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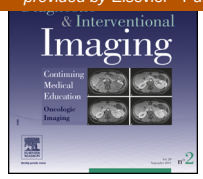

CONTINUING EDUCATION PROGRAM: FOCUS...

Standardized diagnosis and reporting of breast cancer

I. Thomassin-Naggara[a,b,c,*], A. Tardivon[d], J. Chopier[b]

[a] *Sorbonne Universités, UPMC Université Paris 06, IUC, 4, place Jussieu, 75005 Paris, France*
[b] *Équipe 2, UMR970, INSERM, Imagerie de l'angiogenèse, 75005 Paris, France*
[c] *Service de radiologie, Hôpital Tenon, AP—HP, 4, rue de la Chine, 75020 Paris, France*
[d] *Institut Curie, 26, rue d'Ulm, 75005 Paris, France*

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MRI

Abstract Standardized terminology developed by the American College of Radiography (ACR) through the Breast-Imaging Reporting and Data System (BI-RADS) lexicon is used worldwide to describe the findings of the various breast-imaging techniques (mammography, ultrasound, and magnetic resonance imaging (MRI)). A 7-level positive predictive value (PPV) of malignancy classification system (from BI-RADS category 0 to category 6) has been based on this terminology, giving imaging a central role in the diagnostic strategy. This document presents the standardized, compulsory BI-RADS terminology used in breast-imaging reports in 2013 in view of the new edition that will be published at the end of the year.

Mammography

Mammography is the gold standard screening examination, and the first diagnostic examination in a breast-imaging work-up. Standard mammography comprises bilateral craniocaudal and 45° mediolateral oblique views. The breast-imaging report includes:

Clinical context

The following clinical information must be included: patient's age, hormonal status (pre- or post-menopausal, hormone replacement therapy), personal and family history of breast and ovarian disease, and previous surgical history.

* Corresponding author. Service de radiologie, 4, rue de la Chine, 75020 Paris, France.
E-mail address: isabellethomassin@gmail.com (I. Thomassin-Naggara).

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The result of the clinical examination should appear in this paragraph and the availability of previous mammographies for comparison (specifying the dates).

Technique

The type of mammograph used to perform the examination should be recorded and the date in which it was brought into service. It is also important to record the mean glandular dose (MGD) and the number of exposures/breast, especially if the MGD values do not appear on the films (in this situation, enter the value of the MGD obtained at the last six-monthly quality control). If a technical problem is encountered, for example a particular morphology that limits correct positioning, it is also advisable to record it here.

Results

Breast composition

The composition of the breast is scored from 1 to 4 as a function of the percentage of breast glandular tissue in the breast.

- type 1: the breast is almost entirely fatty;
- type 2: there are scattered areas of fibroglandular density;
- type 3: the breasts are heterogeneously dense, which may obscure small masses;
- type 4: the breasts are extremely dense (homogeneously dense).

Description of the main anomalies

Four semiological entities are described in the BI-RADS terminology: masses, asymmetries, architectural distortion, and calcifications. The anatomical location (quadrant, distance from the nipple, and depth) and size must be reported for each entity described. It is also essential, where previous mammograms are available, to assess the development (onset, progression, stability, modification, or regression).

Mass

A mass is defined as a space-occupying lesion that is visible on two different views. If a potential mass is only seen on one view, it should be reported as an ''asymmetry'' until its three-dimensional character is confirmed.

Masses are characterized according to three criteria: shape, margin, and density. Therefore, spot compression views are essential to better assess the margin of masses because this criterion has the greatest positive predictive value for malignancy. When the mass is located in fatty tissue, or if there is a doubt over the presence of associated calcifications, magnification views are useful (increase in spatial resolution). An additional mediolateral view can help to define the exact localisation of the anomaly.

The descriptive criteria that should be used to describe a mass are presented in decreasing order of PPV for malignancy.

- shape: oval (including macrolobulations), round, microlobular, and irregular;
- margin: circumscribed or non-circumscribed (indistinct, obscured, or spiculated);
- density: defined in comparison with the gland, the lesion can be described as hypodense, isodense, or hyperdense. Classically, malignant lesions are hyperdense in comparison with the gland, but this sign has a low PPV for malignancy.

Fatty or completely calcified masses are classified as ACR2 (benign). Other masses should be examined with ultrasound to determine their final BI-RADS classification.

Asymmetries

These densities have a similar shape on both views, but without the margin and sharpness of a true mass. Their ''asymmetrical'' nature implies that the films have been read side by side as mirror images, revealing differences between the right and left sides. Three elements should be assessed to confirm the presence of a true asymmetry: is it a projection of a lesion that is outside the breast? Is it a superimposition image? Is the other view technically correct? Mediolateral and spot compression views are therefore required.

Correlation with the clinical examination is crucial and mainly the palpable character of the abnormality. In decreasing order of importance, the imaging features are as follows: development, presence of associated signs (calcifications, architectural distortion), analysis of the margin, type of asymmetry, and the presence of a density gradient.

The descriptive criteria for asymmetries are as follows:

- development: new, developing, or stable;
- associated features: architectural distortion or calcifications;
- margin: a convex margin has a poorer prognosis than a concave one described, often as ''geographical'';
- type: global (> 1 quadrant), focal (< 1 quadrant);
- density gradient: the presence of a fatty component is a reassuring element.

In summary, any asymmetry must be examined with ultrasound, and the BI-RADS category revised if positive. Asymmetries present an overall risk of malignancy of 1.8%. In the case of associated distortion, the abnormality is classified as BI-RADS category 5. A developing asymmetry has a PPV for malignancy of 13-27% and is therefore given an ACR score of 4a or 4b depending on the analysis of the margin. In the absence of ultrasound abnormality, a focal asymmetry without any other negative criteria is classified as BI-RADS category 3. An overall non-palpable asymmetry has a PPV for malignancy of 0% and is given a BI-RADS category 2 in the absence of associated findings. In the event of a palpable mass, the PPV for malignancy is 15% and the anomaly is classed as BI-RADS category 4b.

Architectural distortion

A proven distortion is visible on two views. If this distortion is only visible on one view, the first step is to rule out a superimposition image and the second step is to analyze the clinical context to rule out scarring linked to a previous trauma or surgery, usually related to a cytosteatonecrosis.

It is important to confirm the distortion with a spot compression view. Breast tomosynthesis will certainly become more important in the future for the deconstruction

Table 1 Summary of the analysis of microcalcifications.

Distribution morphology	Diffuse and bilateral	Focal or regional apparent	Ductal, segmental or with K associated
Round or punctiform	ACR 2	ACR 3	ACR 4A
Coarse or heterogeneous	ACR 4A	ACR 4 C	
Amorphous	ACR 2	ACR 4A	ACR 4 C
Fine and polymorphous	ACR 4A	ACR 4B	ACR 4 C
Line, linear, or branching	ACR 4 C	ACR 5	

of superposition images, which are a source of false positives.

Distortions with a denser center have a poorer prognosis than those with a radiolucent centre. The size and shape of spicules should be described: suspicious spicules are thick and short, compared to long and thin spicules.

Any proven architectural distortion is classified as at least BI-RADS category 4.

Clusters of calcifications

- this is defined as the presence of at least five calcifications measuring less than 1 mm over an area of less than 1 cm^2. It is important to check that they are indeed microcalcifications and not macrocalcifications (vascular, scar tissue, parietal, benign galactophoric, or sedimentary) [1];
- it is a focal lesion and not scattered calcifications;
- the cluster is indeed intramammary (verification by triangulation — take a lateral view then align according to AP — Oblique — Lateral).

Firstly, check whether the cluster of calcifications is associated with a mass, an asymmetrical density, or an architectural distortion, which will have a major impact on the BI-RADS classification of the cluster of calcifications. Next, by order of importance, analyze the spatial distribution of the calcifications. Thirdly, determine the morphology and density of the calcifications. Fourthly, determine the homogeneity of the shape and density of the calcifications. Fifthly, count the number of calcifications, and lastly, establish their progression over time (comparison with previous mammograms if available) [2—4].

Distribution of microcalcifications: segmental, linear, grouped, regional, and diffuse or scattered (decreasing order of PPV for malignancy).

Morphology and density:

- high risk of malignancy (fine pleomorphic, and/or fine linear branching calcifications), intermediate risk of malignancy (large and heterogeneous calcifications, amorphous or scattered calcifications), low risk of malignancy (amorphous calcifications in round clumps);
- homogeneity of calcifications: analysis of the pleomorphic character of the calcifications (negative value if present);
- number of calcifications: if the morphology is reassuring, the presence of more than 10 calcifications/cm^2 is a negative criterion;
- development over time: similarly, this criterion is only considered if the morphology is reassuring and is negative if developing. Ideally, this analysis should be performed with a minimum of two years follow-up.

Table 1 summarizes the classification of calcifications as a function of the two main criteria: their distribution and morphology. The benign categories should be considered in light of the number of calcifications and their development over time [5—7].

Breast ultrasound

Clinical context

The indications for breast ultrasound include: the presence of a clinical abnormality, an abnormal mammography, type 3 and 4 breast densities and certain breasts with a type 2 density with a retro-areolar glandular area. The indication for ultrasound examination can be specified at the beginning of the paragraph.

Technique

The type of machine used should be recorded in the report (with the publication of the new BI-RADS terminology, the use of elastography should probably be mentioned). According to the recommendations of the French National Cancer Institute (INCa) (2012), all breast ultrasound examinations for breast cancer (BI-RADS category 5 or 6) should include an exploration of the axilla during the same session.

Results

Tissue composition

The homogeneity and composition of the tissue should be assessed as this will affect the diagnostic performance of the examination. The breast may be homogeneous and purely fatty, composed of homogeneous hypoechoic lobules, separated by Cooper's ligaments, or homogeneous and glandular with a thin layer of subcutaneous fat. The breast can also be heterogeneous with multiple hypoechoic zones, which makes the detection of hypoechoic nodules more difficult.

Description of abnormalities

Masses

When a nodule is detected in one axis, it is important to confirm its presence along a perpendicular axis. Furthermore, the morphological analysis and measurement should be performed in two perpendicular planes.

The analysis should give a detailed description of the shape, margin, orientation with respect to the skin, the

echostructure with respect to the subcutaneous fat, and posterior features (enhancement, posterior attenuation).

The descriptive criteria are as follows:

- shape: by decreasing order of PPV for malignancy: irregular, round, oval;
- orientation: perpendicular to the skin interrupting the normal architecture of the gland is predictive of malignancy;
- margin: circumscribed (usually benign), or not circumscribed (such as hyperechoic halo, indistinct, angular, spiculated, and microlobulated);
- echo pattern: anechoic, hyperechoic (usually benign), or hypoechoic;
- posterior attenuation of the ultrasound beam: negative sign if present;
- elasticity: hard lesions present a higher PPV for malignancy. The descriptive criteria are defined in the new BI-RADS terminology.

Ultrasonographic non-mass

Calcifications can be seen and should therefore be described. This group also includes echoic galactophoric ectasias, or hyperechoic zones of echostructural alteration with no individually distinct nodules.

Surrounding tissues

Examination of the surrounding tissue should include a description of any echostructural distortions, duct ectasia, skin retraction, edema, and/or hypervascularization, which are all negative elements.

Special cases

Typical ultrasound images that should be recognized and accurately described include:

- intramammary lymph nodes: hypoechoic circumscribed small oval or reniform mass with echogenic hilum;
- clustered microcysts: cluster of tiny anechoic foci, 1—7 mm with thin intervening septae without any solid component (usually located in the superolateral quadrant);
- intra-galactophoric mass: echoic nodule located in a duct ectasia; Doppler analysis is useful for assessing the presence of Doppler;
- cutaneous or dermal mass: space-occupying nodule in the subcutaneous tissue;
- treated breast: echostructural disorganization with a post-surgical scar. Check that this scar remains thin and regular by exerting moderate pressure on the probe to spread the tissues.

Summary

The following are classified as ACR 2: anechoic lesions (cysts), intramammary lymph nodes, cutaneous or dermal masses, and hyperechoic nodules without negative signs.

The following are classified as ACR 3: hypoechoic nodules, with the largest axis in the horizontal plane, homogeneous, oval, with regular margins, without posterior shadowing, and clustered of microcysts.

The following are classified as ACR 4 or 5: all other masses.

Breast MRI

Breast MRI is a second-line technique performed in combination with mammography and breast ultrasonography. The indications for breast MRI are multiple and include screening of women with a high risk of breast and ovarian cancer and the locoregional extension profile of breast cancer in certain specific situations (under 40 years old, neoadjuvant chemotherapy, radio-clinical discordance, oncoplastic decision-making, invasive lobular cancer). The breast MRI report should include the clinical context, technique, and results.

Clinical context

This should include the following information, which is essential for interpretation: patient's age, menopausal status (hormone replacement therapy or not), period of the menstrual cycle, previous personal history of breast or ovarian pathology, surgical history (specify the site of the scar), previous family history of breast or ovarian cancer. Data from conventional mammography and ultrasound imaging, and the results of any previous breast MRIs are essential.

Technique

It is important to specify in this paragraph, which sequences were acquired and what post-treatments were performed (Appendix A).

Results

Background parenchymal enhancement should be scored from 1 to 4 to give the clinician a notion of quality of interpretation. For each abnormality detected, it is important to specify the exact location: laterality, quadrant and clock face, distance from the nipple. It is very useful to indicate the number of the slice on which the lesion was detected, notably with a view to a second intention targeted ultrasound examination.

There are three types of breast MRI uptake anomalies: masses, non-mass enhancement, and focus.

Mass

This is a space-occupying volume (convex contours in the three spatial planes).

A mass is characterized according to its shape, margin, internal enhancement characteristics, and its kinetic curve assessment.

The descriptive criteria of a mass, in increasing order of PPV for malignancy are as follows:

- shape: round, oval, lobular, or irregular;
- margins: smooth, irregular, spiculated;
- internal enhancement patterns: homogeneous, heterogeneous, annular, central. The existence of internal septations that are not enhanced after injection should also be described as these are indicative of a benign mass;

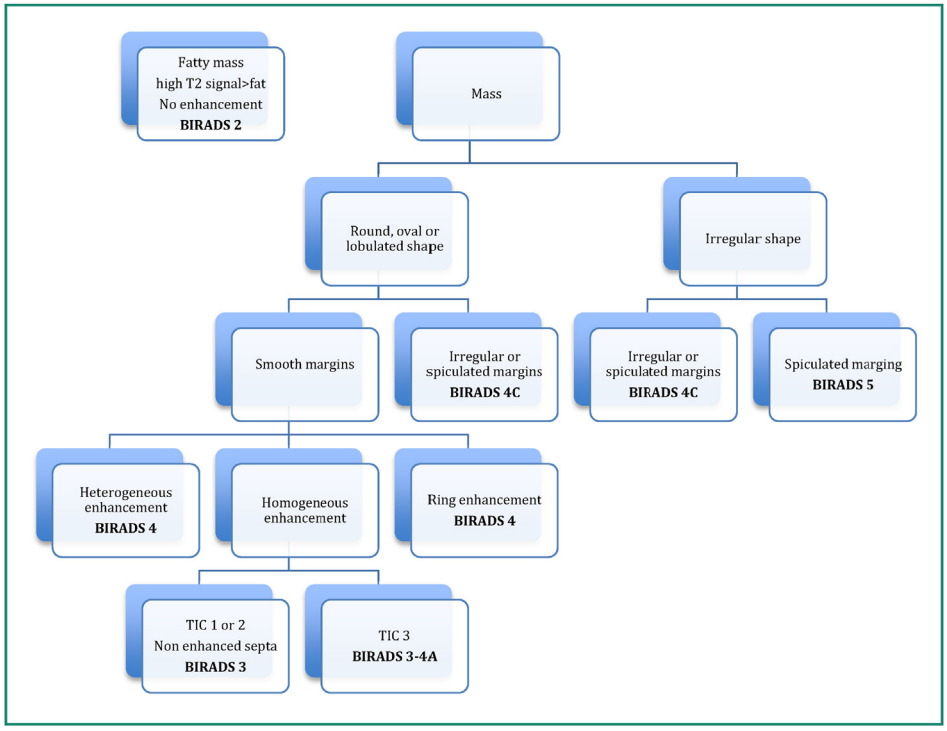


Figure 1. Report of a mammary MRI [8] in a patient with a low risk of breast cancer.

- kinetic enhancement curve: there are three types of curve: type 1 (slow and progressive), type 2 (medium with a plateau), and type 3 (fast, early with secondary washout). The analysis of these curves provides useful information in cases with a benign morphology.

The combination of the various criteria and the resulting classification in patients who do not have a high risk of breast cancer is presented in Fig. 1 [8].

Non-mass enhancement

Non-mass enhancement (NME) is the enhancement of a zone that is not a mass or a vascular structure, and which measures more than 5 mm. By definition, it is a process that is not space-occupying and which cannot be seen on non-enhanced sequences.

Non-mass enhancement is characterized by its spatial distribution and internal enhancement patterns. A major element in the description is the symmetrical or asymmetrical character of the NME and the detection of associated signs.

Descriptive criteria

Distribution: focal, linear, segmental, regional, multiple regions, diffuse.

Internal enhancement patterns: homogeneous, heterogeneous, stippled, clumped, reticular (dendritic).

Symmetry: the symmetrical character of a non-mass enhancement is suspected except in the event of contra-lateral radiotherapy (fibrosis and post-therapeutic hypovascularization).

Associated features: nipple abnormalities (retraction, invasion), spontaneous high T1 signal of ducts, focal or diffuse thickening of the skin, skin invasion, edema, lymph node enlargement, pectoral invasion, hematoma, cysts.

In summary, the reliability and reproducibility of the various descriptive criteria of NME make the inclusion of the conventional report an important component in the diagnostic work-up. The diagnostic tree in Fig. 2 summarizes the diagnostic reasoning for a non-mass enhancement [9].

Focus

Definition

Homogeneous enhancement of less than 5 mm that is not a mass.

Characterization and descriptive criteria

Three important notions to consider: single or multiple, the type of enhancement curve, and the notion of a high risk for breast or ovarian cancer.

Summary

Multiple and bilateral foci are classified as ACR 2 (even in high-risk cases). The discovery of an isolated focus should prompt an ultrasound examination to eliminate the presence of a mass. If no mass is found on ultrasound and with a type 1 or 2 curve, the enhancement is classified as ACR 3. If the curve is type 3, an MRI guided biopsy is an option.

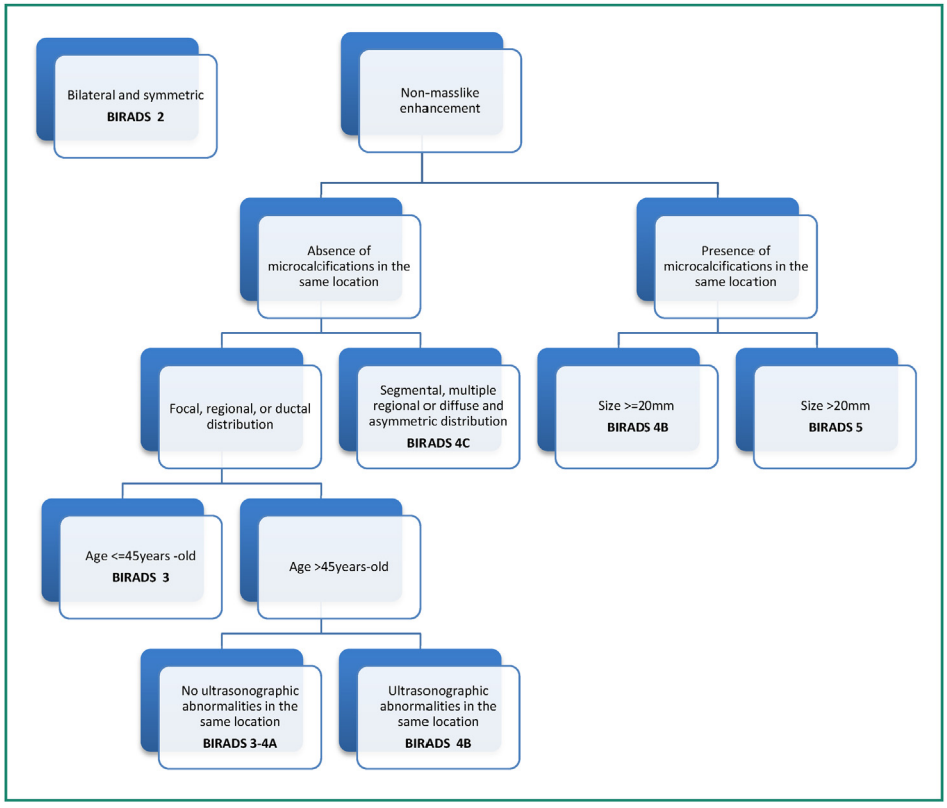


Figure 2. Report of a non-mass enhancement [9] in a patient with a low risk of breast cancer.

Conclusion

The various essential elements that should be included in an imaging report are presented in the appendix. A good interpretation should include the various imaging techniques and summarize the diagnostic strategy for the clinician.

TAKE-HOME MESSAGES

Good interpretation in imaging should:
- respect the descriptive guidelines of the BI-RADS terminology;
- include the various imaging techniques;
- summarize the diagnostic strategy for the clinician;

Case report

Questions

1. Which elements should be included in a mammography report?
   A. Tumor size
   B. The presence of an opacity
   C. The existence of an asymmetrical density
   D. Breast composition
   E. The mean glandular dose
2. Which elements should be included in a breast MRI report?
   A. Physiological glandular enhancement
   B. Breast density
   C. The number of the slice on which an anomaly is detected
   D. The ACR classification
   E. The diagnostic strategy for each of the abnormalities detected

Answers

1. Answers: A, C, D, E
2. Answers: A, B, C, D, E

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Appendix A.

REPORT: BREAST CANCER

ISABELLE THOMASSIN-NAGGARA
pour le comité scientifique de la SIFEM

Clinical information: age, hormone status, day of the cycle, personal or family history of breast or ovarian cancer, hormone treatment, clinical examination.
Comparison to previous examinations (technique, date)

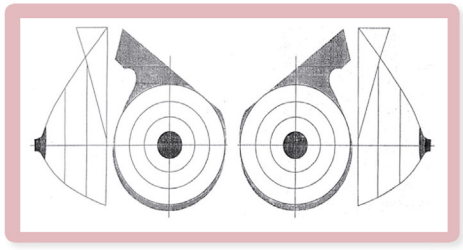
BREAST

Breast composition (from 1 to 4)

PRINCIPAL LESION

Description:
(mass or non-mass, asymmetry, architectural distortion, calcifications, hypoechoic areas)

- ✓ **Laterality:** Right / Left
- ✓ **Two perpendicular diameters:** .... mm
- ✓ **T1 20 mm < T2 50 mm** (largest diameter)
- ✓ **Location:**
  - Clock face
  - Distance from the nipple: .... cm
  - Breast quadrant (anterior, middle, posterior)
- ✓ **Margins:**
  - Irregular / speculated / smooth
- ✓ **Associated features:**
  - Intrinsic or associated calcifications
  - Duct ectasia
- ✓ **ACR– BIRADS classification**



LYMPH NODE ENLARGEMENTS (N1)

(loss of the fatty hilus, focal or diffuse cortical thickening)

- ✓ Homolateral or contralateral
- ✓ Location:
  - Group I (axillary)
  - Group II (central axillary)
  - Group III (subclavicular)
  - Intramammary

EXTRATHORACIC PATHOLOGY* (M1)

- ✓ Liver: Yes / No / Suspicious
- ✓ Bone: Yes / No / Suspicious

* Visible on clinical examinations

ADJACENT STRUCTURES

- ✓ **Skin:**
  Skin retraction
  Skin invasion
  Skin invasion (inflammation)
- ✓ **Nipple:**
  Change in the nipple
- ✓ **Pectoral:**
  Invasion over a distance of ....cm
- ✓ **Thoracic wall:**
  Intercostal muscles, ribs, soft tissues

OTHER LESIONS

- ✓ **Homolateral:** Yes / No
  - Single/multiple
  - Location:
  - Description: largest diameters
  - Inter-lesional distance and maximal external distance
  - Maximal composite distance

(sum of largest diameters of all of the lesions)

- ✓ **Contralateral:** Yes / No

If yes, location, largest diameter

- ✓ **ACR – BIRADS classification**

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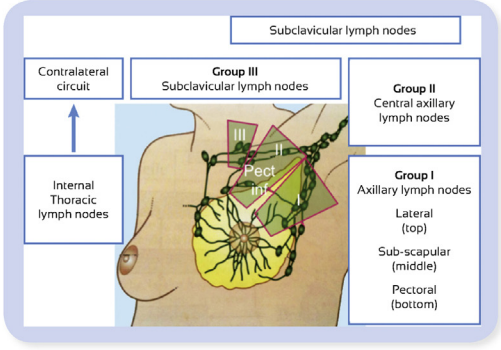

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SUMMARY AND CONCLUSION:

Right breast: unifocal / multiple lesion(s), measured at .... BIRADS-ACR class ....
Left breast: unifocal / multiple lesion(s), measured at ... BIRADS-ACR class ....
Action to be taken in terms of monitoring and percutaneous biopsies

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