FOCAL BREAST LESIONS - ASSESSMENT WITH DYNAMIC CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING

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FOCAL BREAST LESIONS - ASSESSMENT WITH DYNAMIC CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING (Abstract): Aim: To evaluate breast magnetic resonance imaging for the characterization of the breast lesions and compare to pathology. Material and methods: Our study included 64 subjects aged 21 to 76 years with newly discovered breast lesions by mammography and ultrasound who underwent contrast-enhanced MRI at Arcadia Medical Center, Iași between January and December 2016. The following were analyzed: lesion morphology (shape, contour and signal intensity), enhancement pattern and enhancement curve. Results and discussion: Of the total of 65 subjects 44 presented benign lesions and 20 malignant lesions. Lesion morphology was consistent with the pathological diagnosis in 59 cases (90.8%). The shape of the masses was mostly oval or round in the benign lesions (29 cases) and mostly irregular in the malignant ones (11 cases). The contour was lobular in 27 benign masses and irregular in 16 malignant lesions. Regarding signal intensity of the lesions we found that the cysts had a water signal intensity and the solid lesions various combinations of signals. Conclusions: The rapid upslope of the enhancement curve either the first 2 minutes is associated with malignancy and a plateau in the delayed phase with an uncertain diagnosis of malignancy. Benign lesions were round or oval, with well defined, smooth or lobulated margins, low signal intensity in T1 weighed images, high signal intensity in T2 weighted images, homogenous contrast uptake, persistent enhancement curve (fibroadenomas and fibrocystic changes) and no enhancement (cysts). Breast cancer is an irregular mass, with irregular or spiculated margins, variable signal intensity in T1 and T2 weighted images, heterogeneous contrast enhancement and washout enhancement curve. Keywords: MASS LESIONS, MRI, ENHANCEMENT CURVE.

Among the breast lesions the most important is breast cancer, which constitutes a major medical, social and economic problem. Although reliable estimates are lacking in many countries, the incidence of breast cancer in Romania was 46.2 per 100,000 population in 2000 and was the main cause of death in women over 40 years old (28.2 per 100,000 population) (1, 2). The incidence of breast cancer increases with age, with two peaks at 45-50 and 55-65 years. Over 250,000 new cases of breast cancer are diagnosed every year in the European Union and 172,000 new cas-
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es/year in USA (3, 4).

The symptoms related to the disease, its complications, the anxiety given by the diagnosis alone and the treatment have a great negative impact on quality of life. The long-term prognosis of breast cancer is worse than for other cancers; the 5-to 10-year mortality rate is approximately 35-50%. The cost of medical care is measured in billions of euro (5, 6).

Breast cancer is a complex disease with a variable combination of symptoms and signs. Many breast cancers occur in women without any identifiable risks; none of the risk factors is determinant and most of them have expression in women over 50 years of age (7, 8, 9). The early diagnosis of the tumor is highly important, because it reduces mortality and morbidity, increases the quality of life and makes possible a conservative surgical treatment (10, 11).

Dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) of the breast is an important new tool for the detection and characterization of breast lesions. The use of DCE-MRI for breast cancer detection is based on the concept of tumor angiogenesis or neovascularity. Tumor-associated blood vessels have increased permeability, which leads to prompt uptake and release of gadolinium leading to a pattern of rapid enhancement and washout on MRI. This dynamic rapid enhancement pattern helps to distinguish breast cancers from benign lesions. Literature reports have shown that not all malignant lesions show enhancement at DCE-MRI with enhancement absent in up to 12-16% of known malignant lesions, mainly due to small tumor size and diffuse parenchymal enhancement. Diffusion-weighted imaging (DWI) sequences and apparent diffusion coefficient (ADC) can help the differential diagnosis between benign and malignant lesions; ADC is a quantifiable parameter of the molecular movement of water; studies depicted high ADC values in benign lesions and normal fibro-glandular breast tissue, and low values in malignant lesions (12).

MATERIAL AND METHODS

Our study included 64 female patients aged 21 to 76 years old, with newly discovered breast lesions by mammography and ultrasound who underwent contrast-enhanced MRI at the Iasi Arcadia Medical Center between January and December 2016. The following were analyzed: lesion morphology (shape, margins, signal intensity), enhancement pattern (homogenous, heterogeneous, thin or thick rim, dark or enhanced septations), enhancement curve (Kuhl curve): type III (washout) – malignant, type II (plateau) – undetermined and type I (progressive) – benign.

MRI examinations were performed using a Philips Achieva 1.5 T equipment; gadolinium contrast-enhanced breast MRI protocol included:

- patients were asked to sign the informed consent for MRI assessment and fill out a breast questionnaire;
- an intravenous line was placed; the patient was scanned in prone position, and each breast was centered within the aperture of the dedicated radiofrequency breast coil;
- axial T1-weighted spin-echo sequences for localization;
- sagittal fat-suppressed T2 weighted sequences, with repetition time (RT) 4,600 ms and echo time (ET) 84 ms, field of view (FOV) 18 cm, matrix 256 x 192, contiguous 2-mm sections;
- 3D axial 3D fat suppression fast spin echo (FSE) 3D axial T1-weighted fast spin-
Focal breast lesions - assessment with dynamic contrast-enhanced magnetic resonance imaging

echo (FSE) fat-suppressed sequences before and every minute after gadolinium injection (0.1 to 0.2 mmol/kg, injection rate 2 mL/s), for 5 minutes, RT/ET 11.0/4.2, FOV 18 cm, matrix 256 x192, contiguous 2-mm sections;

RESULTS

Of the total of 65 subjects, breast MRI discovered in 44 (56.6%) cases benign lesions (fibroadenomas in 18 cases (27.6%), fibrocystic changes in 14/21.5%, cysts in 11/16.9%, and intra mammary lymph node in 1/1.5%) and malignant lesions in 21 (32.3%).

The shape of the masses was mostly oval or round in the case of benign lesions (29 cases/65.9%) and mostly irregular in the malignant ones (11 cases/52.4%). The contour was lobular in 27 (61.4%) benign masses and irregular in 16 (76.1%) malignant lesions.

We had studied also the signal intensity of the lesions: the cysts had water signal (low signal intensity in T1-weighted images and high signal intensity in T2-weighted images), but the solid lesions showed a heterogeneous signal, given by the components of the mass (solid, necrosis, mucin) and the most frequent was:

- isointense signal on T1-weighted and high signal intensity on T2-weighted images (16-36.4%) in case of benign lesions;
- isointense signal on T1- and T2-weighted images and low signal intensity on T1-weighted and high signal intensity on T2-weighted images (6/28.5 % lesions respectively) in case of malignant lesions.

In our study the pattern of malignant tumors was as follows (fig. 1):

- irregular mass (11/52.4% cases), with spiculated or irregular margins (19/90.5%);
- the signal intensity was low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (6/28.5 % cases) and signal intensity on T1- and T2-weighted images like parenchyma (6-28.5% cases);
- heterogeneous contrast enhancement was the most frequent pattern (12/57.1%), followed by homogeneous (5/23.8%) and clumped enhancement (4/19%); thick rim, central enhancement, enhancing internal septations were not encountered;
- type III (washout) enhancement curve was demonstrated in most cases (12/7.4%)

Fig. 1. Breast MRI, breast cancer with chest wall and nipple invasion - irregular mass, with spiculated margins, low signal intensity on T10 weighted images (a), homogeneous contrast enhancement (b)
chest wall and nipple invasion or lymph node enlargement were additional features which confirmed the malignancy, but were found only in 4 cases with advanced disease.

Fibroadenomas were oval, with well-defined, smooth or lobulated margins, iso-intense on T1-weighted images, high signal intensity on T2-weighted images, homogeneous enhancement (17/94.4%) or dark (unenhanced) internal septations (1-5.5%), with a progressive enhancement curve (fig. 2).

All the cysts were oval or round, had smooth margins, maximum 35 mm in size, water signal intensity; 2 (18.2%) patients had cysts with thin-rim enhancement (inflammation around the cysts) and in 9 (81.8%) patients there was no contrast uptake.

At MRI, the fibrocystic parenchyma is difficult to distinguish from normal breast on non-contrast-enhanced sequences; on post-contrast T1 weighted sequence stippled regional or heterogeneous contrast uptake was seen, which varies with the menstrual cycle. Enhancement curve had continuous (11/78.6%) or plateau (3/21.4%) pattern.
Single and clustered cysts of 3 mm to 23 mm in size, with no contrast enhancement were discovered, signal intensity being homogeneous in 12 (85.7%) cases (simple cysts) and heterogeneous, with fluid-fluid level in 2 (14.3%) cases (complicated cysts).

In one patient with ultrasound suspicion of breast nodule MRI detected an intramammary lymph node, which had an oval shape, smooth margins, central fat content and peripheral uptake of the contrast medium with progressive enhancement curve.

The morphology of the lesions was confirmed in 59 (90.8%) cases by the pathologic diagnosis.

**DISCUSSION**

In malignant tumors, we encountered various aspects:
- in our study the shape and margins of the lesions were like those reported in the literature: most of them had irregular shape, spiculated or irregular margins;
- signal intensity in our study was – low signal intensity on T1-weighted images and high signal intensity on T2-weighted images and signal intensity on T1- and T2-weighted images like parenchyma, compared to the data in the literature (signal intensity on T1-weighted image like that of parenchyma, and isointense to low signal intensity compared to parenchyma on T2-weighted image;
- heterogeneous contrast enhancement was the most frequent pattern, finding in agreement with the literature data, and thick rim or central enhancement, enhancing internal septations were not encountered;
- in agreement with the literature data, type III (washout) enhancement curve was demonstrated in most cases.

The pattern of most fibroadenoma cases in our study was like that described by preexisting studies: oval or round, with well-defined, smooth or lobulated margins, isointense on T1-weighted images, high signal intensity on T2-weighted images, homogeneous enhancement with a plateau enhancement curve.

Our study confirms that irregular shape is consistent with the diagnosis of malignancy (it was not encountered in any benign lesion). The oval or round shape was a pattern of benign lesion in 29 cases but was also found in 6 cases of malignant tumors; the oval or round shape had a relative risk (RR) of benign mass of 1.55 and an attributable risk (AR) of 0.59, so it is a pattern of benign lesions.

The irregular and spiculated margins were found only in the malignant tumors, but the lobular margins were encountered in 27 benign and 2 malignant masses; lobular margins had a RR of benign mass of 1.27 and an AR of 0.46, so it is a pattern of benign lesions.

Washout type of enhancement curve was found only in case of malignancy, but the progressive type was encountered in 25 benign and 7 malignant lesions, plateau type in 19 benign and 2 malignant cases. The progressive type of contrast uptake had a RR of benign mass of 1.27 and an AR of 0.21, so it is a pattern of benign lesions and the plateau type a RR=0.5 and AR = -21 so it is not consistent with a benign or malignant lesion (tab. I).

We found that the rapid upslope of the enhancement curve within the first 2 minutes is associated in 96% of cases with malignancy and a plateau in the delayed phase (minutes 2 to 5) can be associated with a 45% chance of benign and a 55% chance of malignant lesions.
TABLE I

<table>
<thead>
<tr>
<th>MRI pattern</th>
<th>Malignant lesion</th>
<th>Benign lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shape</strong></td>
<td>irregular</td>
<td>Round or oval</td>
</tr>
<tr>
<td><strong>Margins</strong></td>
<td>irregular or spiculated</td>
<td>Smooth or lobular</td>
</tr>
<tr>
<td><strong>Enhancement</strong></td>
<td>heterogeneous</td>
<td>homogeneous</td>
</tr>
<tr>
<td><strong>Enhancement curve</strong></td>
<td>washout</td>
<td>progressive</td>
</tr>
<tr>
<td><strong>Signal intensity</strong></td>
<td>isointense on T1, high signal on T2-weighted images</td>
<td>Variable signal intensity</td>
</tr>
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</table>

**CONCLUSIONS**

The most notable finding of our study is that the rapid upslope of the enhancement curve within the first 2 minutes is associated with malignancy and while a plateau in the delayed phase is a cause of uncertain diagnosis of malignancy.

Benign lesions were round or oval, with well-defined, smooth or lobulated margins, low signal intensity on T1-weighted images, high signal intensity on T2-weighted images, homogeneous contrast, with a persistent enhancement curve (fibroadenomas and fibrocystic changes) and no enhancement (cysts).

Breast cancer is an irregular mass, with irregular or spiculated margins, variable signal intensity in T1- and T2-weighted images, heterogeneous contrast enhancement and washout enhancement curve.

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