



Breast Imaging

Ultrasonography

It is an imaging method that uses ultrasounds, which allows differentiation of the structures (liquid or solid), evaluation of the tumor size, obtaining descriptions of the lesions. It can be a complementary imaging technique to mammography (Fig.1).

Indication: for the evaluation of the dense breasts, small breasts and patients under 40 years, with negative family history.



Ultrasonography

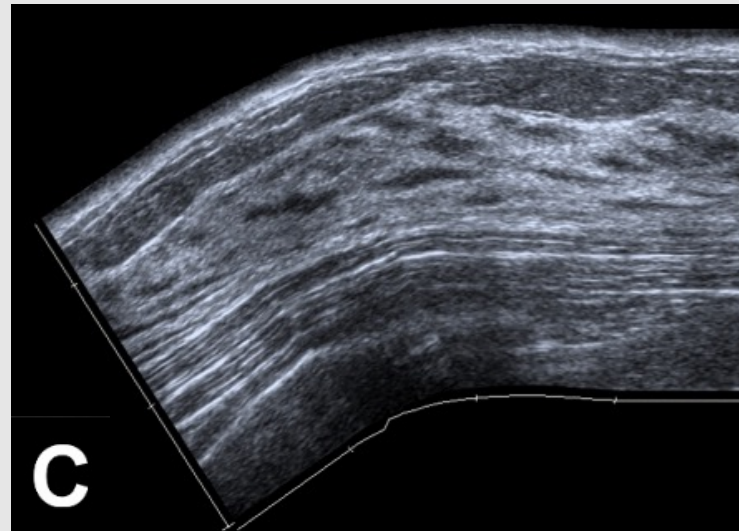
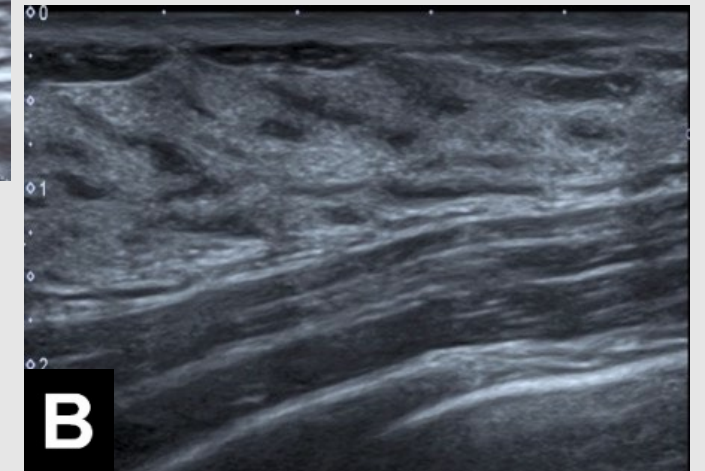
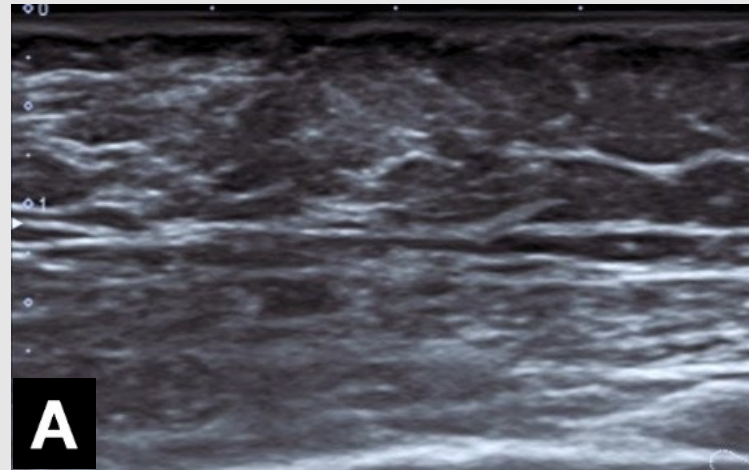


Figure 1. Normal US aspect of breast tissue (A – fatty breast tissue, B – fibroglandular breast tissue, C – mixed breast tissue).

Ultrasound advantages



it is a noninvasive and non-radiant technique;



can be processed in real time;



entails low costs and increased compliance of the patient.

Ultrasound disadvantages



low specificity, low sensitivity in the fatty breast tissue;



it is operator-dependent;



it does not detect microcalcifications.

Mammography

It is an X-ray imaging method that specifies the size, location and structure of the breast tumoral masses.

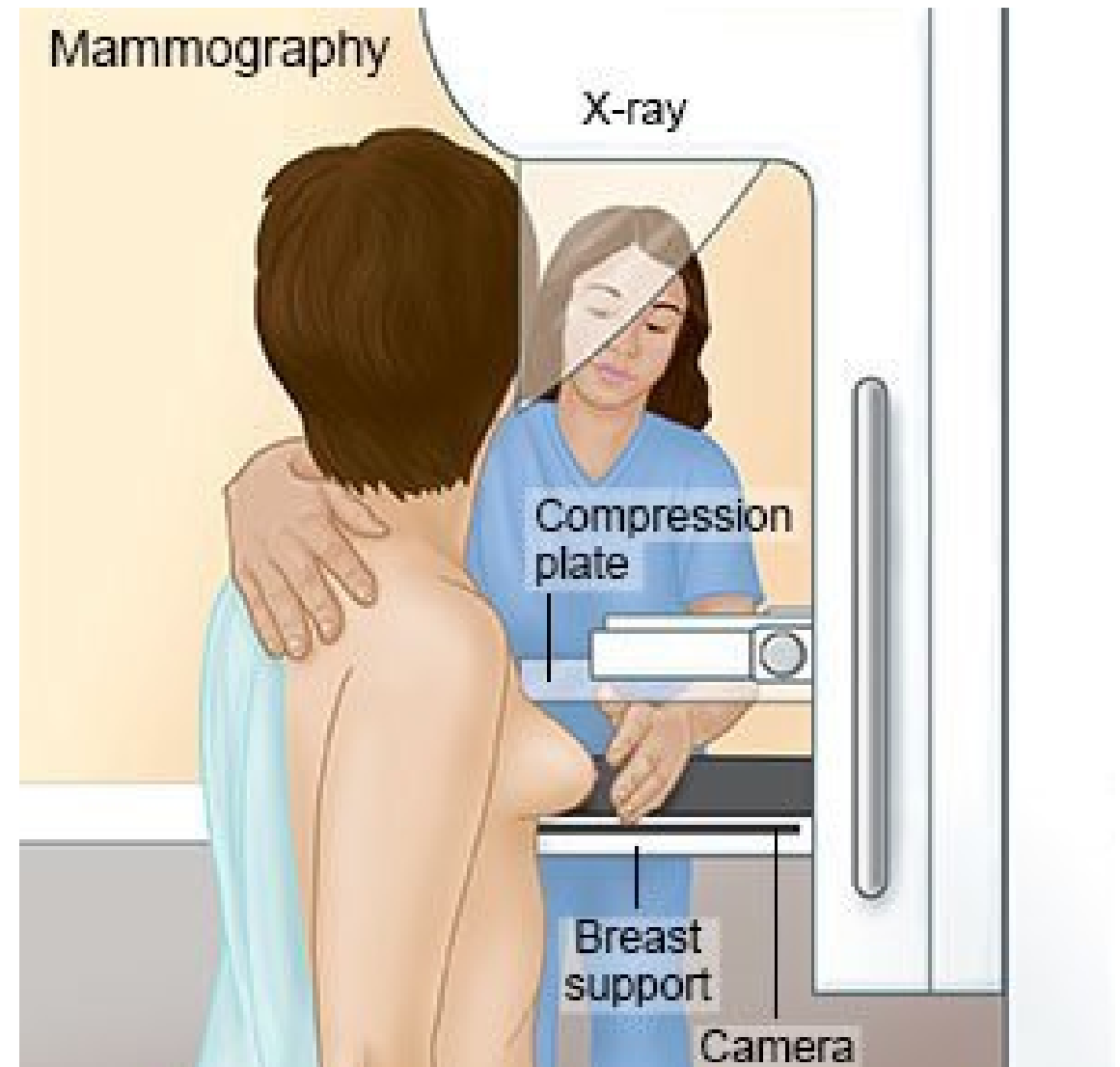
There are multiple types of mammograms (conventional mammography, digital mammography – 2D – and 3D mammography – tomosynthesis).

It is useful in both women and men with signs and symptoms of breast pathology (used for diagnosis).

Mammography represents an overlapped projection of all the images given by the elements of the breast and requires two incidences: **MLO** (mediolateral oblique view) and **CC** (cranio-caudal view) for each breast.

Indication:

- first-intention examination in case of macromastia, asymptomatic women as a screening method (patients over 40 years old). It can identify the presence of calcifications.
- also a screening method in patients with a positive hereditary history.



Mammography

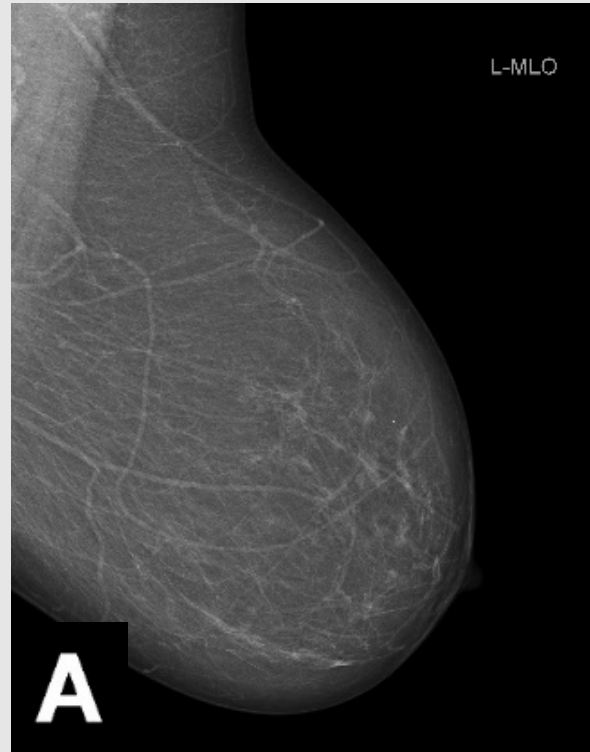


Figure 2. Normal MM aspect of the breast.



- the fatty tissue is *radiolucent*;
- glandular, ductal and connective tissue is *radiopaque*.

Mammography advantages



screening method in asymptomatic patients;



assessment of the health status;



reducing the mortality from breast cancer;



reducing the need to implement oncological therapy;



follow-up.

Mammography disadvantages



the use of X-rays – not recommended for pregnant women, women under 40 (exceptional situations such as positive family history, BRCA +, suggestive aspects of malignancy (US, MRI) or clinical signs;



increased risk of overdiagnosis or false positive;



repeated exposure to X-rays when required additional imaging (SPOT-compression mammography).

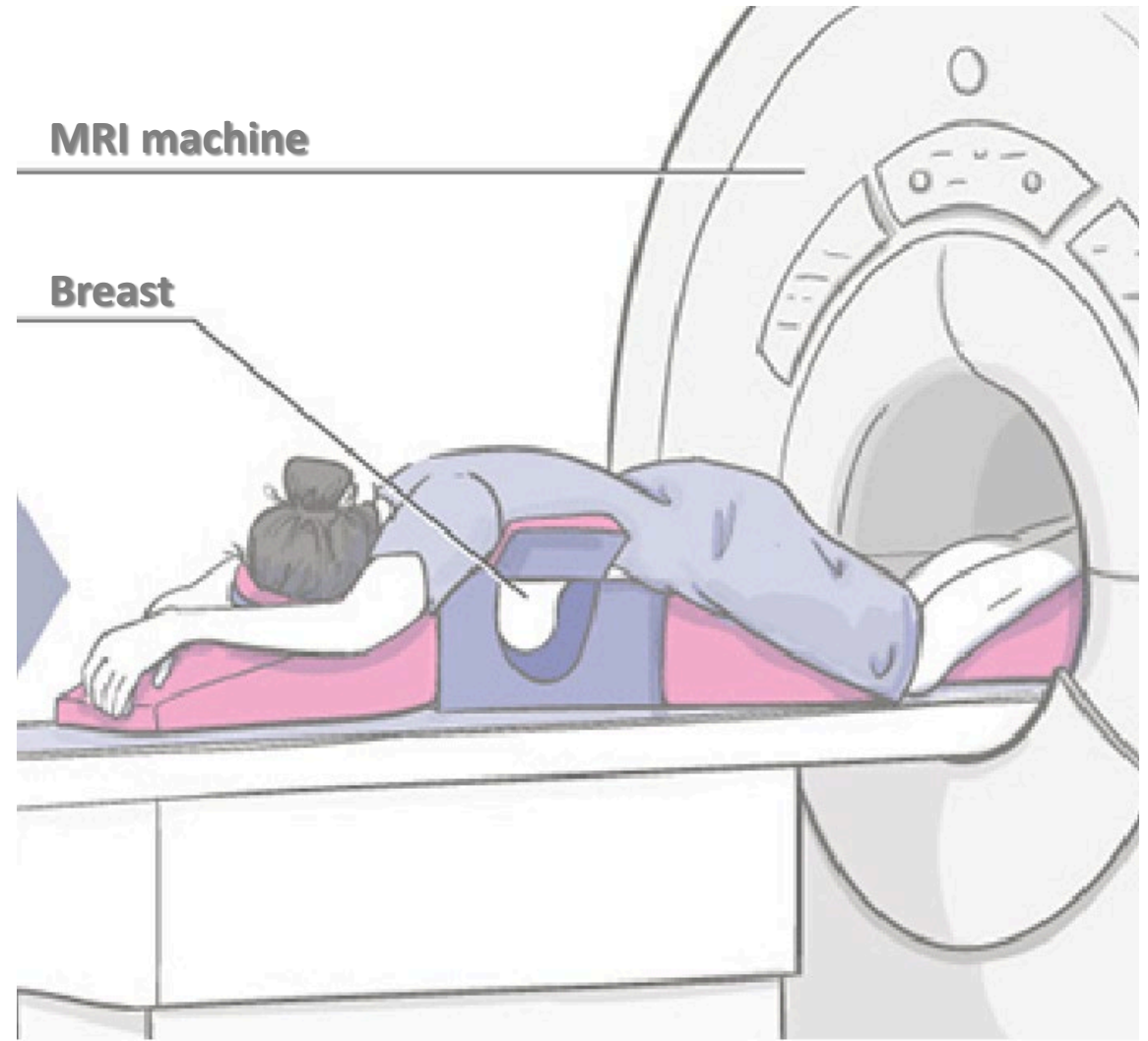
Magnetic Resonance Imaging

Is a complementary method to ultrasound, mammography and ultrasound guided biopsy.

The MRI examination can be performed natively (without contrast agent) or with gadolinium.

In premenopausal women is preferentially performed between days 7-14 of the menstrual cycle and can be whenever performed in postmenopausal women, or during hormone replacement therapy.

Indications: for breast cancer staging - multicentricity/multifocality, evaluation of invasive lobular carcinoma, occult breast cancer, relapse, breast implant.



MRI advantages



non-radiating;



the possibility of storing the
images in an online database.

MRI disadvantages



prolonged time of image acquisition (which is why it is not used in emergencies, like CT examination);



reduced availability in medical centers;



significantly higher costs than CT and ultrasonography.



Pregnancy in the first trimester, allergy to the contrast substance, presence of metallic rods or prostheses, cardiac valve prostheses and claustrophobia represent ***contraindications*** for MRI examination.

BI RADS SCORE

*Breast Imaging Reporting and
Database System

The BI-RADS code (0-6) allows classification of images detected on mammography, ultrasound or MRI and suggests a therapeutic behavior to be adopted depending on the malignancy risk of the lesion.

- **BI RADS 0 (incomplete):** additional breast imaging is necessary (MM/US) or compared results with older examinations.
- **BI RADS 1 (negative):** no evident signs of cancer were found; it is necessary to continue with routine screenings, according to doctor's advices.
- **BI RADS 2 (benign lesions):** no evident signs of cancer; benign lesions present; it is necessary to continue with routine screenings, according to doctor's advices, also to compare the identified lesions.

- **BI RADS 3 (probably benign lesions):** ~ 2 % probability of breast cancer; follow-up exams will be necessary every six months (or more frequent in case of family/personal history of breast cancer).
- **BI RADS 4 (suspicious lesions):** for certainty diagnosis, a breast biopsy is performed in order to obtain the histopathological report.
- **BI RADS 5 (very high probability of malignancy):** 95 % chance of breast cancer; a breast biopsy is necessary for diagnosis and further decisions need to be established with the doctor.
- **BI RADS 6 (confirmed malignancy):** the patient has already been diagnosed with breast cancer.

Categories of patients examined for screening or for diagnosis:

a. Screening:

- patient without any suggestive signs <40 years: US;
- patient > 40 years: MM +/- US.

Particular features for MM:

- Increased genetic risk (BRCA +);
- AHC +;
- APP +.

b. For diagnostic purposes:

- palpable tumor;
- significant skin changes suggestive for breast cancer (Fig. 3);
- spontaneous nipple secretion;
- clinically suspected axillary adenopathy;
- visceral metastases with unknown starting point;
- unilateral changes, recently made by volume or shape.



Figure 3. Skin changes suggestive for breast cancer.

- **Imaging techniques** (MM+US, +/-MRI)
- **Ultrasound guided breast biopsies** in order to obtain the histopathological report

The diagnostic certainty

Benign breast lesions

1. Breast cyst – is a typically benign lesion.

MM: round-oval opacity, well delimited (Fig. 4).

US: characteristics typical of cysts (transonic content, well delimited, round-oval in shape) (Fig. 5).

MRI: round/oval masses, in iso-/hyposignal T1, hypersignal T2. (Fig. 6 A, B)

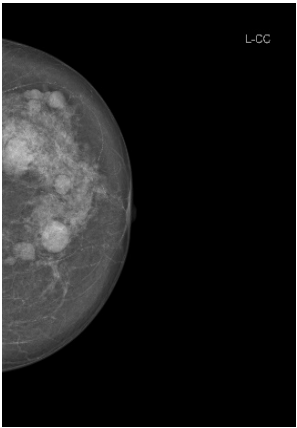


Figure 4. Multiple breast cyst on MM.

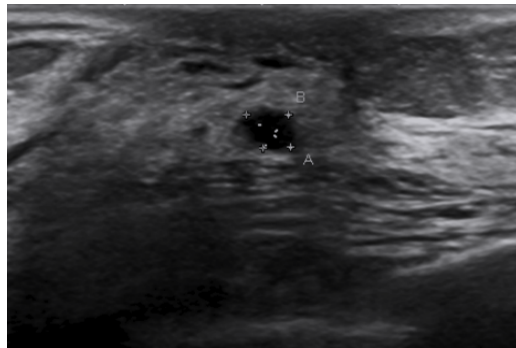


Figure 5. Breast cyst on US.

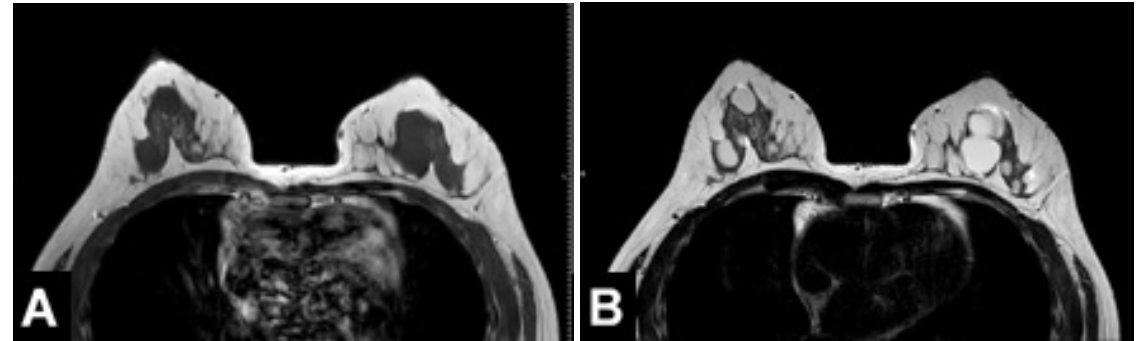


Figure 6 (A, B). Breast cyst on MRI (A –hyposignal T1 and B – hypersignal T2).

Benign breast lesions

2. Breast fibroadenoma (FA) is characterized by a double conjunctival and epithelial proliferation, considered benign, with a risk of malignancy of less than 1%.

MM: hypo-/isodense oval well-circumscribed masses (old fibroadenomas may have calcifications) (Fig. 7).

US: hypoechoic round/oval well-circumscribed masses (Fig. 8).

MRI: round/oval masses iso-/hypointense T1, hypo-/hyperintense T2, with progressively gadolinium enhancement (Fig. 9 A, B)

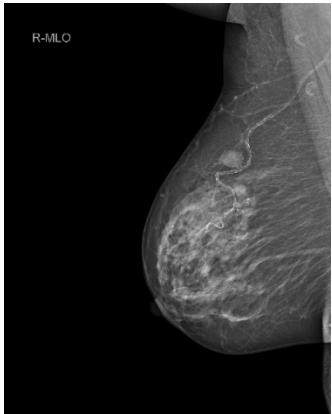


Figure 7. Breast FA on MM.

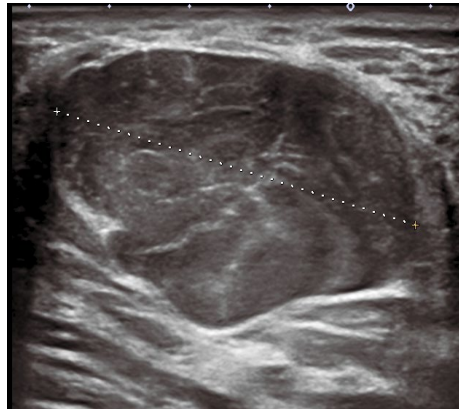


Figure 8. Breast FA on US.

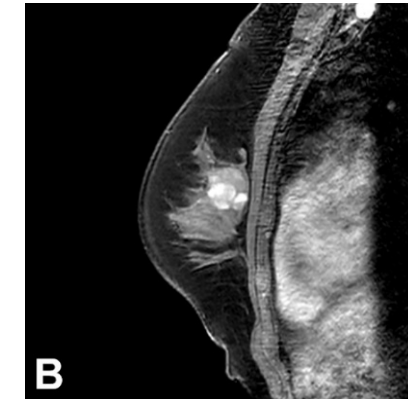
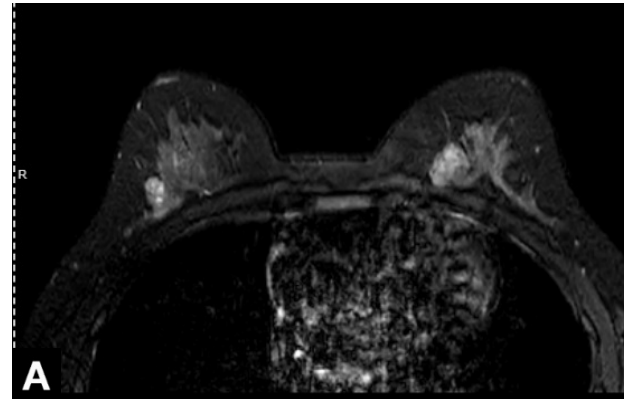


Figure 9 (A, B). Breast FA on MRI – Hypersignal in T2 sequence (A) with benign enhancement (B).

Benign breast lesions

3. Phyllodes tumor represents less than 1% of breast tumors, and the average age at diagnosis is 45-49 years and is characterized by a rapid growth in size ($> 20\%$ in 6 months).

MM: round-oval opacity, net contour (resembling fibroadenoma) with rapid growth (1-45 cm) (Fig. 10).

US: fibroadenoma-like characters (Fig. 11).

MRI: round/oval lobulated mass, in hyposignal T1, hypo-/hypersignal T2 according to tumor grade, with enhancement (Fig. 12 A, B).

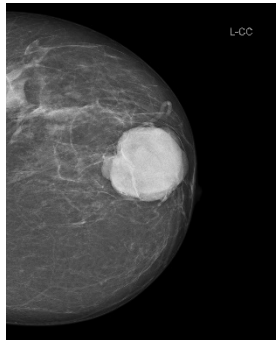


Figure 10. Phyllodes tumor on MM.

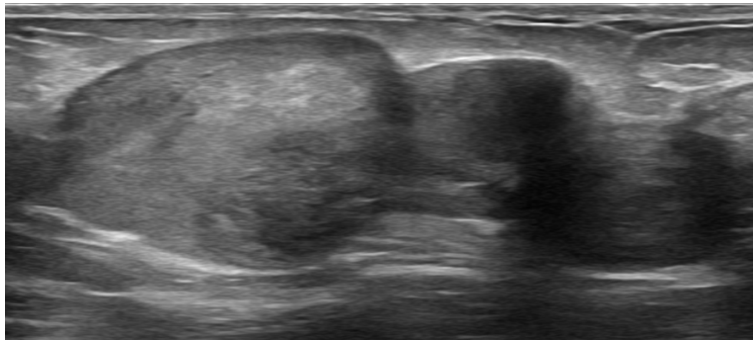


Figure 11. Phyllodes tumor on US.

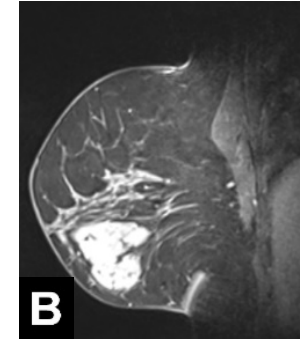
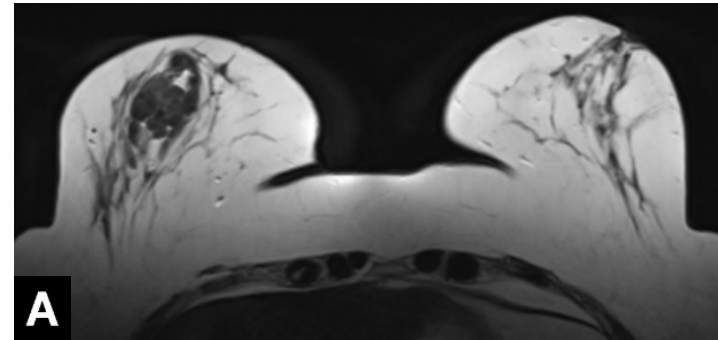


Figure 12 (A, B). Phyllodes tumor on MRI – Hypointense in T2 sequence (A), hyperintense T1 post-gadolinium enhancement (B).

Benign breast lesions

4. Fibrocystic mastitis (FCM) includes all older names: Reclus disease, mastopathies, breast sclerosis. Histologically, many varied lesions can be encountered: cysts, fibrosis, adenosis, lobular hyperplasia etc. It is frequently multiple and bilateral.

MM: the aspect is extremely varied from the absence of mammographic changes to the presence of sharp opacities, with or without microcalcifications included (Fig.13).

US: conglomerate of cystic lesions in an echoic region, corresponding to the palpatory anomaly (Fig. 14).

MRI: conglomerate of cystic lesions, with/without heterogenous adjacent mass, with peripheric inhomogeneous enhancement (Fig.15 A-C).



Figure 13. FCM on MM.

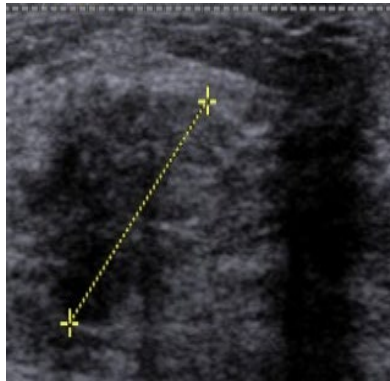


Figure 14. FCM on US.

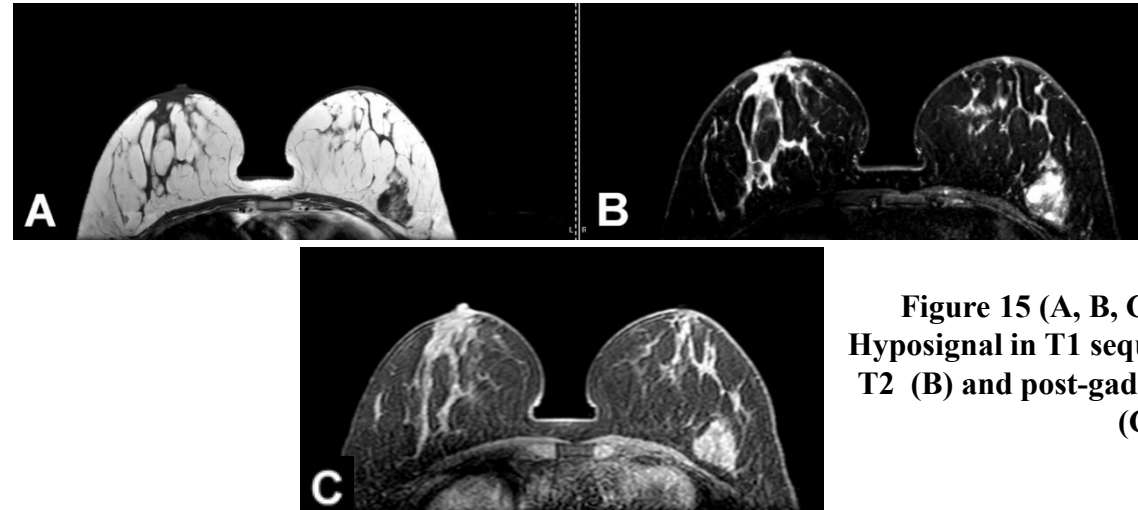


Figure 15 (A, B, C). FCM on MRI – Hyposignal in T1 sequence (A), hypersignal T2 (B) and post-gadolinium enhancement (C).

Benign breast lesions

5. Breast abscess is represented by inflammatory changes in the breast (hyperthermia, pain, redness) and can be caused by bacterial infection, tuberculosis, actinomycosis, syphilis, fungal infections, parasitosis.

MM: asymmetric density, mass or distortion.

US: hypoechoic collection with no vascularity inside and acoustic enhancement due to fluid content (Fig. 16)

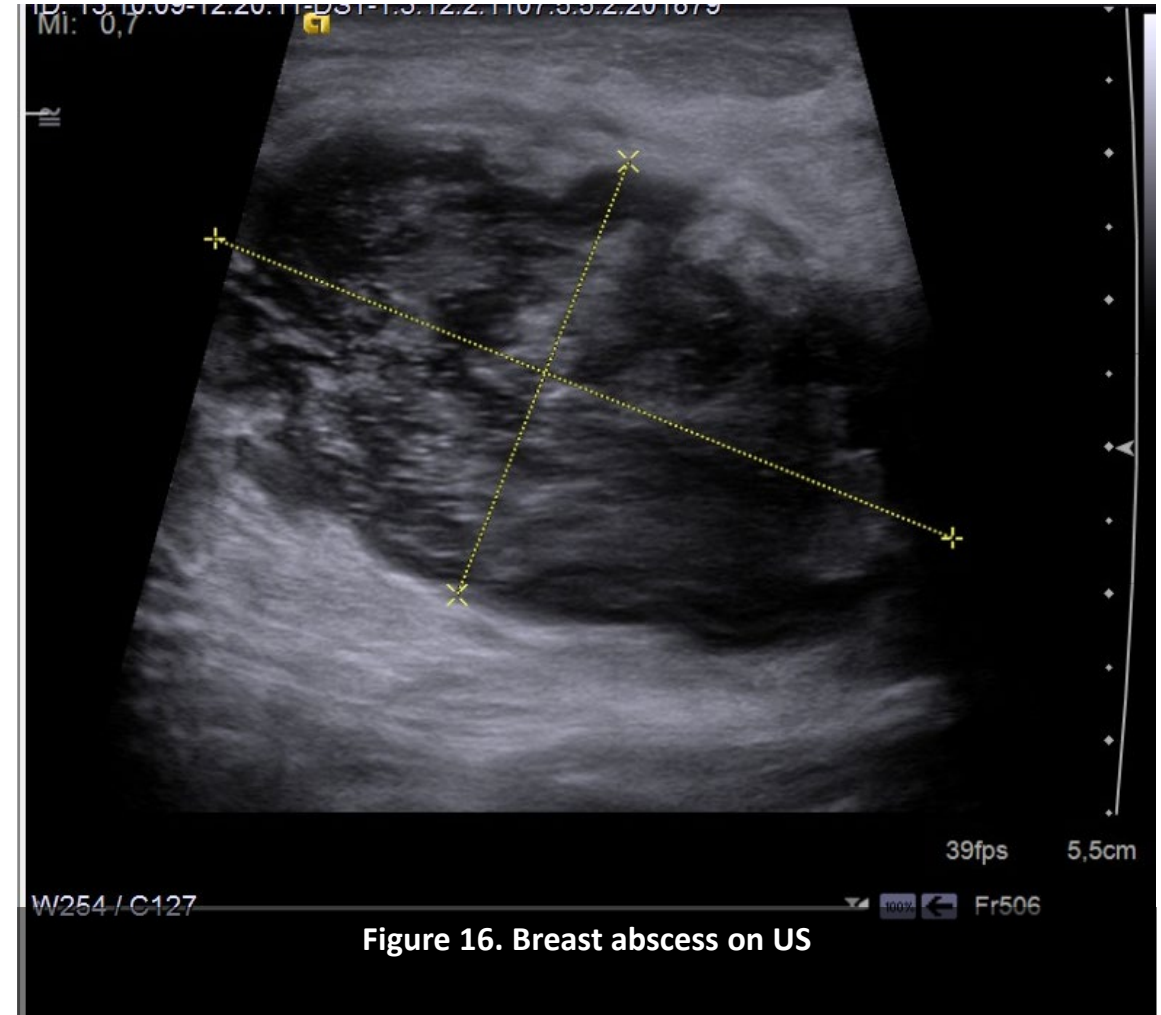


Figure 16. Breast abscess on US

Benign breast lesions

6. Breast papilloma is represented by a small proliferation developed inside a galactophorous duct, which frequently causes bloody nipple discharge;

MM: regular/irregular opacity (Fig. 17).

US: ductal ectasia with an echogenic mass inside (Fig. 18).

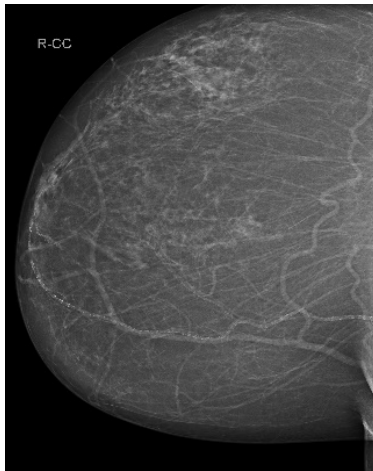


Figure 17. Breast papilloma on MM.

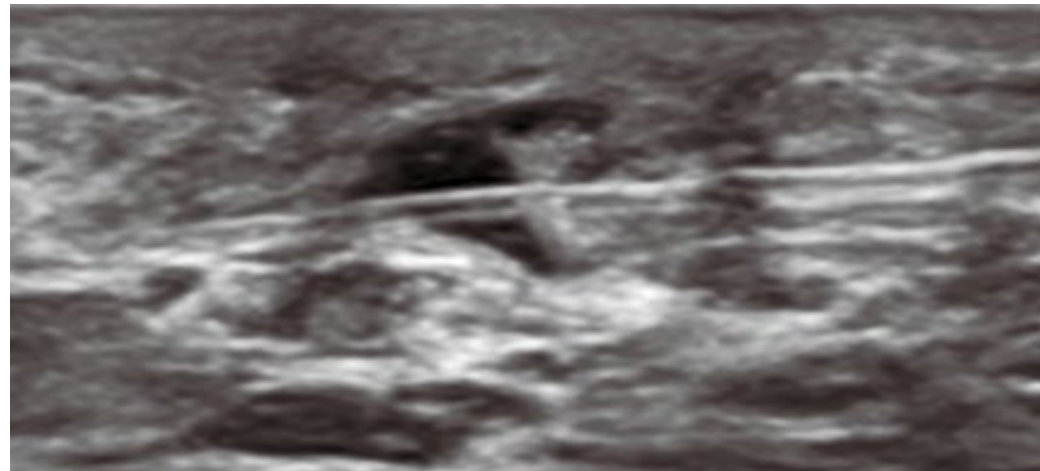


Figure 18. Breast papilloma on US during US-guided breast biopsy.

Benign breast lesions

7. Breast hamartoma can present as a painless soft breast lump.

MM: well-circumscribed, round/oval mass surrounded by a thin capsule (Fig. 19)

US: well-circumscribed lesion with both hypoechoic and hyperechoic components (Fig. 20)

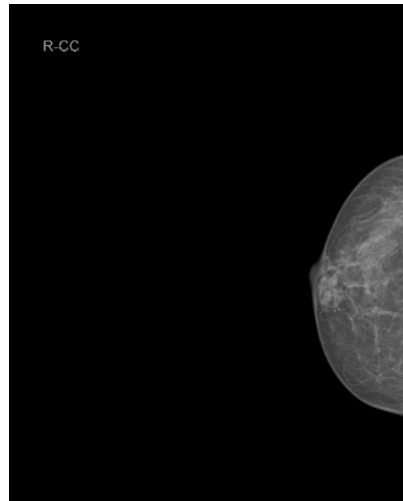


Figure 19. Breast hamartoma on MM

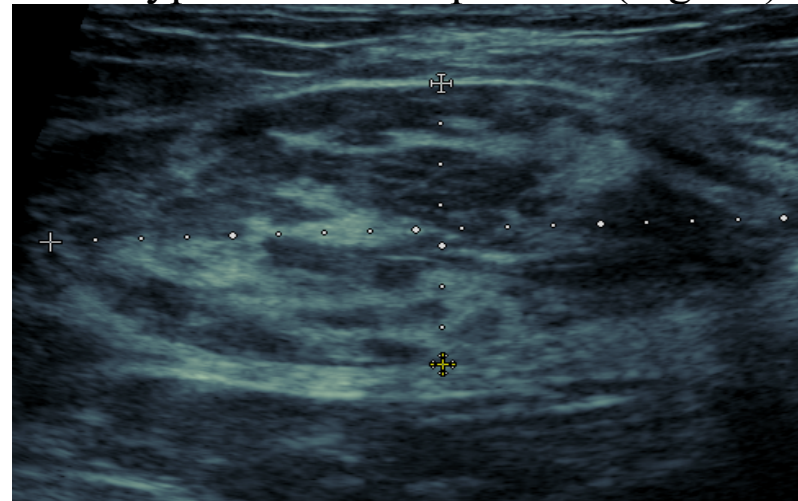


Figure 20. Breast hamartoma on US

Benign breast lesions

8. Ductal ectasia is the abnormal widening of one or more breast ducts. It can be due to benign or malignant processes (Fig. 21).

The ducts may be filled with lipid-containing sediment, frequently producing creamy, serous or bloody discharge; initially they are not associated with pain, but, over time, intermittent mastodynia may occur as the disease spreads to the periphery.

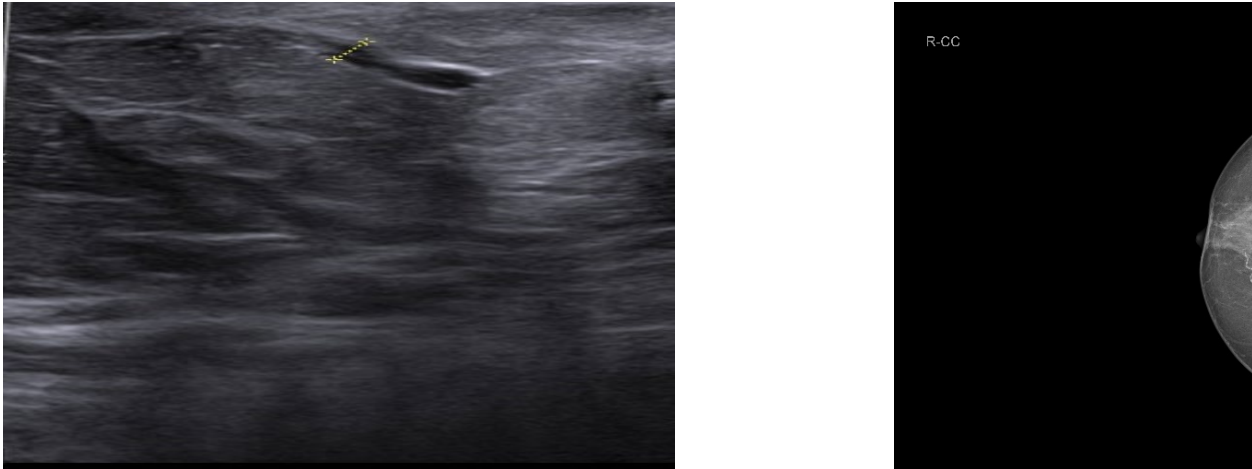


Figure 21. US and MM aspect of ductal ectasia

Benign breast lesions

9. Breast lipoma is mostly asymptomatic, being a benign breast tumor composed of mature adipose tissue.

MM: radiolucent round-oval opacity, with net contour.

US: round/oval lesion iso-/hyperechoic to surrounding fat.

MRI: round/oval mass, well-circumscribed in hypersignal T1 with fat suppression, hypersignal T2, with no enhancement.

Malignant breast lesions

1. Breast ductal carcinoma

Macroscopic: mostly scirrhous tumors = hard tumors (dense fibrotic stroma), stellate margins, irregular, gray-whitish on section with/without white-yellow stripes (elastosis); very rarely: circumscribed and/or soft consistency.

MM: opacity with a dense center, irregular, spiculate +/- microcalcifications (Fig. 22).

US: hypoechoic mass, irregular, imprecisely delimited, inhomogeneous, with calcifications included.

MRI: irregular mass with hyposignal in T1 and T2 sequences, with initial intense enhancement and fast wash-out (Fig. 23). MRI can also identify axillary and internal mammary adenopathy.

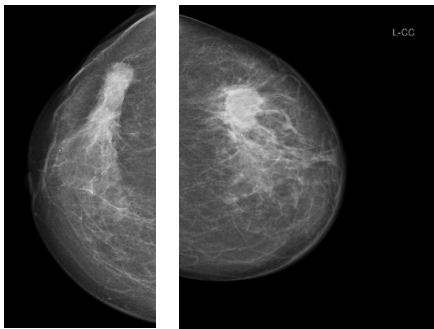


Figure 22. Breast ductal carcinoma on MM

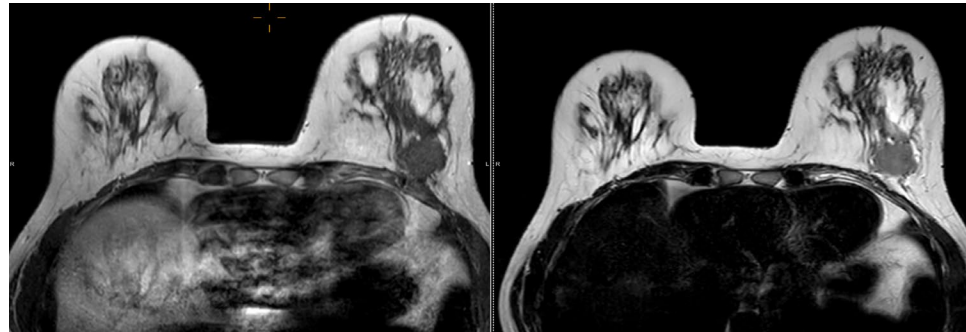


Figure 23. Breast ductal carcinoma on MRI with hyposignal in T1 and T2 sequences

Malignant breast lesions

2. Lobular carcinoma is rare, with the highest incidence around 50 years old.

MM: can be normal and SPOT images can be required (Fig. 24).

US: hypoechoic mass, heterogenous.

MRI: irregular spiculated mass with heterogenous enhancement.

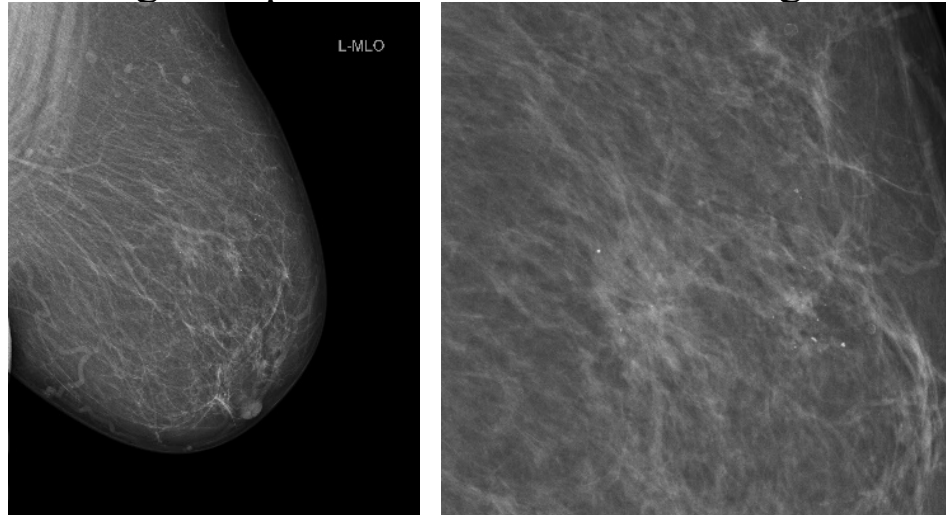


Figure 24. Lobular carcinoma on MM with SPOT image (right)

Malignant breast lesions

3. Medullary carcinoma, colloid (mucinous) carcinoma (Fig. 25), papillary (Fig. 26) and tubular carcinomas are rare breast cancers with unspecific malignant imaging characteristics.

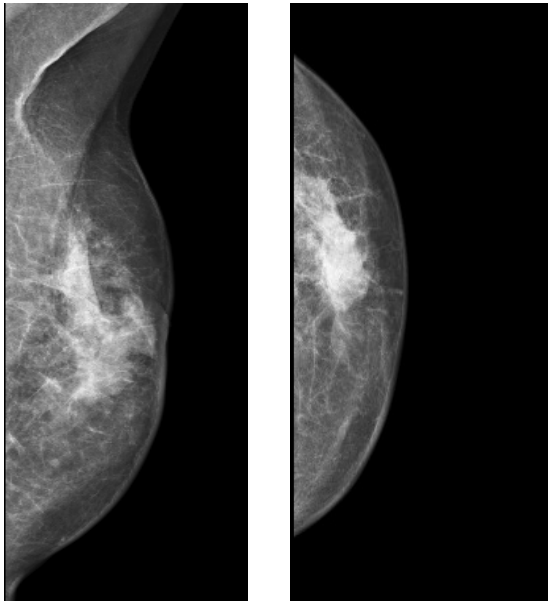


Figure 25. Colloid (mucinous) carcinoma on MM

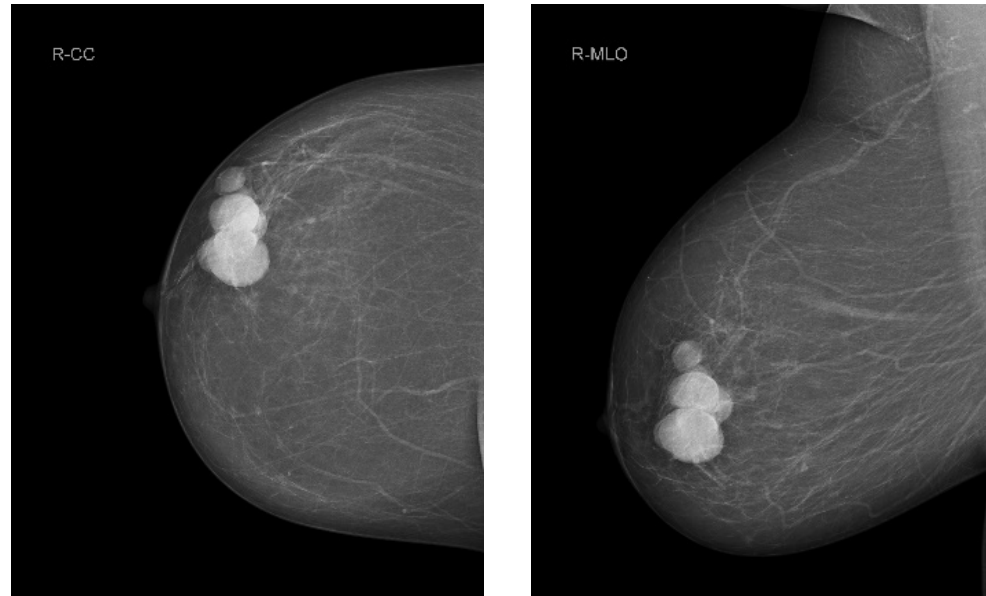


Figure 26. Papillary carcinoma on MM

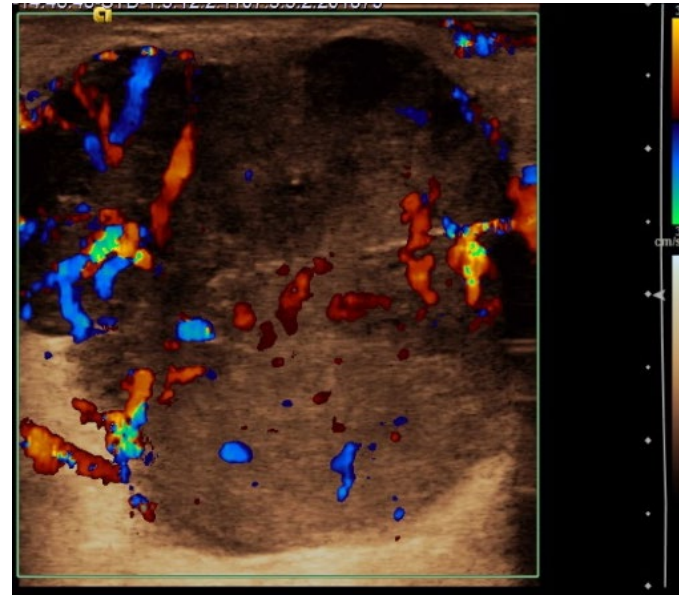
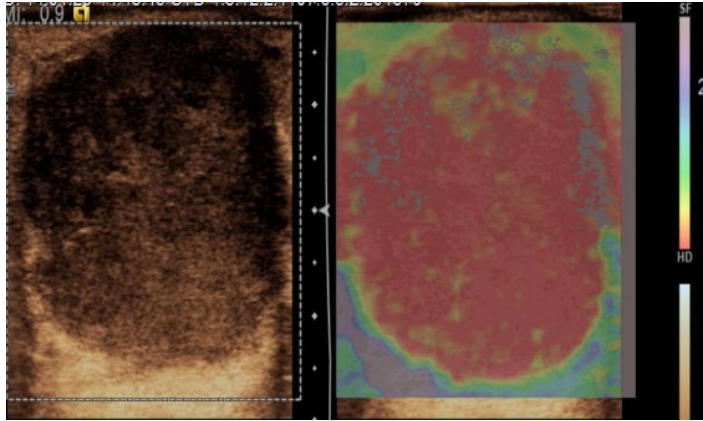


Figure 27. Macroscopic aspect and US aspect of Paget disease



Malignant breast lesions - particular aspects

Paget disease – the characteristic sign is the presence of Paget-type neoplastic cells in the nipple epidermis and is a manifestation of invasive ductal carcinoma.

MM: skin thickening, retracted nipple, with malignant calcifications.

US: hypoechoic masses, heterogenous with the presence of one or more dilated ducts (Fig.27).

MRI: abnormal gadolinium enhancement around the nipple.

Malignant breast lesions – particular aspects

Mastitis carcinomatosa
(**inflammatory carcinoma**) – 1% of breast carcinoma, is represented by erythematous, warm and painful enlarged breast.

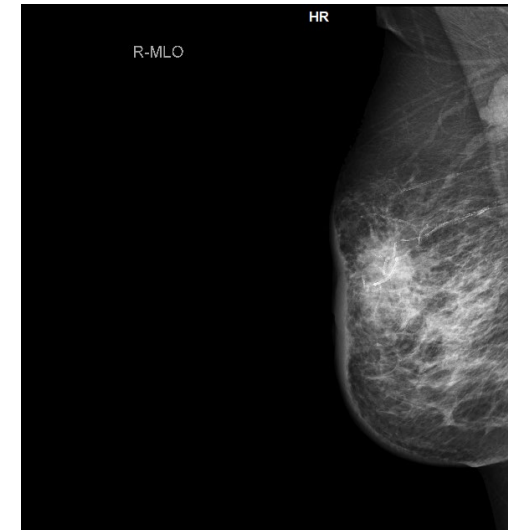
MM: tumor mass with malignant calcifications, skin thickening.

US: skin thickening and hypoechoic masses difficult to identify in breast with high density (Fig. 28).

MRI: multiple masses, with irregular contour, confluent, with internal heterogeneous enhancement.



Figure 28. Macroscopic aspect and MM aspect of inflammatory carcinoma



Malignant breast lesions – particular aspects

Breast sarcoma is a rare type of breast cancer and can be primary or secondary (post-oncological treatment, chronic lymphedema).

MM: large opaque, tumoral mass, well circumscribed (Fig.29).

US: hypoechoic breast mass, heterogenous.

MRI: hyperenhancing lesion and type II curve (initial uptake followed by the plateau phase towards the latter part of the study) with central necrosis (Fig. 30 A-C).

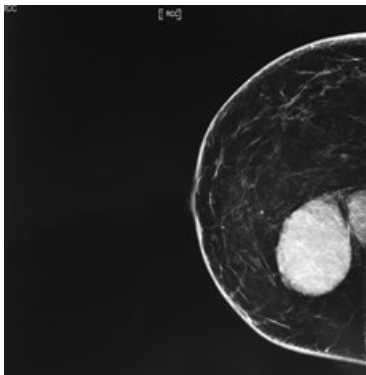


Figure 29. Sarcoma on MM

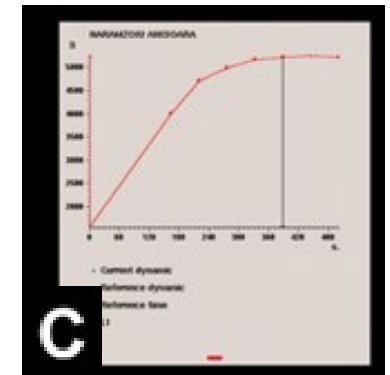
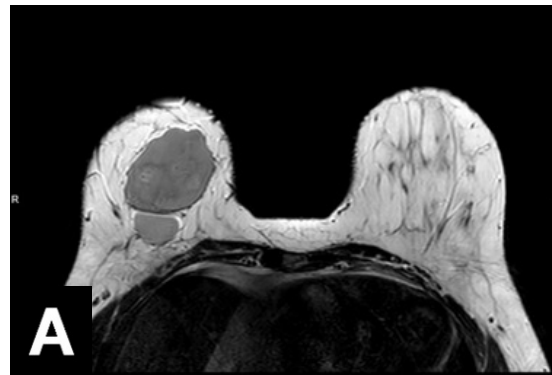


Figure 30. Breast sarcoma on MRI with hyposignal in T2 (A), hyperenhancing lesion (B) and type II curve (C).

Breast Pathology In Men

1. Gynecomastia represents a benign excess of male breast tissue, frequently bilateral, presenting as a tender, mobile, disk-like tissue mass (Fig. 31 A-C).

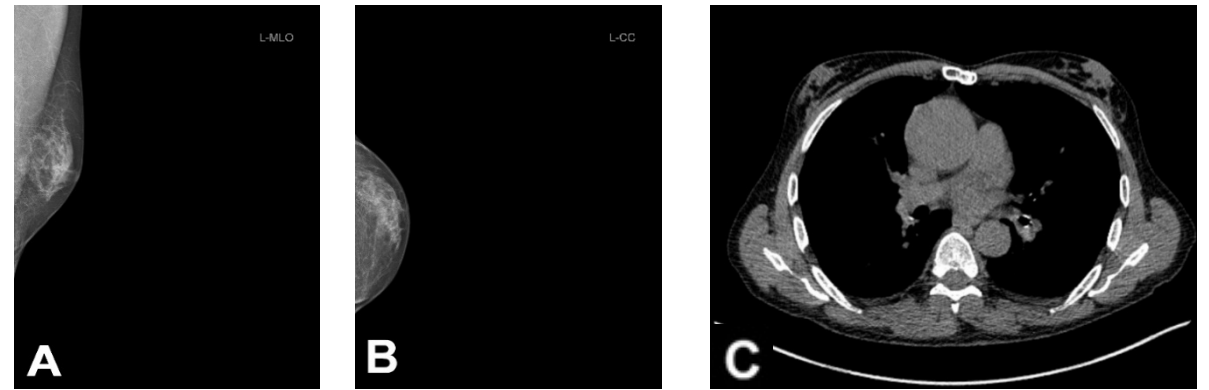


Figure 31. Gynecomastia on MM image (A, B) and CT image in a male known with cirrhosis (C).

Breast Pathology In Men

2. Breast cancer is rarely represented in males (<1%) and is diagnosed in later stages, than in women. The most frequent type is represented by ductal carcinoma.

Clinic: nipple retraction, hard mass, with no pain (Fig. 32)

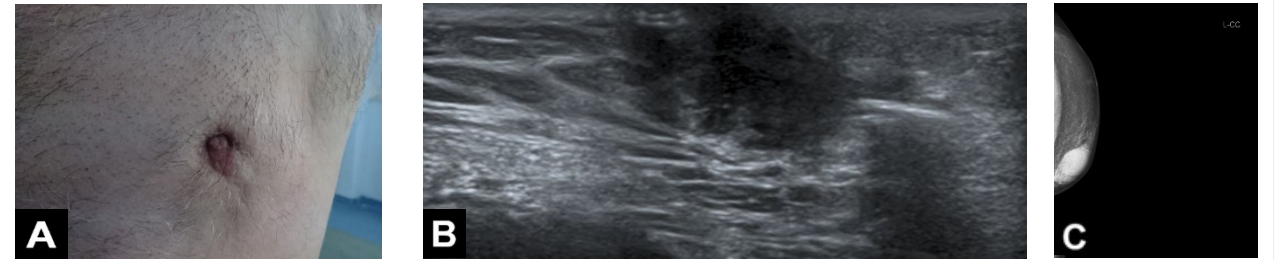


Figure 32. Ductal carcinoma in male – macroscopic image (A), US (B) and MM image (C).