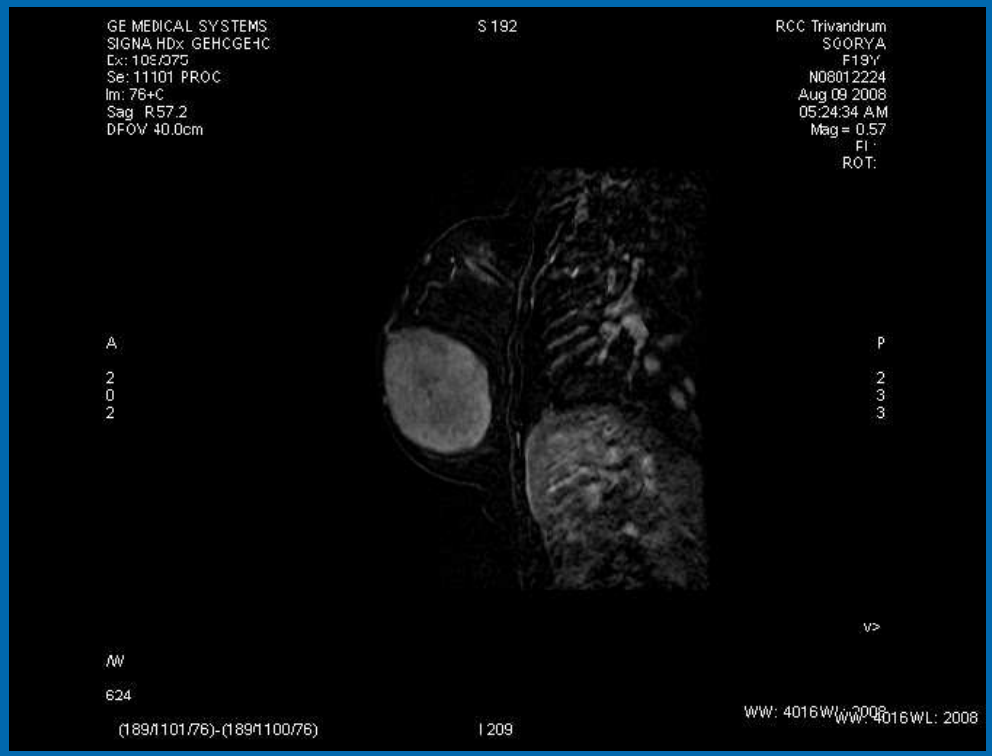
CONTRAST ENHANCEMENT IN MRI:

1. Malignant lesions__enhance because they have increased number of vessels or have increased vascular permeability due to leaky endothelial cells.
2. They exhibit wash out – i.e. decrease in enhancement after peak enhancement has been reached.
3. Wash out results from increased vascular permeability and presence of arteriovenous shunts.
4. In general malignant lesions enhance more rapidly and wash out faster than benign lesions. But overlap does occur.

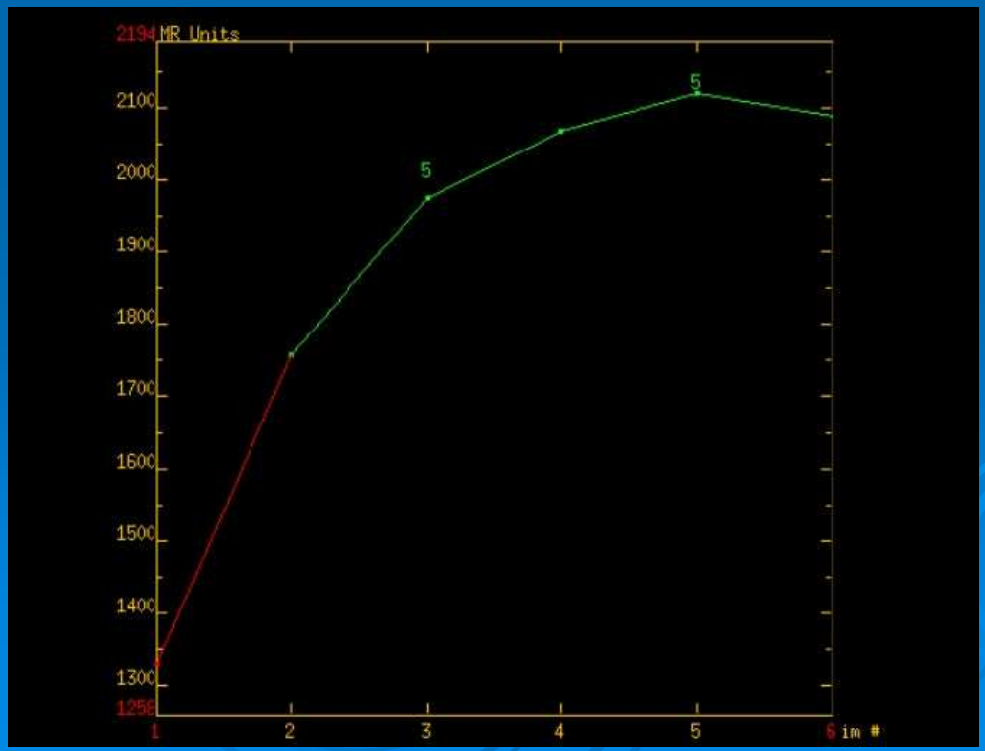

Signal Intensity
1
2
3
Time


GE MEDICAL SYSTEMS
SIGNA HDx GEHCGEHC
Ex: 109/075
Se: 3
Im: 19
Ax 12.3
DFOV 27.0cm
P 142
RCC Trivandrum
SOORYA
F19Y
N08012224
Aug 09 2008
04:36:08 AM
Mag = 1.15
FL:
ROT:
ET:2
L
R
1
4
5
1
4
8
FSE-XL/90
TR:540
TE:11.0/Ef
EC:1 /1 31.2kHz
HDBreast/FL:p+
FOV:31x31/W
4.0thk/2.0sp
32/03:47
384X256/1.00 NEX
St:SI/NP/SPF
A 128
WW: 4038WL: 2019


GE MEDICAL SYSTEMS
SIGNA HDx GEHCGEHC
Ex: 109/075
Se: 6
Im: 19
Ax 12.3
DFOV 27.0cm
P 142
RCC Trivandrum
SOORYA
F19Y
N08012224
Aug 09 2008
04:48:33 AM
Mag = 1.15
FL:
ROT:
ET:16
L
R
1
4
5
1
4
8
FSE-XL/90
TR:7500
TE:120.5/Ef
EC:1 /1 31.2kHz
HDBreast/FL:p+
FOV:31x31/W
4.0thk/2.0sp
32/02:23
384X256/1.00 NEX
St:SIF/NP/SPF
A 128
WW: 2089WL: 967

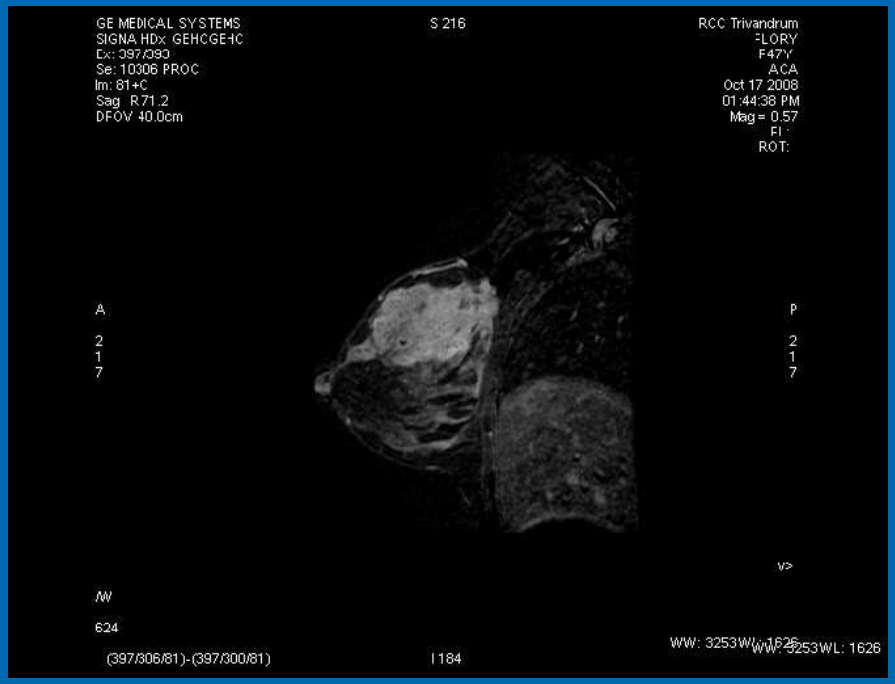

GE MEDICAL SYSTEMS
SIGNA HDx GEHCGEHC
Dx: 105/075
Se: 11101 PROC
Im: 76+C
Sag R57.2
DFOV 40.0cm
S 192
RCC Trivandrum
SOORYA
F19Y
N08012224
Aug 09 2008
05:24:34 AM
Mag = 0.57
FI :
ROT:
A
P
2
0
2
2
0
3
3
v>
/W
624
(189/1101/76)-(189/1100/76)
I 209
WW: 4016WL: 2008

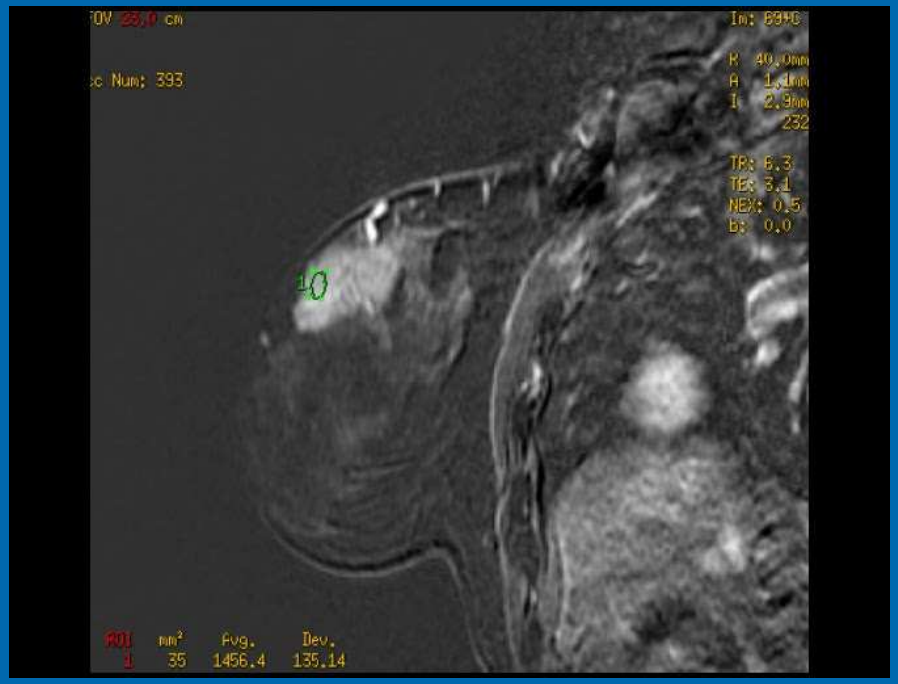

GE MEDICAL SYSTEMS
SIGNA HDx GEHCGEHC
Dx: 105/075
Se: 11106 PROC
Im: 76+C
Sag R57.2
DFOV 40.0cm
S 192
RCC Trivandrum
SOORYA
F19Y
N08012224
Aug 09 2008
05:31:16 AM
Mag = 0.57
FI :
ROT:
A
P
2
0
2
2
0
3
3
v>
/W
624
(189/1106/76)-(189/1100/76)
I 209
WW: 4266WL: 2133

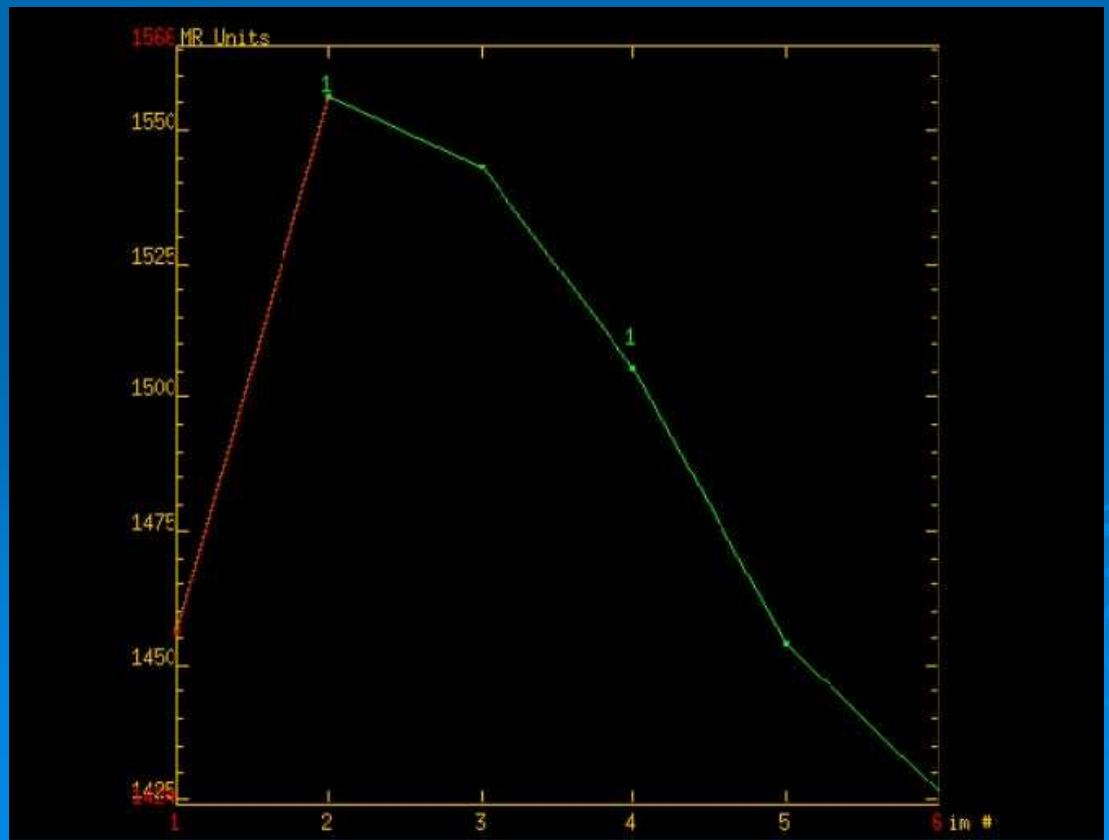

MR Units
2194
2100
2000
1900
1800
1700
1600
1500
1400
1300
1258
5
5
1
2
3
4
5
6
Im #


GE MEDICAL SYSTEMS
SIGNA HDx GEHCGE1C
P 100
RCC Trivandrum
Se: 3
Im: 9
Ax S 34.5
DFOV 22.6cm
Oct 16 2008
03:26:30 PM
Mag = 1.15
ET:2
L
R
FSE-XL/90
TR:460
HDBreast/FL:p+
FOV:26x26/W
4.0thk/2.0sp
384X256/1.00 NEX
St:SI/NP/SPF
A 126
WW: 4443WL: 2221


GE MEDICAL SYSTEMS
SIGNA HDx GEHCGE1C
P 100
RCC Trivandrum
Se: 4
Im: 9
Ax S 34.5
DFOV 22.6cm
Oct 16 2008
03:32:02 PM
Mag = 1.15
ET:16
L
R
FSE-XL/90
TR:6280
HDBreast/FL:p+
FOV:26x26/W
4.0thk/2.0sp
384X256/1.00 NEX
St:SI/NP/SPF
A 126
WW: 3115WL: 1557


GE MEDICAL SYSTEMS
SIGNA HDx GEHCGE4C
Ex: 397/393
Se: 10306 PROC
Im: 81+C
Sag R 71.2
DFOV 40.0cm
S 216
RCC Trivandrum
FLORY
F47Y
ACA
Oct 17 2008
01:44:38 PM
Mag = 0.57
ROT:
A
P
2
1
7
2
1
7
/W
624
(397/306/81)-(397/300/81)
I 184
WW: 3253WL: 1626


Num: 393
ROI
mm²
Avg.
Dev.
1
35
1456.4
135.14


MR Units
1550
1525
1500
1475
1450
1425
1
2
3
4
5
6
Im #

Conclusions

- Mammography is still the gold standard for early detection of breast cancer. It is the only method validated for screening in breast cancer.
- Stereotactic biopsy, Computer aided diagnosis, digital mammography, vacuum assisted biopsy techniques are the various new developments in the field of Mammography.
- The risk of cumulative radiation dose has been seen to outweigh the benefits and screening in breast cancer is now widely accepted.

- Dynamic contrast enhanced breast MRI has emerged as a sensitive modality for evaluation of the breast
- However it is limited by low specificity
- MRI cannot replace mammography for screening in general population.


Thank you