

The role of US and MR imaging in detecting local chest wall tumor recurrence after mastectomy

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PURPOSE

To determine the role of clinical examination, ultrasonography (US), and magnetic resonance imaging (MRI) in detecting local tumor recurrence in patients who underwent modified radical mastectomy for breast cancer.

MATERIALS AND METHODS

The study included 27 patients who were examined between April 1999 and April 2003. US evaluation of the chest wall was performed in all patients. MRI was performed on 10 patients due to suspicious findings in clinical examination, on 3 patients due to US findings, and on 8 patients due to both US and clinical examination findings. Six patients without any suspicious findings underwent MRI for follow-up purposes. The lesions detected with MRI were evaluated according to their morphology, contrast enhancement characteristics and dynamics. The focal lesions that enhanced intensely at the early phase were accepted as suspicious for malignancy.

RESULTS

Of the 10 cases that underwent biopsy secondary to suspicious lesions for malignancy according to MRI findings, 7 were found to have recurrence. In the remaining 3 patients, recurrence diagnosis was made based on the fact that the lesions regressed in response to chemotherapy. In 17 cases, there were no suspicious findings on MRI for local recurrence. In 2 of these cases, biopsies were performed due to suspicious US findings; however, no malignancies were detected. The sensitivity and specificity of clinical examination in detecting local recurrence was 70% and 35.2%, respectively. These values were 90% and 88.2% for US, and 100% and 100% for MRI.

CONCLUSION

In patients with mastectomy, US and MRI were more successful in detecting local recurrence than clinical examination. Considering the fact that US is cheaper and more readily available than MRI, it should be part of the routine follow-up in order to detect local recurrence early. MRI will be helpful in cases with suspicious US findings by increasing the specificity of the evaluation as well as determining the actual size and spread of any lesions, which is valuable information for the subsequent management and response to the particular treatment.

Key words: • breast neoplasms • recurrence
• magnetic resonance imaging • ultrasonography

Despite developments in surgical treatment, radiotherapy, and adjuvant chemotherapy protocols, tumor recurrence and metastasis have remained as a major problem in breast cancer management. Chest wall recurrence after mastectomy is classified into 2 groups: local recurrence (sternum, clavicles, posterior axillary line and skin around the costal arc, subcutaneous tissue, chest wall, and rib lesions) and regional recurrence (axillary, internal mammary, and supra- and infraclavicular lymph ganglion recurrence). In general, the terms local recurrence or locoregional recurrence refer to both groups of recurrences.

The rate of local recurrence at the chest wall following mastectomy ranges between 5% and 27%. Around 80% of local recurrences occur within the first 5 years and 25%-35% cause significant morbidity. Although it had been thought that the early diagnosis of local recurrence did not affect prognosis, currently it is known that early diagnosis is important for prognosis since only 30% of recurrences have distant metastases at the time of diagnosis (1). Recent studies have shown that the size and number of post-operative local recurrences affect prognosis, as well as the T status of primary tumors during mastectomy and lymph node involvement (2-6).

Clinical examination is a must, but not entirely sufficient for evaluation of the mastectomy region. Clinical examination is relatively weak in the early diagnosis of local recurrence as well as in determining its spread and size in comparison to radiological modalities.

The purpose of this study was to evaluate the roles of ultrasonography (US) and magnetic resonance imaging (MRI) in detecting local breast cancer recurrences and to compare them to clinical examination findings.

Materials and methods

The study included 27 women (11 with right and 16 with left modified mastectomy for breast cancer performed between April 1999 and April 2003), who were evaluated for locoregional recurrence at the chest wall with US and MRI. Patient age ranged from 30 to 73 years (mean, 50.8 years). Time interval between surgery and MRI was between 1 month and 9 years (mean, 27.7 months). All patients were examined by a clinician prior to referral to the radiology department and all the examination findings were documented.

MRI was performed on 10 patients due to suspicious findings in clinical examination, on 3 patients due to US findings, and on 8 patients due to both US and clinical examination findings. Six patients without any suspicious findings underwent MRI for follow-up purposes, as requested by the clinician.

All the patients underwent mammography—and US if needed—for the contralateral breast and US (Siemens, Sonoline SI 400, Germany) of the chest wall ipsilateral to the mastectomy site prior to the MRI exam.

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A 7.5 MHz linear array probe was used for all US examinations. In US evaluations, the presence of a mass lesion, the size and border of the mass(es) (smooth, irregular, or unclear), echo structures, such as acoustic impedance and relationships to surrounding structures, and solid or cystic specifications were determined.

A special dual breast coil was used for MRI examinations (1.0 Tesla, Siemens Magnetom Impact, Erlangen, Germany). Axial T2-weighted turbo SE (TR/TE, 5200/90 msec; slice thickness, 5 mm), axial and sagittal (if needed) T1-weighted FLASH 3D (TR/TE, 19/7 msec; matrix, 256 × 256; field of view, 33 cm; slice thickness, 4 mm; acquisition time, 70 s; flip angle, 30°) sequences were used in all examinations with dynamic contrast enhancement. Initial phases of dynamic exams were obtained without contrast. Intravenous (IV) contrast material injection (0.2 mmol/kg IV bolus; Magnevist, Schering, Germany) was then performed during the 30 s equipment waiting period with the patient laying still. Each field of view was scanned 4 times with no time interval between each scan. Sagittal images were initially obtained without contrast and then during the late phase of the dynamic exam with contrast. Overall scan time was around 15 to 20 min. To detect any contrast enhancement, subtraction images were obtained by subtracting the no contrast images from early and late contrast phase dynamic images using the standard software functions of the equipment. In cases with contrast enhanced lesion(s), time/signal intensity curves were obtained, which demonstrated contrast enhancement rate by time and contrast enhancement intensity by time. These time/signal intensity curves were classified into 3 types, as reported in the literature (7):

- a) Type 1: signal intensity of the lesion keeps increasing until the late phases after contrast injection;
- b) Type 2: increase in intensity peaks during the first 3 min and then draws a flat line;
- c) Type 3: increase in intensity peaks during the first 3 min and then decreases rapidly (washout phenomenon).

Morphological appearance of the lesions found at MRI were also detected. Size, border (smooth, lobular, irregu-

lar), and contrast enhancement characteristics (peripheral, central) were reviewed. The relationships between the lesions and the pectoral muscles, chest wall, and skin were assessed. Increased skin thickness, retraction, and the presence of a collection at the operation site were inspected. Any edema at the chest wall or contralateral breast parenchyma was evaluated on T2-weighted images. Lesion signal intensities on MRI were evaluated as hypo-, iso-, and hyperintense in comparison to the surrounding muscles in T1- and T2-weighted images.

In US examinations, all solid lesions and structural distortions that were considered to be other than postoperative scar formation at the site of operations were considered to be suspicious. All focal lesions that showed early and intense contrast enhancement with MRI (at least 2 times that of non-contrast exam) were accepted as suspicious for malignancy without considering the contrast enhancement patterns and morphological findings.

In cases with suspicious recurrence, diagnosis was proved in 7 patients with excisional biopsy or fine needle aspiration biopsy (FNAB). Histopathological verification was not needed in 3 cases, and chemotherapy was initiated. Additionally, in order to rule out malignancy, FNAB was performed in patients with highly suspicious US lesions that MRI did not show as a mass or as pathological contrast enhancement. Patients with no pathological US and MRI findings were scheduled for routine follow-up.

Results

Local recurrence at the chest wall was diagnosed in 10 patients. Diagnosis was made by FNAB in 5 cases, by excisional biopsy in 2 cases, and by response to chemotherapy in 3 patients. In 7 cases, invasive ductal carcinoma was found with histopathological examination. Table 1 provides the rate of recurrence diagnosed among the patients who underwent evaluation as a result of suspicious clinical examination (Table 2) and/or suspicious US findings, or for follow-up. No recurrence was detected in patients with only suspected clinical examination findings.

In local recurrence cases, the time interval between surgery and local recurrence was 9 months to 9 years (mean, 35.7 months). In cases without local recurrence, the time interval between surgery and MRI examination was 1 month to 4 years (mean, 22.9 months).

Local recurrence was diagnosed in 9 out of 11 cases that had suspicious lesions observed in US examinations. Among them, 7 patients also had suspicious clinical findings for local recurrence. Only US findings were suspicious for local recurrence in the remaining 2 patients. All the recurrences were focal mass lesions, except in 1 patient who had suspicious structural distortion. More than 1 focus was detected in 6 cases with local recurrence and the sizes of the lesions were between 1 and 9.5 cm. In a patient with no clinical evidence of recurrence, a false negative diagnosis was made by US examination, with a later positive diagnosis with MRI (Fig. 1).

Table 1. MRI indications in the study group

	Local recurrence (+)	Local recurrence (-)
Suspicious clinical examination findings	-	10
Suspicious US findings	2	1
Suspicious clinical exam and US findings	7	1
Control	1	5
Total	10	17

Table 2. Distribution of clinical findings in the study group

Clinical findings	Local recurrence (+)	Local recurrence (-)
None	3	6
Swelling/pain	-	1
Redness	2	1
Mass/firmness	5	9

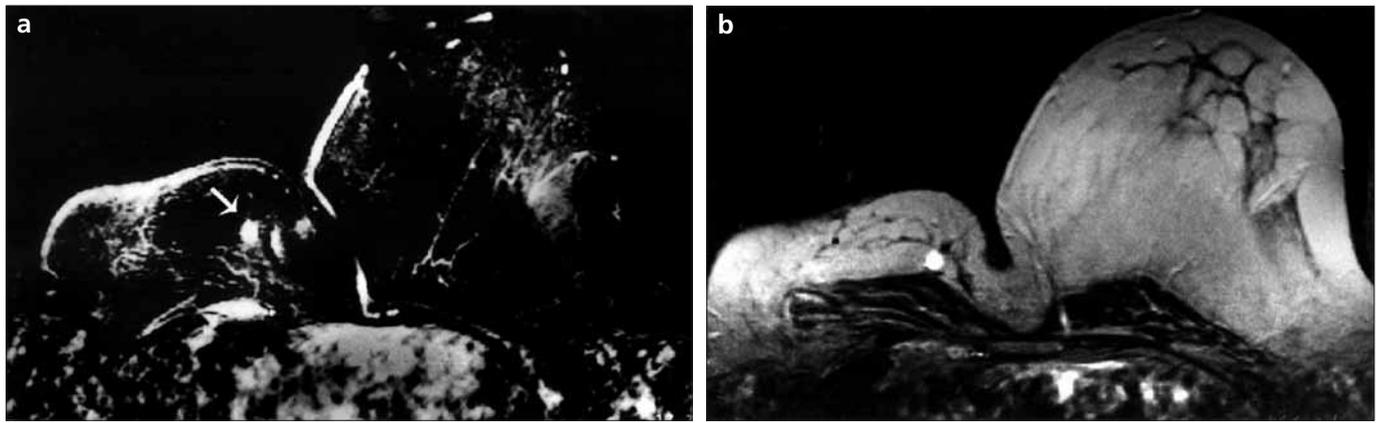


Figure 1. a-c. A 52-year-old female with a history of mastectomy performed 3 years previously, referred for follow-up purposes. No lesion was detected with US. Subtraction MRI (a) shows a nodule with intense contrast enhancement at the inner side of the right chest wall (arrow). Type 3 contrast enhancement in time/signal intensity curve obtained from the dynamic MRI view (b, c) of the nodule. An excisional biopsy after marking the approximate location of the lesion revealed invasive ductal carcinoma.

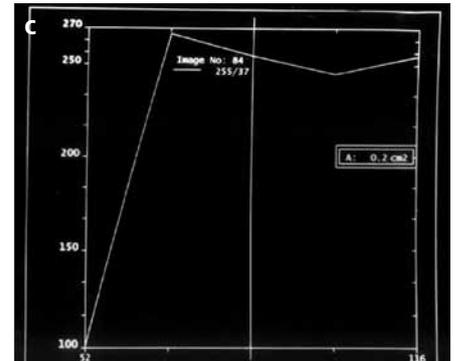
In all 10 patients who had local recurrence according to histopathological examination and response to the chemotherapy, MRI results were compatible with recurrence. The sizes of the lesions detected with MRI as local recurrences were between 1 and 11 cm. More than 1 tumoral focus was found in 6 patients. MRI showed more extensive involvement or more foci than was seen with US in 5 cases (Fig. 2). MRI was the only modality that detected the recurrent mass in one patient. Among the patients with recurrences, 6 had lesions with irregular borders and 4 had lesions with smooth borders. Among the recurrence cases, MRI revealed peripheral contrast enhancement in 5 cases, diffuse contrast enhancement in 3 cases, and non-homogeneous contrast enhancement in 2 cases' recurrent lesions. Time/signal intensity curves were created for suspicious lesions based on early and late phase subtraction images from dynamic examinations with contrast material; 5 cases had type 3 and 2 curve patterns, whereas 2 cases had both types 3 and 1, 2 cases had only type 3, and 1 case had only a type 1 curve pattern. The most suspicious curve pattern was tak-

en into consideration. Nine cases had type 3, and 1 case had a type 1 curve pattern. Contrast enhancement intensity during the first 3 min ranged from 2.5 times to 8 times the baseline.

In 6 cases with local recurrence, several degrees of chest wall edema were detected by MRI. There was no chest wall edema or contralateral breast edema in 4 cases. Chest wall edema was detected in 2 cases, in which MRI did not detect any local recurrence (Table 3). The presence of edema was statistically significant according to Fisher's exact probability test ($P = 0.014$).

In 2 cases with clinically palpable chest wall lesions, US and MRI showed postoperative collections. Collections disappeared with residual scar tissue at follow-up MRI exams in 1 of these 2 cases. The size of the other collection was observed to have decreased at US follow-up.

Diffuse contrast enhancement at the chest wall along the pectoral muscles was detected secondary to early postoperative changes in a patient one year after surgery. Since there was no lesion suspicious for recurrence, this patient received close clinical and radiological follow-up, and during the next 3 years,



no changes suspicious for recurrence were detected.

MRI did not reveal any suspicious finding for local recurrence in 17 patients. Of these patients, 10 had suspicious clinical findings, 1 had suspicious US findings, and 1 case had both suspicious clinical and US findings. MRI was performed only for follow-up purposes in 5 cases. Two cases underwent US guided FNAB of the suspicious lesions at the chest wall which were detected by US and/or clinical examination, while there were no suspicious lesions found with MRI. Two hypochoic lesions at the upper outer quadrant of the chest walls in 2 patients were detected with US. One of these lesions had smooth borders, while the other had irregular borders. The one with smooth borders was histopathologically determined to be an oil cyst and the one with irregular borders was found to be fat necrosis (Fig. 3). All the patients without evidence of recurrence based on MRI exams were clinically and radiologically followed up; no changes were detected during the follow-up.

Both the sensitivity and specificity of MRI in detecting local chest wall recurrence in patients with mastectomies was 100%. On the other hand, the sensitivity and specificity of US

Table 3. Case-based distribution of the presence of edema

	Local recurrence (+)	Local recurrence (-)
Edema (+)	6	2
Edema (-)	4	15
Total	10	17

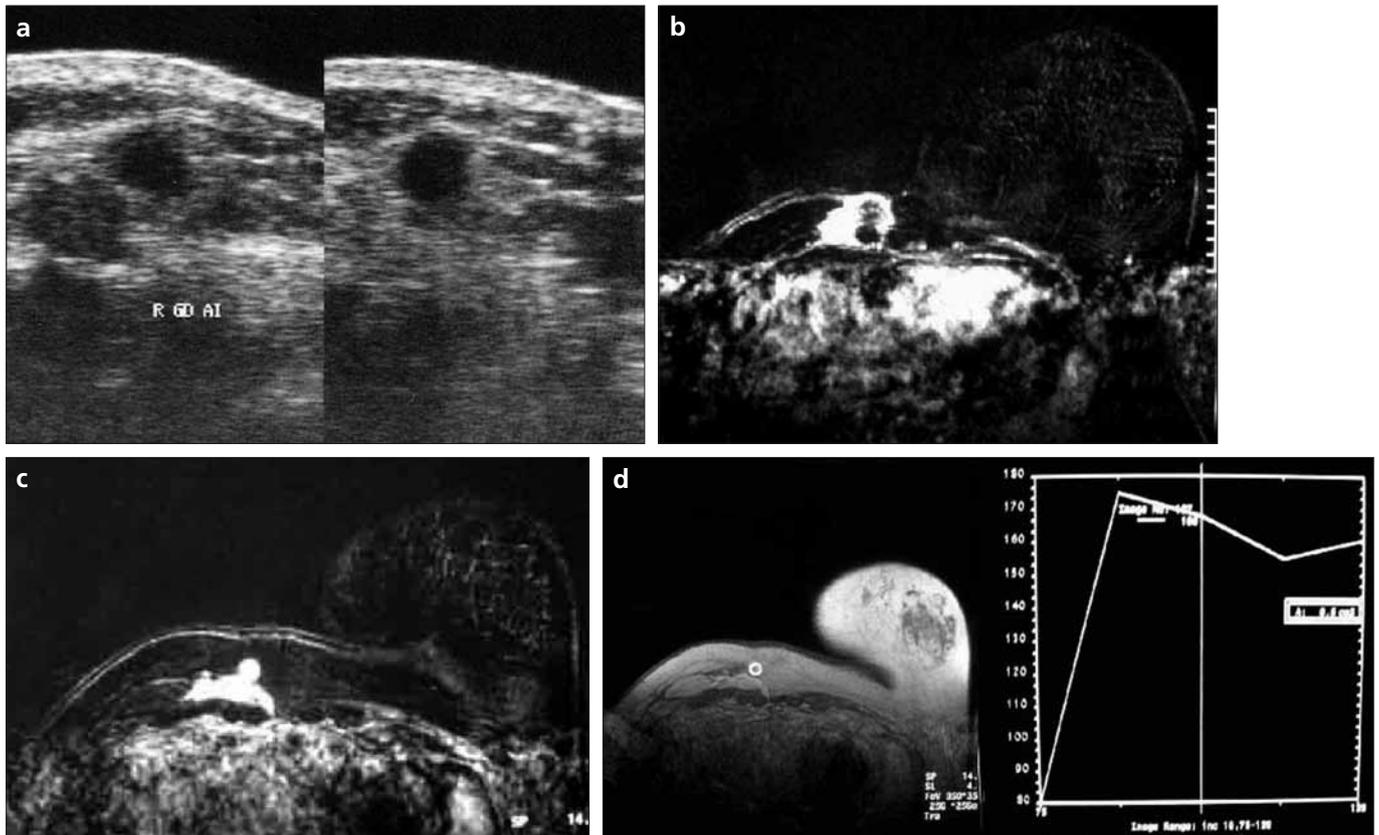


Figure 2. a-d. A 61-year-old female who underwent right mastectomy 5 years previously. US (a) revealed a 2 cm diameter solid mass with irregular borders and neighboring several solid masses as large as 1-cm in diameter, with irregular borders at the right chest wall skin, which extended into the deeper soft tissues from the medial corner of the incision line. Subtraction MRI view (b) shows a 4.5 × 3 cm mass with irregular borders invading the pectoral muscle and rib at the medial side of the right chest wall. MRI revealed that the mass was bigger than did US, and that it had invasion of deep tissue planes. Subtraction (c) and dynamic (d) MRI views, and time/signal intensity curve (d) from the nodular lesion at the right chest wall showed type 3 contrast enhancement pattern.

was 90% and 88.2%, respectively, and the sensitivity and specificity of clinical examination was 70% and 35.2%, respectively (Table 4).

Discussion

Despite the increasingly widespread application of preservative breast surgery techniques for breast cancer, modified radical mastectomy is still considered to be the primary treatment method. The risk of local recurrence at the chest wall is around 5%–10%, despite surgery. This rate is even higher in local advanced stage cancers. In patients who receive postoperative radiotherapy to the chest wall and lymph node regions, the risk of local recurrence in 5 years is around 3.9% (6, 8, 9).

Local recurrence after mastectomy has a negative effect on survival. Distant metastases develop in a short period of time in most of these patients. Based on recent studies, several prognostic factors have appeared to affect the survival of patients with local re-

currence. Among those factors, T status of the primary tumor, presence of axillary lymph node involvement, and the location, size, and number of the recurrent tumors are important. Patients with primary tumors of T1 and T2 without necrosis or axillary lymph node involvement, recurrent tumors only located at the chest wall or axilla, or a single recurrent lesion <3 cm have a much better prognosis (6, 10). However, patients with primary tumors of T3 and T4 or lymph node involvement at the time of initial diagnosis mostly have subclinical or clinical distant metastases. Cases with multiple and large

local recurrences have a similar prognosis (6).

In follow-up of patients with mastectomies, periodical clinical examinations are scheduled for early diagnosis of recurrent lesions. Recurrent lesions at the skin can easily be detected by clinical examination due to their obvious changes, such as palpable masses, skin thickening, retraction, edema, and redness. However, these findings are not specific for recurrences; therefore, clinical examinations can frequently result in false positivity. Moreover, recurrent lesions located deep within the soft tissue of the chest wall cannot be

Table 4. Statistical comparison of clinical examination, US, and MRI

	Sensitivity	Specificity	Positive predictive value
Clinical examination	70%	35.2%	48.1%
US	90%	88.2%	88.8%
MRI	100%	100%	100%

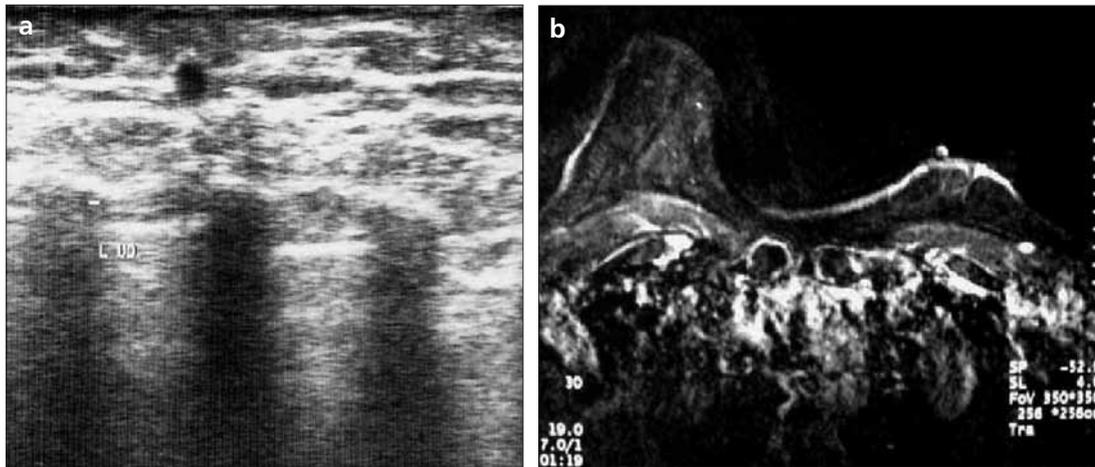


Figure 3. a, b. A 45-year-old female who underwent unilateral modified radical mastectomy for left breast cancer 2 years previously. US image (a) shows a 6 mm diameter hypoechoic lesion with irregular borders at the left upper outer chest wall. Subtraction MRI view (b) did not reveal any pathological contrast enhancement at the chest wall or contralateral breast after marking the lesion at the left chest wall, which was initially found to be suspicious with US. (Histopathological diagnosis: fat necrosis.)

easily detected by clinical examination, which has a significantly low sensitivity (6). Among the 18 patients in our study with clinically suspected recurrence, only 7 of them were diagnosed with recurrence. On the other hand, 2 cases without clinically suspicious findings were found to have recurrence with both US and MRI. Additionally, one case without clinically suspicious findings was found to have a recurrence with MRI. In the present study, clinical examination had low sensitivity (70%) and specificity (35.2%). This might have been due to the inexperience of the resident examiners who performed the physical examinations in some of the cases, which is a usual occurrence in a university hospital such as ours. However, daily practice encounters elsewhere are not very different.

US evaluation of the chest wall is not routinely performed in the follow-up of mastectomy patients. US is generally preferred due to several indications in cases of suspected findings at the chest wall by clinical examination or in cases in which the chest wall cannot be evaluated thoroughly due to postoperative or post-radiotherapy changes. US, indeed, would potentially provide much more information about the deeper tissues compared to clinical examination. Additionally, postoperative collections can be easily differentiated from recurrent lesions with US. False positive results in cases of fat necrosis and structural distortion due to surgery are disadvantages of US, as is the dependence on operator experi-

ence. There are studies regarding US evaluation of the chest wall (2, 11–15). Tarja et al. reported that the sensitivity of US evaluation in detecting recurrent lesions is higher than that of clinical examination (2). Sensitivity and specificity of US evaluation was 90% and 88.2%, respectively, and higher than that of clinical examination in our study, too. Biopsy was performed for undetermined hypoechoic lesions detected with US in 2 cases, which were found to be an oil cyst and fat necrosis. MRI correctly diagnosed no recurrence in both cases.

MRI has become an important part of the breast-imaging routine. Breast MRI is frequently preferred in patients with breast cancer who underwent preservative breast surgery. MRI is successful in these patients, both in early diagnosis of local recurrence and in differentiating recurrences from postoperative changes. Although there are recent studies that evaluated the effectiveness of MRI in patients who underwent preservative breast surgery and autogenous tissue reconstruction, there are not enough studies in the literature, which report on the role of MRI in detecting chest wall recurrence in mastectomy patients (16–18).

The time interval between MRI and surgery and radiotherapy is important in patients who have undergone preservative breast surgery, and performing MRI at least 3 to 6 months after surgery and 9 to 18 months after radiotherapy are the generally accepted intervals. Earlier exams may lead to false

positive results due to possible focal or diffuse contrast enhancement of chest wall inflammation, edema, fresh scar tissue, and fat necrosis (19, 20). Recent reports showed that the above-mentioned time intervals could be shorter (21–23). The amount of chest wall inflammation after mastectomy and whether there is proportional difficulty in diagnosis is not clear. We also had cases that underwent early evaluation in our study. Among those patients, no focal contrast enhancement was noted that would have led to difficulty in diagnosis, including 1 patient that showed low intensity contrast enhancement considered to be secondary to early postoperative changes.

Morphological and contrast enhancement characteristics in dynamic MRI exams are used to classify the lesions for differential diagnosis (24, 25). Contrast enhancement dynamics are evaluated based on the time-signal intensity curves. Type 3 curves are reported to be seen in 50% of malignant lesions, whereas type 2 curves are seen in 40% and type 1 curves in 10% (7). Of the 10 cases with focal contrast enhancement in our study, type 3 curve patterns were detected in 9; however, both type 2 and type 1 curves were obtained in 7 of these 9 patients. When reviewing the time-signal intensity curves, the area of interest should be focused on the point most enhanced with contrast, measurements should be performed several times from each lesion, and the most suspicious curve type should be taken into consideration. In this study, the

lesion with a type 1 contrast enhancement pattern was also initially considered to be malignant. The reason was that, unlike routine breast exams, there were no benign lesions of the chest wall other than the changes related to the treatment. Therefore, every kind of focal contrast enhancement was considered to be suspicious for malignancy in our study. Malignancy was proved in all 10 cases with focal contrast enhancement at the chest wall. Only 6 of these cases showed typical contour irregularity for malignancy and, similarly, in only 5 cases, peripheral circular contrast enhancement was noted. These findings suggested that the differential diagnostic criteria in chest wall MRI exams should be different than that of other breast MRI exams.

MRI is more accurate than US in determining the size and spread of recurrent lesions. In this regard, not only does MRI play an important role in the choice of treatment, but it also accurately evaluates the response of the lesions to systemic treatment. Likewise, in this study, 5 out of 10 cases with lesions seen with US actually had more lesions—and more tumoral spread—based on MRI. We believe that this is the most important advantage of MRI over US.

Chest wall edema was detected by T2-weighted MR images in 6 out of 10 cases with local recurrence. On the other hand, only 2 out of 17 cases without local recurrence showed edema. The presence of edema was statistically significant for malignancy ($P = 0.014$); therefore, more frequent follow-ups for local recurrence should be scheduled in cases with chest wall edema detected in a mastectomized patient.

In conclusion, clinical examination was inadequate in detecting local chest wall recurrence and deeply located lesions in our mastectomized patients. Similarly, it was inadequate in clarifying the confusions related to postoperative and post-radiotherapy changes. Despite the limited number of patients in the present study, our findings suggest that the sensitivity and specificity of US and MRI exams for detecting local recurrence were higher than clinical examination. Since US exams are cheaper and more readily available than MRI, we think that chest wall US exams should be added to the routine follow-up protocol for mastectomy patients. In this way, it will be possible to

detect recurrent tumors at earlier stages that are associated with better prognosis. MRI increases the specificity of the evaluation in patients with suspicious lesions detected with US. Furthermore, MRI is more accurate in detecting the size and spread of recurrent lesions. Hence, MRI plays an important role in treatment planning and is more objective in determining the response of these lesions to systemic treatment. Despite having no false negative results with MRI in our study, the number of our patients was too small to reach a definitive conclusion. More studies are needed with larger samples of patients to obtain more concrete results. Therefore, until the results of larger studies are obtained, diagnosis based on biopsy should be made for all suspicious lesions detected with US, even if they have negative MRI results.

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