Review the applicability of advanced techniques of breast MRI in the evaluation of suspicious lesions evidenced by conventional imaging methods.

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**Authors:** C. A. P. Fontes$^1$, A. A. S. M. D. Santos$^1$, S. Kelmer$^2$, R. S. VASCONCELLOS$^1$, V. C. Menezes$^1$, $^1$Niterói - Rio de Janeiro, RJ/BR, $^2$Rio de Janeiro/BR  
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Learning objectives

• To review the current and advanced techniques for breast MRI, the main sequences and post-contrast kinetic study, especially in lesions with mammography or ultrasound failed to characterize the malignancy.
• Describe the advantages of the methods compared with conventional studies.
Background

- Breast cancer is the most common malignancy in women, and there are limitations in differentiating benign-looking malignant breast lesions from truly benign breast lesions, especially when using conventional imaging modalities such as mammography and ultrasonography.
- Screening mammography potentiates the detection of early, clinically occult cancers. Additional workup, including diagnostic mammography and/or US, may be required to differentiate suspicious findings, such as masses and asymmetries/focal asymmetries, from normal breast tissue.
- However, not all breast cancers manifest a malignant appearance. Although a vast majority of all well-circumscribed breast masses are benign lesions, 10%-20% of breast malignancies are also well-circumscribed masses, and these malignant masses include papillary, mucinous, medullary, and metastatic carcinomas, as well as malignant phyllodes tumors. Generally, such lesions may be difficult to recognize as malignant if they possess a benign appearance such as a well-circumscribed margin or oval shape.
- Because it is sometimes not easy to differentiate between benign and malignant breast lesions with conventional imaging modalities such as mammography and US, MR imaging appears to be of substantial help in characterizing carcinomas with a benign morphologic appearance such as a well-circumscribed margin.
Imaging findings OR Procedure details

- Breast cancer is a malignant disease with higher mortality among women worldwide, and its diagnostic imaging has been used many methods, especially mammography, ultrasound, and elastography, among these methods Breast MRI stands out combining the evaluation of morphological aspects of the use of intravenous contrast, recent sequences including diffusion and spectroscopy, and improvements of the software with new automated software applied to interpret breast MRI (computer-aided evaluation) with automated lesion kinetic information.

- Breast MRI with dynamic study in a high sensitivity for detection of breast cancer, and recently indicated as a method of screening women at high risk.

- MR imaging can provide both morphologic and functional information. Analysis of lesion signal intensity on nonenhanced T2-weighted MR images, determination of enhancement patterns, and kinetic curve assessment can be helpful in differentiating well-circumscribed breast malignancies from benign breast lesions.

- Techniques to improve the specificity Breast MRI may reduce unnecessary biopsies in the detection of breast cancer. Some of these advanced MRI techniques have been recent developments with a group studying and trying to acquire and standardize protocols, especially spectroscopy and diffusion, so that these techniques can be incorporated into the routine practice of testing in the near future.

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**CAD:**

- Computer-assisted diagnosis (CAD) in Breast MRI is a method that uses computer programs to perform automatic processing of the kinetic curve, giving more detailed measures of the lesions, thus improving the differentiation between benign and malignant lesions.

- The fact that the process is made by computer eliminates the need for technical training of the technologist and shortens the time spent in preparation of the report by the radiologist.

- The ability to layer in the same image the reconstruction MIP (maximum intensity projection), and the kinetic curve in presentation as color graphics, can provides details of the lesions to the radiologist.

**SPECTROSCOPY:**
• Spectroscopy allows the assessment of the metabolites present in a tissue by placing the findings on a graph, a range of, chemical shift, evaluating the relationship between the amplitude and frequency of each metabolite.
• With the single voxel technique can be performed one-dimensional study, and in a larger area can be used multivoxel technique, assessing a larger volume, and in accordance to each RMI unit.
• In breast cancers and other malignancies, the choline metabolite increased cell proliferation by forming a peak at 3.22 ppm topography on the scale of the horizontal axes of the chemical shift. But choline can also occur at lower levels in fibroadenomas or even in the normal parenchyma.
• This evaluation of spectral profile reflects changes in phospholipid metabolism in tumors, is still in the initial evaluation, and being considered consisting of up to a given diagnosis. And also can be used to monitor response to neoadjuvant chemotherapy.

DIFFUSION:

• The diffusion-weighted imaging is an MRI technique that can be used to differentiate between benign and malignant breast, the sequence can be done without significant increase in the total examination time, using lower values b.
• The information in diffusion-weighted allows identifies tissue metabolic and molecular lesions, identified high cellularity, and can be used as monitoring of early response in the neoadjuvant chemotherapy.
• In addition, diffusion-weighted sequence, as a molecular imaging technique enables the identification of information metabólicas. It is currently considered the equivalent of PET resonance, it has the ability to reflect molecular changes in response tumor therapy early and possibly information about the tumor grade.
• Using the value of the ADC (apparent diffusion coefficient), described below, allowed an adequate differentiation between benign and malignant.

3 TESLA:

• Breast MRI is usually performed using a 1.5 T, but as the devices currently 3T has become more available, the number of exams made on these devices has increased.
• There are not yet consistent comparative studies, but suggest that 3T is at least equivalent and often better than that of 1.5 T. The exams are faster, with better sequences with fat suppression and a better quality spectroscopy.
• The MRI at 3T has a higher signal to noise ratio, providing higher spatial resolution and / or temporal resolution and better espectral, then the RM 3T
can shorten acquisition time and improve sequences of the sequences with DW diffusion.

These advanced techniques in MRI has been a progression with groups studying and standardizing protocols and acquisitions, so that these techniques are incorporated into future practice of routine examinations.

To illustrate the different techniques used in MRI of the breast, five different cases are presented, in which the sequences were used from traditional to advanced techniques.
**Fig. 1:** Patient has already held two mastoplasies aesthetic. She went to the mastologist because as she detected an increase on the internal upper region of the left breast. T2 with fat suppression and T1 in sagittal plane, show elongated lesions in the middle and posterior third of left breast, inseparable from the pectoralis major muscle.

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Fig. 2: T2 in the coronal plane dissociates the lesion of the other tissues

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Fig. 3: Dynamic study in the sagittal plane shows heterogeneous enhancement of the lesion.

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Fig. 4: Late post-contrast sequence in T1 with fat supression in axial plane, shows the lesion inseparable from the more anterior fascia of the pectoralis major muscle.

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**Fig. 5**: Patient with 55 years old. Conservative surgery for cancer in left breast 01Y6M ago, previous Breast MRI unaltered. Mamography was not requested. T1 and T2 show magnetic susceptibility artifact in the path of surgery, with progressive enhancement of oval lesions with irregular borders.

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**Fig. 6:** PEI map axial e sagittal, demonstrate the nodule hypervascularized

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Fig. 7: Dynamic series in the first and fifth minutes show progressive irregular enhancement.

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Fig. 8: Patient with 59 years with palpable nodule in the lower external quadrant, along the contour of silicone prosthesis. The patient refused to perform mammography by the silicone prosthesis. US showed a conglomerate of solid nodules, regular, in the lower outerright breast, the largest measuring 1.2 and 0.7 cm.

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Fig. 9: Dynamic serie in the first and fifth minute show kinetic curve type III

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**Fig. 10:** Color map shows anterior extension, to the periareolar region and nipple

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Fig. 11: Patient in follow-up of nodules in both breasts. US describes solid nodules in both breasts, BI-RADS category 2 and 3. Referred to a mastologist who palpated mass in the right breast.

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Fig. 12: Mammography: Normal.

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Fig. 13: Dynamic study: kinetic curve type II
**Fig. 14:** Other breast nodules: kinetic curve type I

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**Fig. 15:** Multiplanar reconstructions in MIP.

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Fig. 16: Spectroscopy: peak Cholin (3,2).

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**Fig. 17:** T2 Fat Sat and Sag Reconstruction: extension to the papilla.

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**Fig. 18:** Surgical removal of fibroadenoma in the left breast, three weeks after the patient noticed increased volume. Oval image with T1, T2 and STIR hyperintense, compatible with hematoma.

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**Fig. 19:** There is inhomogeneous peripheral enhancement by contrast, progressive.

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Fig. 20: Diffusion weighted sequences and ADC map: hyperintensity within the lesion.

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Conclusion

- Breast MR imaging can play a substantial role in distinguishing between benign and malignant breast lesions, especially in cases that are difficult to diagnose by using conventional imaging.
- The advanced techniques of breast MRI is an important tool to help the differential diagnosis of breast lesions.
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