



Role of Magnetic Resonance in Modifying the Therapeutic Approach in Patients with Diagnosis of Breast Cancer and MRI Findings According to Histological Subtype

Cáncer de mama: hallazgos en la resonancia magnética según tipo histológico y modificación de la conducta terapéutica



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Palabras clave (DeCS)

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Summary

Introduction: MRI is important in diagnosis and staging of breast cancer, providing information on tumor size and degree of local extension, key findings when defining a therapeutic approach. **Objective:** To describe the percentage of change in the therapeutic conduct in relation to imaging findings in MRI. **Methods:** Observational cross-sectional study in patients with a confirmed diagnosis of breast cancer who underwent MRI. The variables were classified into demographic and clinical data and diagnostic test results. The main variable was the therapeutic intent, measured before and after each study. The descriptive analysis of quantitative variables was performed with measures of central tendency and dispersion; and qualitative distributions of absolute and relative frequencies. **Results:** 107 patients with confirmed breast cancer were analyzed, (average age of 50.6 years(\pm 10.4)). The most common histological subtype was infiltrating ductal cancer (69.1%) followed by infiltrating lobular cancer (13%). The most common indication for MRI was tumor staging (74.7%). Of the total number of patients included, a change in therapeutic approach was found in 21.5% of cases. **Conclusions:** The importance of MRI in modifying the therapeutic approach is confirmed, demonstrating this shift in one of every four patients. MRI should be seen as an indispensable study in all women requiring staging of their pathology previous to deciding a therapeutic approach.

Resumen

Introducción: La resonancia magnética (RM) es importante en el proceso de diagnóstico, estadificación y tratamiento del cáncer de mama, aporta información valiosa del tamaño tumoral y el grado de extensión local. **Objetivo:** Describir el porcentaje de cambio de conducta terapéutica en relación con los hallazgos de la RM en pacientes con cáncer de mama confirmado. **Métodos:** Estudio observacional de corte transversal en pacientes con diagnóstico confirmado. Se clasificaron las variables en datos demográficos, clínicos y resultados de pruebas diagnósticas. La principal variable fue la intención terapéutica, medida antes y después de cada estudio. El análisis descriptivo de las variables cuantitativas se realizó con medidas de tendencia central y dispersión; y en las cualitativas, con distribuciones de frecuencias absolutas y relativas. **Resultados:** Se analizaron 107 pacientes con diagnóstico confirmado de cáncer de mama (edad

promedio de 50,6 años [±10,4]). El subtipo histológico más frecuente fue el cáncer ductal infiltrante (69,1 %) seguido por el lobulillar infiltrante (13 %). La estadificación tumoral fue la indicación más común de la RM (74,7 %). Se encontró cambio de actitud terapéutica en el 21,5 % de los casos. **Conclusión:** Se confirma la importancia de la RM para la toma de decisiones, demuestra cambio en una de cada cuatro pacientes de esta serie. Se debería contemplar como un estudio indispensable en todas las mujeres que requieran estadificación de su patología previo a la toma de una conducta terapéutica.

Introduction

For approximately 14 years, magnetic resonance imaging (MRI) of breast in patients with suspected or diagnosed breast cancer has become a valid diagnostic tool that is based on the neovascularization of the neofor-mative processes, with a sensitivity of 95-100 % and specificity of 80-93 %, valuable in terms of tumor size and degree of local extension, decisive findings to define a therapeutic behavior in these patients (1).

When comparing MRI to other diagnostic imaging methods, it has important advantages, among others, the possibility of detecting findings that are not found in mammography or ultrasound, such as bilaterality, multifocality, multicentricity, distance between tumor and the areola-nipple complex and other associated findings (2).

This imaging method offers additional benefits in post-surgical treatment and control in patients with breast cancer, with the aim to establish whether or not there is recurrence, for which a MRI is performed six months after surgery and controls every two years. In addition, patients who have received radiotherapy are given the study 18 months later (2). However, at the present time, there is no knowledge of local statistical data that demonstrate how MRI influences therapeutic decision-making. The aim of this paper is to describe the percentage change in therapeutic management and the imaging findings according to the histological type of the tumor, which has an impact on the overall management of the patient and the future of the indications of breast MRI.

Methodology

Descriptive cross-sectional study carried out in an institution of level IV of care. The target population was patients with a diagnosis of breast cancer who underwent MRI Between April 4, 2007 and May 31, 2011. We included patients with confirmed histological diagnosis of breast cancer who underwent MRI for any of the following indications: a) study for an adequate assessment of the extent of the disease in pretreatment (staging); b) detection of recurrence in the treated breast; c) detection of occult neoplasia (patients with histological diagnosis of metastasis in the documented axillary node); d) monitoring of neoadjuvant chemotherapy; e) special situations, women of high risk due to family history of breast cancer by direct maternal line, ideally with genetic study or diagnosis of breast cancer; and f) evaluation of breast implants.

At least one MRI study was performed within 15 days previous to its surgical intervention, when this was the first therapeutic option. In the event that the patients had been treated with neoadjuvant chemotherapy, at least two studies were performed, one for staging and another immediately prior to surgery for response assessment.

The descriptive analysis in the quantitative variables was performed with measures of central tendency (average and median) and dispersion (interquartile range and standard deviation); and in the qualitative ones with absolute and relative frequency distributions.

Results

We studied 107 patients diagnosed with breast cancer, with an average age of 50.6 years (± 10.4). In relation to the histological type of malignant neoplasia, the most frequent were carcinoma of infiltrating ductal type (n = 74; 69.1 %) and infiltrating lobular carcinoma (n = 14; 13 %). The median size of the lesion was 28.5 mm with an interquartile range of 14-31 mm. The most frequent indication for MR imaging was staging in 74.7 % (n = 80). In 58.8 % (n = 63) of the patients, initial treatment was instituted With neoadjuvancy. Of the total number of patients included in the study, a percentage of change of therapeutic attitude of 21.5 % (n = 23) (table 1) was found.

Table 1. General characteristics of the study population

| General characteristics | n (%) |
|--|--------------|
| Age | |
| Median (SD) | 50.6 (±10.4) |
| Minimum | 30 |
| Maximum | 77 |
| Size of lesion (mm) | |
| Median (IQR) | 28.5 (14-31) |
| Minimum | 5 |
| Maximum | 129 |
| Indication | |
| Breast cancer staging (recent diagnosis) | 80 (74.7) |
| Chemotherapy monitoring | 23 (21.5) |
| Post-surgical follow-up | 2 (1.8) |
| Lesion characterization | 2 (1.8) |
| Histological type of breast cancer | |
| Ductal infiltrating cancer | 74 (69.1) |
| Lobular infiltrating cancer | 14 (13.0) |
| Ductal in situ cancer | 12 (10.2) |
| Others | 4 (3.7) |
| Papillary cancer | 2 (1.8) |
| Lobular in situ cancer | 1 (0.9) |
| Medullar cancer | 1 (0.9) |
| Change of therapeutical approach due to MR | 23 (21.5) |
| Instaured treatment | |
| Neoadjuvancy | 63 (58.8) |
| Mastectomy with emptying | 37 (34.5) |
| Conservatory (quadrantectomy) | 7 (6.5) |

SD: Standard Deviation; IQR: Interquartile range

When analyzing the specific characteristics for each type of malignant neoplasm according to the histological report, it was found that the largest lesion size was 129 mm in a patient diagnosed with infiltrating ductal carcinoma. The smallest tumors were 5 mm and were infiltrating ductal carcinoma (one case) and infiltrating lobular carcinoma (two cases) (figure 1).

The most common type of malignant neoplasm was ductal and infiltrating ($n = 74$; 69.1 %) (figure 2a, b, c, d and e), multicentric in 16.2 % ($n = 12$) and multifocal 13.5 % ($n = 10$) of the cases. Additional findings were found in 78.4 % of the cases ($n = 58$). The most common dynamic curve was washed type in 59.5 % ($n = 44$). The most frequent pattern of enhancement was nodule in 74.3 % ($n = 55$) (figure 3). 75.7 % ($n = 56$) of the cases had a lesion with angiogram by CAD-Stream (table 2) (figure 4a, b, c and d).

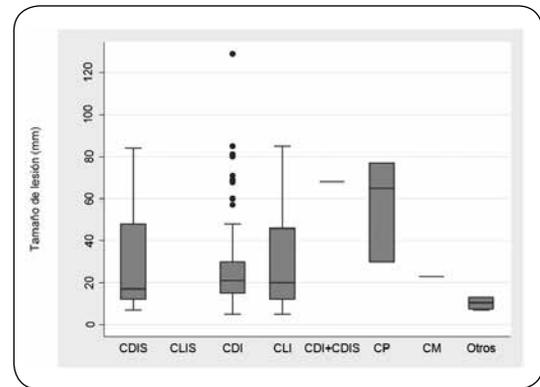


Figure 1. Size of the lesion according to the histological type of breast cancer
DCIS: ductal cancer in situ; LCIS: lobular cancer in situ; IDC: infiltrating ductal cancer; ILC: infiltrating lobular cancer; PC: papillary cancer; MC: medullary cancer.

Table 2. MRI results according to histological type of cancer

| MRI Results | Histological type of breast cancer | | | | | | |
|--|------------------------------------|--------------|--------------|--------------|------------|------------|----------------|
| | CDIS $n = 12$ | CLIS $n = 1$ | CDI $n = 74$ | CLI $n = 14$ | CP $n = 2$ | CM $n = 1$ | Others $n = 4$ |
| | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) |
| Multifocality | 2 (18,2) | - | 10 (13,5) | 3 (21,4) | 1 (50,0) | - | 2 (50,0) |
| Multicentricity | 2 (18,2) | - | 12 (16,2) | - | - | - | - |
| Bilaterality | - | - | 2 (2,7) | - | - | - | - |
| Extension to the areola-nipple complex | - | - | 4 (5,4) | 4 (28,6) | - | - | - |
| Additional findings | 12 (100) | 1 (100) | 58 (78,4) | 13 (92,9) | 2 (100) | - | 4 (100) |
| Dynamic highlight curve | | | | | | | |
| Upward curve | 1 (9,1) | - | 7 (9,5) | 1 (7,1) | - | - | 1 (25,0) |
| Plateau curve | 3 (27,3) | - | 16 (21,6) | 1 (7,1) | - | - | 1 (25,0) |
| Wash type curve | 5 (45,5) | - | 44 (59,5) | 9 (64,3) | 2 (100) | 1 (100) | 2 (50,0) |
| No enhancement | 2 (18,2) | 1 (100,0) | 7 (9,5) | 3 (21,4) | - | - | - |
| Pattern of enhancement with contrast medium | | | | | | | |
| Focus | 1 (9,1) | - | 3 (4,1) | 1 (7,1) | - | - | - |
| Nodule | 6 (54,5) | - | 55 (74,3) | 7 (50,0) | 2 (100) | 1 (100) | 3 (75,0) |
| Non-nodular enhancement | 2 (18,2) | - | 10 (13,5) | 4 (28,6) | - | - | 1 (25,0) |
| Does not enhance | 2 (18,2) | 1 (100,0) | 6 (8,1) | 2 (14,3) | - | - | - |
| Angiogram by CAD-Stream | | | | | | | |
| Marking of injury | 9 (81,8) | - | 56 (75,7) | 10 (71,4) | 2 (100) | 1 (100) | 4 (100) |

DCIS: ductal cancer in situ; LCIS: lobular cancer in situ; IDC: infiltrating ductal cancer; ILC: infiltrating lobular cancer; PC: papillary cancer; MC: medullary cancer.

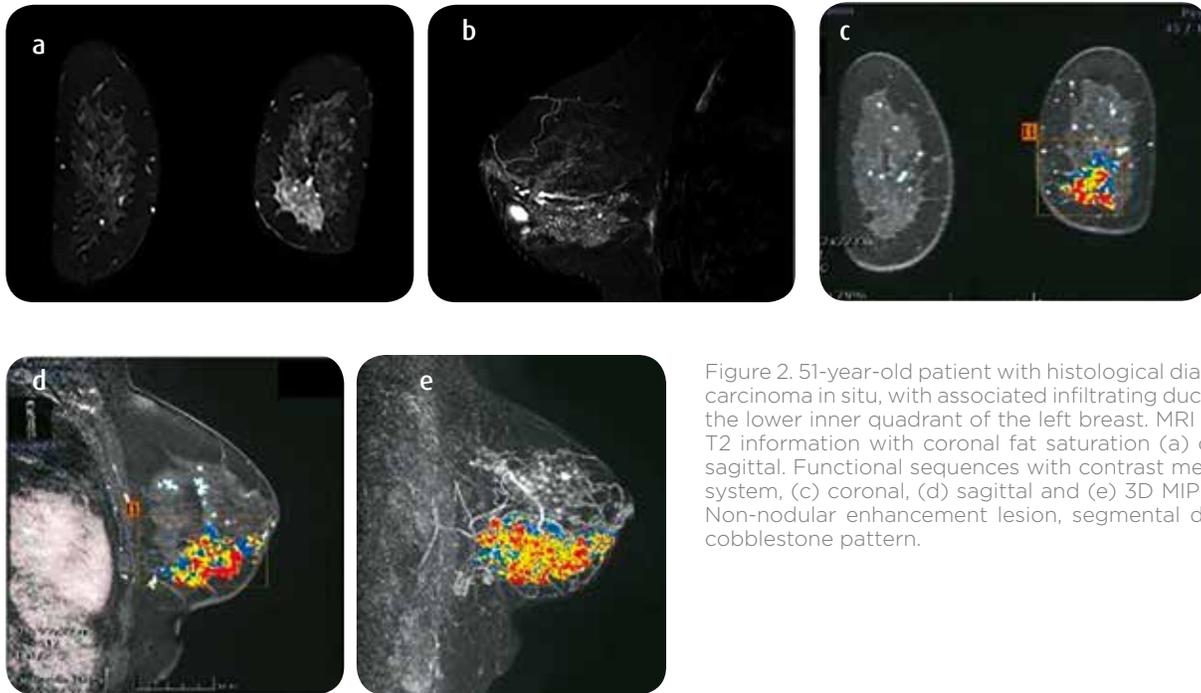


Figure 2. 51-year-old patient with histological diagnosis of ductal carcinoma in situ, with associated infiltrating ductal carcinoma in the lower inner quadrant of the left breast. MRI sequences with T2 information with coronal fat saturation (a) coronal and (b) sagittal. Functional sequences with contrast medium with CAD system, (c) coronal, (d) sagittal and (e) 3D MIP reconstruction. Non-nodular enhancement lesion, segmental distribution with cobblestone pattern.

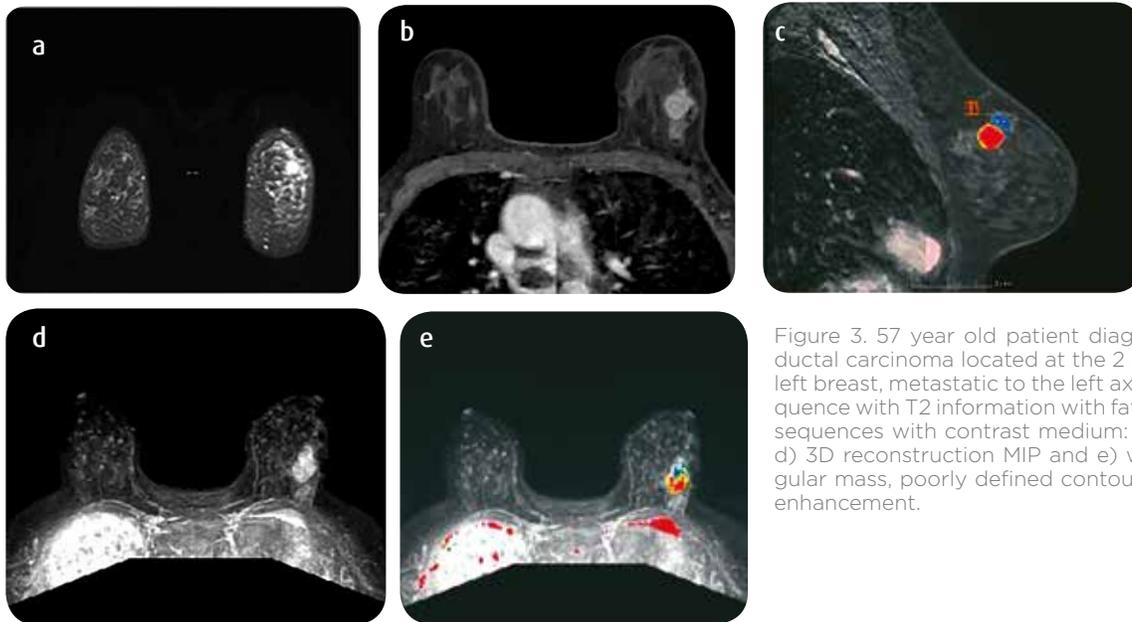


Figure 3. 57 year old patient diagnosed with infiltrating ductal carcinoma located at the 2 o'clock meridian in the left breast, metastatic to the left axilla. a) Coronal MRI: sequence with T2 information with fat saturation. Functional sequences with contrast medium: b) coronal, c) sagittal, d) 3D reconstruction MIP and e) with CAD system. Irregular mass, poorly defined contours and Heterogeneous enhancement.

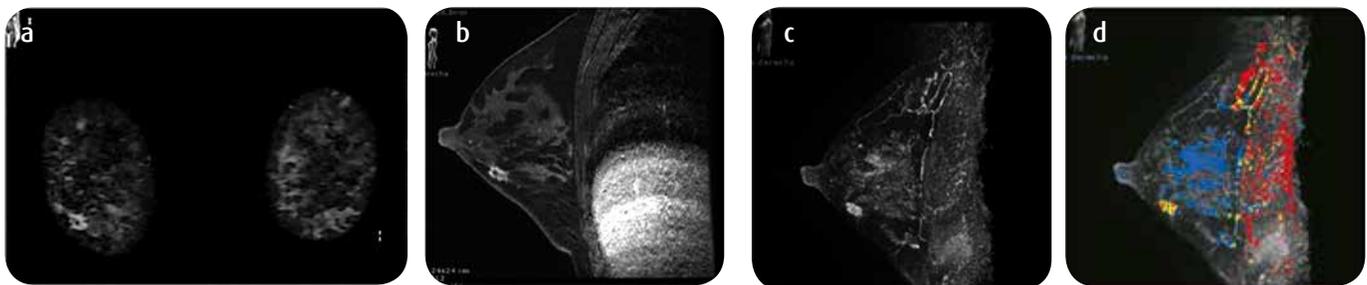


Figure 4. Patient of 47 years with diagnosis of infiltrating ductal carcinoma located in the meridian of the 8 hours in the right breast. a and b) coronal and sagittal MRI sequences with T2 information with fat saturation; and functional sequences with contrast medium c) sagittal and d) 3D reconstruction MIP with CAD system. Irregular mass, spiculate and with nodular enhancement in ring.

The second most frequent type of malignant neoplasm in the studied population was infiltrating lobular carcinoma, with 14 cases (13 %), multifocality was found in 21.4 % (n = 3) of the patients, but no multicentricity. Extension to the nipple-areola complex was found in 28.6 % (n = 4) and additional findings in 92.9 % (n = 13). The most common type of dynamic curve was washing 64.3 % (n = 9) and the nodule enhancement pattern in 50 % (n = 7) of the cases. 71.4 % (n = 10) had an injury marking with Angiomap by CAD-Stream (table 2).

Ductal cancer in situ (third histological type n = 12) was characterized by showing in 100 % of the cases additional findings. In two cases (18.2 %) multifocality and multicentricity were evidenced. A wash curve was found in 45.5 % (n = 5), 54.5 % (n = 6) showed a pattern of nodule enhancement and 81.8 % (n = 9) had an Angiomap injury by CAD-Stream (table 2).

The change in therapeutic attitude was more frequent in the cases classified as infiltrating ductal carcinoma, 74.1 % (n = 20) (table 3).

Table 3. Change of therapeutic attitude according to the histological type of breast cancer

| Histological type of breast cancer | Change of therapeutic attitude | |
|------------------------------------|--------------------------------|------------------|
| | Yes n = 27 (%) | No n = 84 (%) |
| Ductal <i>in situ</i> cancer | 4 (14,8) | 8 (9,5) |
| Lobular <i>in situ</i> cancer | 0 | 1 (1,2) |
| Infiltrating ductal cancer | 20 (74,1) | 56 (66,7) |
| Infiltrating lobular cancer | 1 (3,7) | 13 (15,5) |
| Papillary cancer | 2 (7,4) | 1 (1,2) |
| Spinal cord cancer | 0 | 1 (1,2) |
| Others | 0 | 4 (4,8) |

When comparing the variables evaluated in the study according to the change or not of the therapeutic attitude, no

statistically significant difference in any variable was found (table 4).

Table 4. Findings in MRI according to the change in therapeutic behavior

| MRI Results | Behavior change | | p |
|--|-----------------|-----------|------|
| | Yes | No | |
| | n (%) | n (%) | |
| Multifocality | 1 (4,3) | 17 (20,2) | 0,05 |
| Multicentricity | 2 (8,7) | 12 (14,3) | 0,37 |
| Bilaterality | 1 (4,3) | 1 (1,2) | 0,38 |
| Extension to the areola-nipple complex | 1 (4,3) | 7 (8,3) | 0,45 |
| Additional findings | 19 (82,6) | 70 (83,3) | 0,57 |
| Dynamic highlight curve | | | |
| Upward curve | 4 (17,4) | 6 (7,1) | 0,50 |
| Plateau curve | 4 (17,4) | 17 (20,2) | |
| Wash type curve | 12 (52,2) | 51 (60,7) | |
| No uptake | 3 (13,0) | 10 (11,9) | |
| Pattern of enhancement with contrast medium | | | |
| Focus | 2 (8,7) | 3 (3,6) | 0,63 |
| Nodule | 15 (65,2) | 59 (70,2) | |
| Non-nodular enhancement | 3 (13,0) | 14 (16,7) | |
| No uptake | 3 (13,0) | 8 (9,5) | |
| Angiomap by CAD-Stream | | | |
| Marking of injury | 16 (69,6) | 66 (78,6) | 0,26 |

Continue

Continuation

| MRI Results | Behavior change | | p |
|---|------------------|---------------|------|
| | Yes | No | |
| | n (%) | n (%) | |
| Contrast enhancement pattern | | | |
| Histological type of breast cancer | | | |
| Ductal in situ cancer | 3 (13,0) | 8 (9,5) | 0,54 |
| Lobular in situ cancer | - | 1 (1,2) | |
| Infiltrating ductal cancer | 18 (78,3) | 56 (66,7) | |
| Infiltrating lobular cancer | 1 (4,3) | 13 (15,5) | |
| Papillary cancer | 1 (4,3) | 1 (1,2) | |
| Spinal cord cancer | - | 1 (1,2) | |
| Others | - | 4 (4,8) | |
| Injury size | | | |
| Average | 34,3 (± 24,2) | 26,8 (± 22,5) | 0,13 |

In cases in which a change of therapeutic attitude was verified, the initial treatment with the greatest frequency of change was that of neoadjuvancy in 78.3 % (18) of these patients. Regarding the change according to the initial treatment recorded, the subsequent management of MRI and histological type of neoplasia, the following changes are highlighted (table 5).

Initial conservative treatment: in 66 %, two cases, posterior management was with mastectomy plus emptying, classifying one case as infiltrating ductal carcinoma and one case as ductal in situ carcinoma. One case (33.3 %) was classified as infiltrating ductal carcinoma and subsequent management was with neoadjuvancy. In three of the cases (100 %) where there was a change in management there were additional findings.

Initial treatment of neoadjuvancy: in 83.3 % (n = 15) of cases subsequent management was with mastectomy plus emptying, and the most frequent type was infiltrating ductal carcinoma (n = 12; 66.7 %). In three cases (16.7 %) the subsequent therapeutic management was conservative and were classified as infiltrating ductal carcinoma in two cases (11.1 %) and infiltrating lobular carcinoma in one case (5.6 %). In 72.2 % (n = 13) of the cases where there was evidence of change in the therapeutic approach, there were additional findings.

Initial treatment of mastectomy plus emptying: there was change in two cases, one towards conservative management and another to neoadjuvancy. Both cases were classified as infiltrating ductal carcinoma. At 100 % (n = 3) of the cases where change in management was evidenced, there were additional findings.

Table 5. Change in therapeutic behavior according to the type of histopathological cancer

| Initial treatment | Histological type of breast cancer | Conservative n (%) | Neoadjuvancy n (%) | Mastectomy plus emptying n (%) |
|--------------------------|------------------------------------|-----------------------|-----------------------|-----------------------------------|
| Conservative | Ductal in situ cancer | 0 | 0 | 1 (33,3) |
| | Infiltrating ductal cancer | 0 | 1 (33,3) | 1 (33,3) |
| Neoadjuvancy | Ductal in situ cancer | 0 | 0 | 2 (11,1) |
| | Infiltrating ductal cancer | 2 (11,1) | 0 | 12 (66,7) |
| | Infiltrating lobular cancer | 1 (5,6) | 0 | 0 |
| | Papillary cancer | 0 | 0 | 1 (5,6) |
| Mastectomy plus emptying | Infiltrating ductal cancer | 1 (50,0) | 1 (50,0) | 0 |

Discussion

Nowadays it is well recognized the importance of MRI for the following indications: study for adequate assessment of the extension of the disease in the pretreatment (staging), detection of relapse in the treated breast, detection of occult neoplasia (patients with histological diagnosis

of metastasis in the documented axillary ganglion), monitoring of neoadjuvant chemotherapy, women with high risk for family history of breast cancer by direct maternal line, ideally with genetic study or diagnosis of breast cancer and evaluation of breast implants (3).

Several studies have published favorable results on its sensitivity and

specificity (Sensitivity 95-100 % and specificity 80-93 %), despite the variability that is presented according to the indication of the exam (4-8).

Significant advances have been found in the study of the impact of breast MRI on the change in therapeutic behavior, which is relevant at the time of defining a specific therapeutic method and it has been demonstrated that it can be modified in 11 to 20 % of cases after applying this technique (6,8-11). Three publications emphasizing the change in the therapeutic behavior due to MRI findings are highlighted (12,13). In the study by Camps et al. (5), 338 patients with a diagnosis of breast cancer were followed up, in which a behavioral change was described in 24.2 % of the cases. Of the total of these cases, the change of approach was correct in 20.4 % and more frequently consisted on the modification of conservative surgery (30.4 % additional excisions), followed by conservative surgery to mastectomy (29.1 %). Another study, published by Avendaño et al. (14), reports a post-MRI behavior change of 42.5 % in patients with an initial treatment of conservative surgery, most frequently modified to mastectomy (29.7 %). There are studies that demonstrate that the patients who obtain greater benefit from preoperative breast MRI are young, with dense breasts and with histological diagnosis of invasive lobular carcinoma (15). Several publications have revealed that women who underwent preoperative MRI received a higher percentage of neoadjuvant chemotherapy than those who were not taken to preoperative MRI, and of the latter, most required a new surgical intervention. The conservative management was higher in women who did not undergo MRI while 50 % of those who had MRI were submitted to a more aggressive treatment (quadrantectomy, mastectomy and neoadjuvant chemotherapy) (10,16).

The study published here found a change in therapeutic approach in 24 % of the patients: the change of neoadjuvancy to mastectomy plus emptying (78.9 %) was the most frequent, followed by conservative treatment to mastectomy plus emptying (66 %), findings very similar to those of the mentioned studies; displaying a greater frequency of change from conservative treatment to a more aggressive one, as a consequence of the additional findings in the MRI.

Infiltrating ductal (68.5 %) and lobular infiltrating carcinomas (12.6 %) were the most frequent in the study population, similar to the information reported by Camps (5) and Avendaño (14), who indicate a frequency of 54 and 79.2 % of cases of ductal type carcinoma, respectively, with in situ component up to 10.8 % of cases.

Of the variables studied, the only statistically significant difference related to behavior change was the size of the lesion, possibly because of the low sample size. We believe that a more representative sample is needed to assess the statistical significance of the other variables.

We consider that, despite having limitations on the size of the sample, these results provide evidence highlighting the importance of MRI for local staging of breast cancer; however, it is necessary to carry out prospective studies that can evaluate the change of therapeutic behavior comparing the results found by different imaging techniques and clinical assessment, with the objective of validating the performance of the MRI in our environment.

Conclusion

Our study highlights the importance of MRI in changing therapeutic behavior, evidencing that in one out of four cases of breast cancer a change in management after the MRI findings was observed, possibly influenced by the size of the lesion and the additional findings that should be evaluated with subsequent studies.

References

1. Tan J, Orel S, Schnall M, et al. Role of magnetic resonance imaging and magnetic resonance imaging guided surgery in the evaluation of patients with early-stage breast cancer for breast conservation treatment. *Am J Clin Oncol.* 1999; 22:414-8.
2. Teifke A, Lehr HA, Vomweg TW, et al. Outcome analysis and rational management of enhancing lesions incidentally detected on contrast-enhanced MRI of the breast. *AJR Am J Roentgenol.* 2003;181:655-62.
3. Mann RM, Balleyguier C, Baltzer PA, Bick U, Colin C, Cornford E. Breast MRI: EUSOBI recommendations for women's information. *Eur Radiol.* 2015;25:3669-78.
4. Tillman GF, Orel SG, Schnall MD, et al. Effect of breast magnetic resonance imaging on the clinical management of women with early-stage breast carcinoma. *J Clin Oncol.* 2002;20:3413-23.
5. Camps J, Sentis M, Ricart V, et al. Utilidad de la resonancia magnética en la evaluación local del cáncer de mama: impacto en el cambio de actitud terapéutica en una serie prospectiva de 338 pacientes. *Rev Senol Patol Mam.* 2007;20:53-66.
6. Schelfout K, Van Goethem M, Kersschot E, et al. Contrast-enhanced MR imaging of breast lesions and effect on treatment. *Eur J Surg Oncol.* 2004;30:501-7.
7. Beran L, Liang W, Nims T, et al. Correlation of targeted ultrasound with magnetic resonance imaging abnormalities of the breast. *Am J Surg.* 2005;190:592-4.
8. Lira França LK, Vieira Bitencourt AG, Souza Oaiva HL, Baptista Silva C, Pacheco Pereira N, Paludo J, et al. Role of magnetic resonance imaging in the planning of breast cancer treatment strategies: comparison with conventional imaging techniques. *Radiol Bras.* 2017;50:76-81.
9. Bedrosian I, Mick R, Orel SG, et al. Changes in the surgical management of patients with breast carcinoma based on preoperative magnetic resonance imaging. *Cancer.* 2003;98:468-73.
10. Berg WA, Gutiérrez L, Ness-Aiver MS, et al. Diagnostic accuracy of mammography, clinical examination, US, and MR imaging in preoperative assessment of breast cancer. *Radiology.* 2004;233:830-49.
11. Tsina G, Simon P. Breast magnetic resonance imaging and its impact on the surgical treatment of breast cancer. *Obstet Gynecol Int.* 2014;2014:632074.
12. Sardaneli F, Giusepetti G, Panizza P, et al. Sensitivity of MRI versus mammography for detecting foci of multifocal, multicentric breast cancer in fatty and dense breasts using the whole-breast pathologic examination as a gold standard. *AJR Am J Roentgenol.* 2004;183:1149-57.
13. Hlawatsch A, Teifke A, Schmidt M, et al. Preoperative assessment of breast cancer: Sonography versus MR imaging. *Am J Roentgenol.* 2002;179:1493-501.
14. Avendaño-Ávalos DB, Garza-Montemayor ML. Papel de la resonancia magnética en la decisión del tratamiento quirúrgico en pacientes con diagnóstico reciente de cáncer de mama. *An Radiol México.* 2014;13:277-91.
15. Debal M, Abramian A, Nemes L, et al. Who may benefit from preoperative breast MRI? A single-center analysis of 1102 consecutive patients with primary breast cancer. *Breast Cancer Res Treat.* 2015;153:531-7.
16. Camps Herrero J. Resonancia magnética de mama: estado actual y aplicación clínica. *Radiología.* 2011;53:27-38.

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