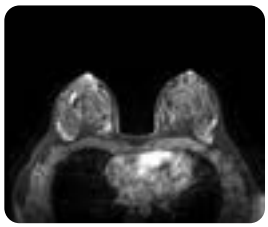

BREAST MRI GUIDED PROCEDURES: OUR EXPERIENCE

Procedimientos de mama guiados por resonancia magnética: nuestra experiencia

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Key words (MeSH)

Key words
Breast
Magnetic resonance imaging
Biopsy
Breast neoplasms

Palabras clave (DeCS)

Mama
Imagen por resonancia magnética
Biopsia
Neoplasias de la mama

Summary

Breast magnetic resonance imaging (MRI) is the most sensitive diagnostic modality for the detection of breast cancer; however, its specificity is limited, ranging from 40% to 80%. This is due to the enhancement characteristics of some benign lesions that overlap those of malignant lesions, for which histology is required for diagnosis. For the histological diagnosis of these lesions, which are only visualized by MRI and not by any other diagnostic method, MR-guided procedures are the choice. MR-guided biopsy is used in patients with negative directed ultrasound. ROLL (Radioguided Occult Injury Localization) is an alternative technique to preoperative wire marking of hidden lesions and has been more widely used in ultrasound than in MRI, with very good results. Retrospectively the data of all patients admitted to our center for Breast MRI biopsy and Breast MRI localizations were retrieved. Pathologies were then collected and the results were tabulated in Excel for analysis.

Resumen

La resonancia magnética (RM) de seno es la modalidad diagnóstica más sensible para la detección de cáncer de seno; sin embargo, su especificidad es limitada, pues varía entre el 40 y 80 %. Esto se debe a las características de realce de algunas lesiones benignas que se sobreponen a las de lesiones malignas, y para cuyo diagnóstico se requiere análisis histológico. Para el diagnóstico histológico de estas lesiones —que solo se visualizan por RM y no por otro método diagnóstico— los procedimientos guiados por RM son la elección. La biopsia guiada por RM se utiliza en pacientes con ultrasonido dirigido negativo. El ROLL *(Radioguided Occult Lesión Localization)* es una técnica alternativa a la marcación prequirúrgica con alambre de lesiones ocultas y ha sido más ampliamente utilizada en ultrasonido que en RM, con muy buenos resultados. Se obtuvieron de manera retrospectiva los datos de las pacientes que ingresaron al sistema de nuestra institución para la realización de biopsia de seno y marcación de seno guiada por RM. Posteriormente se recopilaron las patologías. Los resultados se tabularon en Excel para su análisis.

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1. Introduction

Magnetic resonance imaging (MRI) is the most sensitive diagnostic modality (94-100%) for breast cancer detection. It allows observation of lesions not evident in other methods in 10-39% of cases, additional foci of ipsilateral cancer in 6-34% of cases and foci of contralateral carcinoma in 4-24% of cases; however, its specificity is limited (37-97%) (1, 2). This is due to the

enhancement characteristics of some benign lesions that overlap with those of malignant lesions (3).

If a suspicious lesion is identified on MRI, the indication is to perform a directed ultrasound evaluation (second look US). If there is a correlation, the ultrasound directed biopsy is performed; otherwise, the MR guided biopsy is indicated.

In the literature, information on the effectiveness of directed ultrasound varies widely, between 23-71%, although in general it is more likely to detect masses than "non-mass" type foci or enhancements, i.e. invasive carcinoma than carcinoma in situ (4).

Biopsy is a minimally invasive diagnostic alternative that, compared with surgical resection, has lower morbidity and better cosmetic results with similar diagnostic accuracy; however, MRI biopsy is a complex procedure, because of the time it takes to perform it, the inputs required and the degree of expertise of the professionals performing the procedure, which entails a high cost.

The reported effectiveness of MR-guided biopsies varies widely in the literature, with cancer detection rates between 20-50% (5, 6).

According to American College of Radiology (ACR) guidelines, the only indication for MR biopsy is for BI-RADS 4 or 5 lesions that were not seen on mammography and ultrasound (7).

Absolute contraindications for performing MR-guided procedures include: patients with electronic devices that are not compatible with the magnetic field, patients with claustrophobia, renal failure or a history of gadolinium allergy; in addition, it is contraindicated when the lesion is not visualized at the time of the procedure. This occurs in approximately 14% of cases (6) and can be attributed to changes in breast tissue or injury secondary to hormonal variation in the menstrual cycle, hormonal treatments (hormone replacement therapy, tamoxifen), or excessive compression of the breast during the procedure. These patients should have a follow-up MRI in 3-6 months to confirm that the lesion is not evident (3). Another limitation for these procedures is the superficial location of the lesions with respect to the skin (less than 2 cm), near the chest wall, in the retro-areolar region or in patients with breast prostheses (4).

ROLL (Radioguided Occult Lesion Localization) is an alternative technique to pre-surgical wire marking of occult lesions and has been more widely used in ultrasound (6). It consists of the injection of albumin macro-aggregates marked with technique 99 (Tc-99m) in the center of the suspected lesion. During surgery, the surgical area is explored with a probe to identify the point of greatest activity of the radiotracer (8, 9).

In the literature, an adequate location of the lesion is reported in more than 90% of the cases. Also, a greater prevalence of negative margins, reduction in the volume of tissue resected and therefore better cosmetic results and less postoperative pain (10).

Given that in most MRI guided breast biopsies the results are benign, it is of crucial importance to determine them accurately, especially considering that the population examined is at high risk. This is done by evaluating the concordance between the pathology and the image. In the literature, this outcome is approximately 7% and of these lesions approximately 30% are malignant (7). In addition, a follow-up MRI at 6 months is recommended for all patients. In small stable lesions, follow-up MRI is recommended for two years (11, 12).

When the biopsy results do not show agreement as to whether the lesion is benign or malignant by MRI, the biopsy should be repeated or the lesion resected surgically (6).

The objective of this study is to inform our initial experience with MRI-guided breast procedures and to make an analysis of the results obtained.

There are no other case series on MRI-guided procedures of breast lesions in Colombia. Published experiences in BI-RADS 4 or 5 patients in Colombia only include ultrasound or mammography guided procedures (5, 6).

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2. Methods

Data were obtained retrospectively from patients admitted to our institution's system for breast biopsy and MRI-guided breast marking, from 2009 to 2018. We found 55 patients and 57 procedures of which 48 are MRI-guided biopsies and 9 are markers. Subsequently, the pathologies were collected from the archive of the pathology laboratory of the Clínica del Country and the laboratories of the health entities affiliated with the clinic, through contact with the treating physicians and, by telephone, with the patients.

The results were included in an Excel table for analysis.

2.1 Description of the biopsy procedure and ROLL

The following is a description of the procedures performed on patients in the cases described, which is specific to the institution that carried out the study.

All patients who underwent biopsy were scheduled for a preliminary interview with the radiologist in charge of the biopsy in order to evaluate the indications or contraindications for the procedure, the MRI images where the suspicious lesion was found and the special conditions inherent to the patient. The procedure was explained to them and the informed consent was signed on the day of the procedure.

After asepsis and antisepsis, compressive grids were placed over the medial and lateral aspect of the breast to be examined. Three vitamin A capsules were placed on the lateral grid triangulating the suspicious lesion, according to the location on the previous MRI (Figure 1). Subsequently, in 1.5T equipment and with an 8-channel antenna, simple images were acquired in the axial plane in STIR sequences, and in the coronal and sagittal planes in sequences with information in T1 and fat saturation.

Subsequently, images were obtained in dynamic sequence (THRIVE) before and after the administration of gadolinium by endovenous route.

Post-contrast images were obtained in the coronal and sagittal planes.

The suspicious lesion was located and at the work station the lesion was related in the three image planes. The center of the lesion was marked in the sagittal plane with a ROI. The ROI was glued to all the images of the sequence up to the skin plane to choose the optimal grid grid to introduce the coaxial system. The vitamin A capsules were taken as a reference. Measurements were taken from the center of the lesion to the skin to calculate the depth to which the needle should be taken, either for biopsy or for injection of the radiotracer.

Only in the case of a biopsy was a local anaesthetic injected, a small incision was made in the skin with a scalpel blade and the coaxial system was introduced.

For biopsies, a trocar with a plastic shirt was used. A long #14 helmet was used for the markings, the metal part of which was removed when the images were acquired, leaving only the plastic jacket in place. The last biopsy system used (ENCOR) has as an accessory a plastic shutter with gadolinium (VISILOC) that is introduced in the coaxial system once it is in position, to confirm more accurately its location in the control images.

Sequential images were obtained with information in T1 and fat saturation in the three planes, to determine if the tip of the coaxial system was located inside the suspicious lesion and was optimal for the introduction of the biopsy needle or for the injection of the radiotracer.

Because the lesion has washed out the intravenous contrast medium at the time of imaging, reference points adjacent to the lesion that were evident on the single images were taken into account as guides; for example, the pattern of fibroglandular tissue, Cooper's ligaments, or cystic or solid lesions.

Once the optimal location was confirmed, the biopsy needle or the needle was inserted to inject the radiotracer.

In the case of biopsy, three different needle types were used: Initially, conventional biopsy needles TRUCUT14G and 18G were used. Later, biopsies were performed with the VACORA® 10G needle vacuum aspiration system (BARD). Only one biopsy, the last one, was performed with the ENCOR vacuum aspiration biopsy system (BARD).

At least four tissue samples were obtained from each injury. Images were taken on two planes to confirm that representative samples of the suspected lesion had been obtained.

After the procedure, compression was made over the biopsy area and bleeding or bruising was assessed. Patients were left for observation for one hour, with ice over the biopsy site. With adequate progress, the patient was discharged with recommendations and alarm signs.

The patients were responsible for taking the samples to the pathology laboratory authorized by their health institution.

In the case of marking, 1 cm3 of the radiotracer previously prepared by the Department of Nuclear Medicine of the Clínica del Country was injected (500mCi of albumin macro-aggregates marked with Tc-99).

The patients were discharged from the hospital and were to be taken to surgery within 6 hours to resect the marked lesion.

It was always confirmed verbally with the mastologist that the surgical excision of the lesions was successful.

2.2 Search for information

We searched the literature available in the PubMed, EMBASE, CENTRAL, SCOPUS, LILACS and PsycINFO databases, using indexed and free terms:

No case reports or case series were found in Colombia.

3. Results

In this retrospective study we were able to obtain complete information on all 56 patients, with an average age of 45 years. The type of needle, number of samples, complications, indication for examination, type of injury and histological outcome were recorded and analyzed.

Only one patient was categorized as BI-RADS 5. In 73% of the cases, the indication was for a suspicious nodule.

The proportion of procedures (biopsies and ROLL) not performed due to non-visualization of the lesion was 17%. Only in one patient the procedure was not performed due to technical difficulties.

An average of 6 samples were taken for each patient and in 75% of the biopsies the VACORA® needle was used.

Of the procedures performed, histological results were obtained in 100% of the cases. The proportion of benign lesions was 63% and of malignant lesions 30%. The rest of the lesions were described as high risk. Of the patients with "no mass" enhancement, 75% had benign pathology results and 25% had malignant results. Of the patients with masses, 57.7% had benign pathology, 28.8%, malignant and 14%, high risk.

In the patient categorized as BI-RADS 5, the histologic-method result showed benign pathology.

The rate of complications was 5%: there was hematoma at the puncture site in three patients and in one of these cases there was superinfection which was treated and resolved with antibiotics. In patients who underwent ROLL, histological results were obtained in 100 %.

In half of these cases, the result showed malignancy. In none of these procedures were there any complications.

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3.1 Case Presentation

Below are images of the procedures performed in two clinical cases.

- **Case 1.** Patient diagnosed with infiltrating carcinoma in the right breast. He was given an MRI to evaluate the extent of the cancer (figure 2).
- **Case 2**. Patient referred for biopsy by "no mass" type enhancement, with linear morphology in the interline of the external quadrants of the right breast (figure 3). The biopsy guide was successful and the histological study of the lesion confirmed infiltrating tubular carcinoma (figure 4).

4. Discussion

The use of MRI as a guide to obtain tissue in breast lesions in Colombia has been slow to spread. For several years, the institution responsible for this study was one of the few that offered the possibility of MRI-guided breast biopsies in the country. For this reason, it had the opportunity to receive patients from all over the country, with diagnosis of BI-RADS 4 or 5 lesions by MRI.

As pioneers, MRI biopsies were not yet recognized by health care providers and were not authorized; most were paid for by patients, so it was not possible to perform all procedures that were referred

In 2009, breast MRI was a relatively new diagnostic modality in Colombia and therefore, radiologists faced with the reading of these exams began their learning curve. Although the sensitivity of MRI for the diagnosis of cancer was very high since its emergence, the specificity in principle was much lower. This specificity increased, both in the world literature and in Colombia, as the experience of radiologists faced with reading breast MRI increased (11). A limitation for planning the procedure was the diversity in the quality of the images of the studies. Sometimes not all the necessary sequences were available and the protocols were not adequate. Additionally, lesions did not always meet the criteria to be classified as BI-RADS 4, so lesions taken for biopsy did not always meet these criteria. This may have affected the cancer rate calculated for our procedures (30%), although it is in the range of the rate reported by other centers in the literature (20-50%). Therefore, it was also not possible to calculate the sensitivity and specificity of our center in the diagnosis of BI-RADS 4 or 5 suspicious lesions by MRI.

Figure 1. Positioning the patient prone with a compressive grid on the breast.

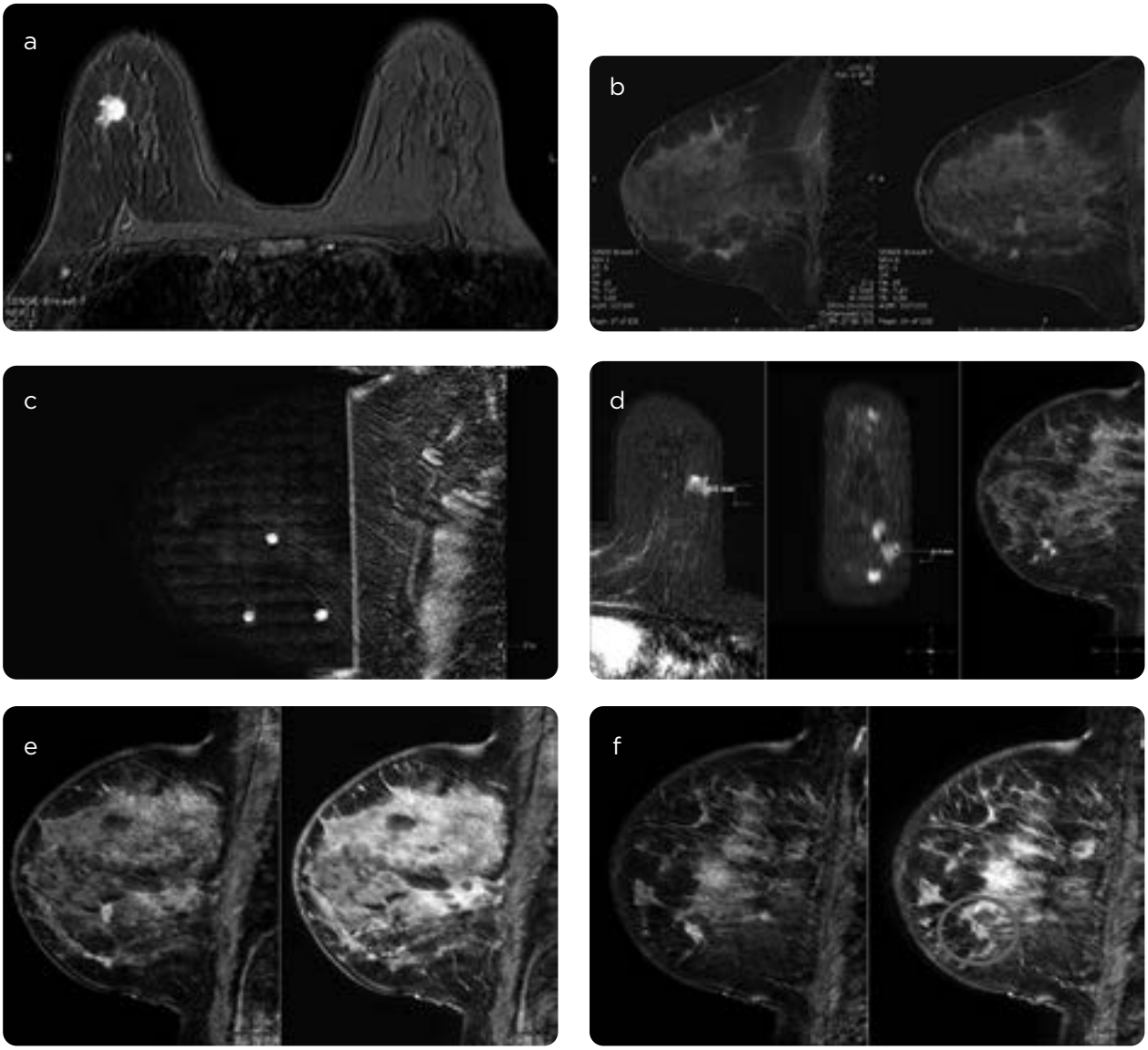

Figure 2. MRI. a) A rounded, spiculated mass is observed, which is intensely enhanced with the contrast medium, related to invasive ductal carcinoma with known histology. b) Sagittal reconstructions of the left breast. Three spiculated masses are observed, with fast ascending curves and washout in the dynamic sequence, suspected of neoplastic involvement. Biopsy is suggested. c) Location of the lesions during the biopsy procedure with compressive grid on the skin in the lateral face of the left breast. Vitamin A capsules are demonstrated by triangulating the lesion. d) Location of the three lesions in the three planes (axial, coronal, sagittal) at the work station. e and f) Images in the sagittal plane demonstrating the suspicious lesions in the lower and outer left quadrant during the dynamic sequence and after biopsy. Post-biopsy images demonstrate artifacts from the passage of the needle in the topography of the lesions.

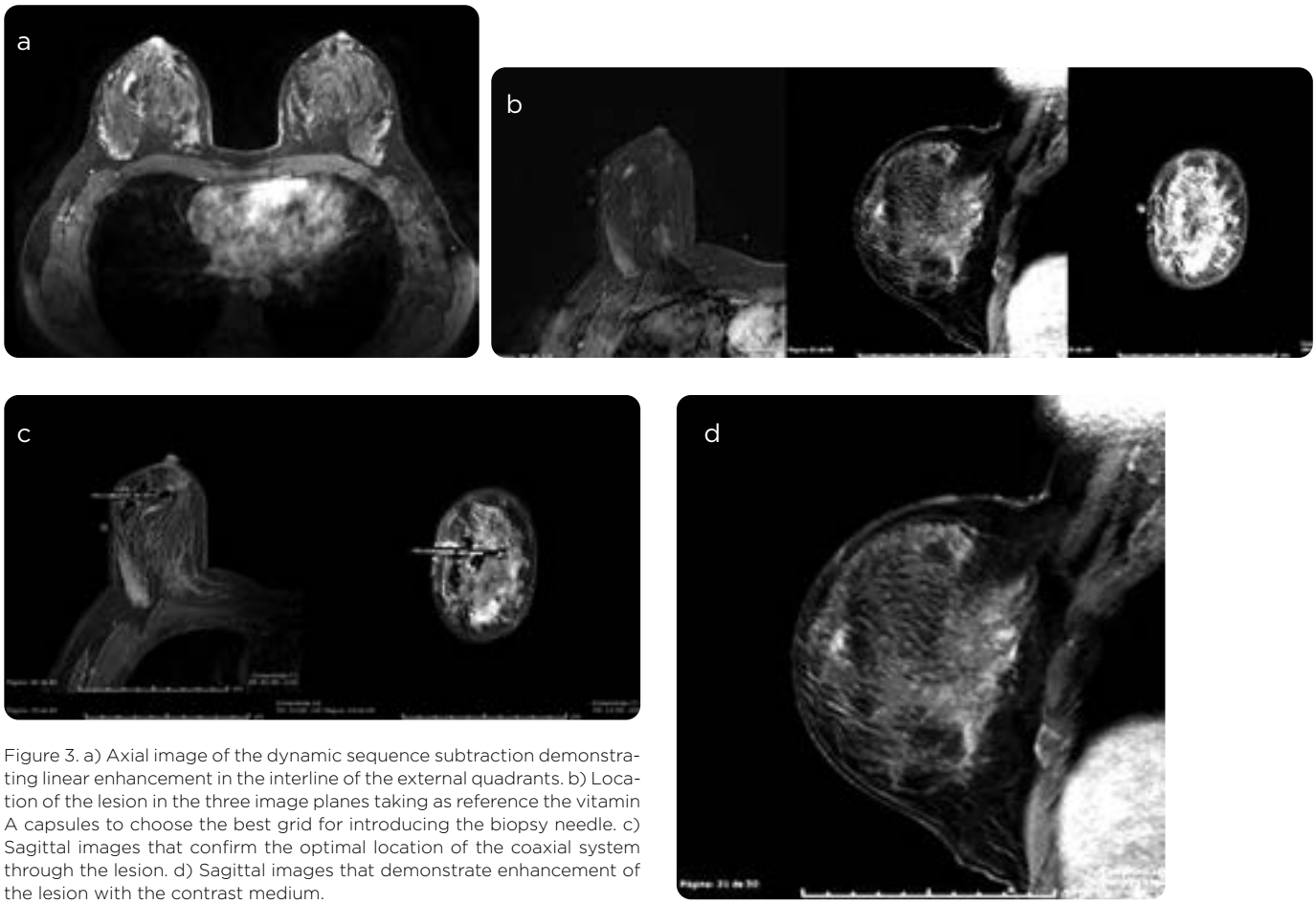

Figure 3. a) Axial image of the dynamic sequence subtraction demonstrating linear enhancement in the interline of the external quadrants. b) Location of the lesion in the three image planes taking as reference the vitamin A capsules to choose the best grid for introducing the biopsy needle. c) Sagittal images that confirm the optimal location of the coaxial system through the lesion. d) Sagittal images that demonstrate enhancement of the lesion with the contrast medium.

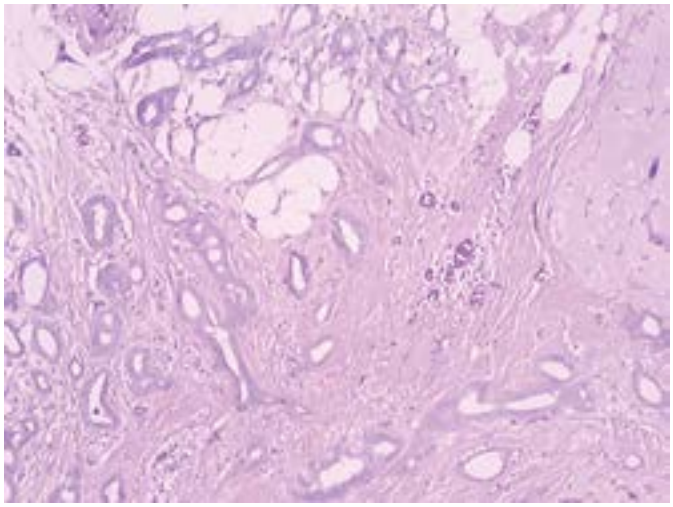

Figure 4. Microphotography showing the invasive tubular structures by infiltrating tubular carcinoma.

An indication to cancel the biopsy once the images are acquired after the injection of the contrast medium, is the non-visualization of the lesion (12).

In the literature the reported rate varies around 14%. Our cancellation rate was slightly higher at 17%. In this study the cancellation rate was higher initially because patients referred for biopsy from other centers were scheduled after the interview with the radiologist performing the procedure. Sometimes, due to administrative procedures, these patients arrived with studies that were more than 2 and up to 6 months old. Therefore, and in order to reduce these cancellations, a protocol established that all patients referred for biopsy should have a recent study performed at our center.

Another limitation related to the referral of patients from other centers was the collection of pathology reports. The samples obtained were given to the patient at the end of the procedure to be taken to the pathology laboratory authorized by their health care provider. Less than half of the patients arrived at the laboratories that provide their service to our centre. The name of the treating physician was not always on file and the telephone numbers noted no longer corresponded. Seven patients had to be excluded from these series because it was not possible to obtain the results of the pathology.

Most of the biopsies were performed with a needle with vacuum aspiration, according to the recommendations in the literature for this procedure (3), since adequate samples of small lesions are obtained, an

adequate volume of tissue for histological analysis and they reduce the displacement of tissues secondary to bleeding or the injection of local anesthesia since they have permanent aspiration/suction.

The average number of samples obtained per patient in this series was six, less than that obtained in other centers where similar caliber needles are used (12 samples with 9G caliber needles) (3).

Complications in this series were 5%, a percentage comparable to that reported in the world literature (0-6%), which confirms the low morbidity of these procedures (3).

It has been established in several centers that the follow-up of patients taken for MRI biopsy is critical, since all belong to the highest risk group, given the indications for breast MRI. This follow-up has several objectives: first, to correlate the image with histology; second, to confirm with a subsequent MRI if the sample obtained was adequate; and third, to confirm if the benign results really correspond to benign lesions in the follow-up (evaluating changes in residual or long-term lesions and defining whether a malignant lesion emerged from the lesion studied). There is a lack of agreement in the literature of around 7%, of which 30% turn out to be malignant lesions (13). In this series it was not possible to calculate the rate of non-conformity or false negatives, which in the literature is described as around 0.9-2.3% (14). This lack of follow-up of the pathologies in our center could have an important impact on the future management of these patients and is a consideration that will be taken into account in our protocols.

The rate of malignancy was higher in "mass" type lesions than in "non-mass" type lesions, which correlates with what is reported in the literature (3).

There are few centers in the world literature where ROLL markings are performed by MRI. In our center, the first marking was performed in 2016 and the main indication was the lack of access to MRI compatible marking wires; however, the need to mark lesions visualized only by MRI arose, which were requested by the mastologist in order to completely dry them out for histological evaluation. The sample in this series of cases, specifically of the ROLL markings, is still too small to make an in-depth analysis, but so far the results are favourable and similar to those of other series of cases and allow us to continue performing this procedure.

An important point to consider in further studies will be the cost-effectiveness analysis of these procedures, within the diagnostic process in these patients.

5. Conclusion

MRI-guided breast procedures (biopsies and markings) are now considered a mandatory tool in centers that perform breast MRI, because there are lesions that are visualized only by this modality and that require histological diagnosis, taking into account that patients who undergo breast MRI are at greater risk. Despite the limitations of this series, breast MRI scans and biopsies have been shown to be safe procedures. It is necessary to follow up on these patients after the procedure to establish the outcome to allow for analysis of agreement with the histologic result. Post-biopsy follow-up with MR imaging of patients should be included in diagnostic and management guidelines.

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Received for evaluation: July 1, 2019
Accepted for publication: August 7, 2019