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## The Added Value of Preoperative Magnetic Resonance Imaging of Breast in Surgical Decision

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### ABSTRACT

**Background:** Breast MRI has demonstrated excellent sensitivity in determining the extent of breast cancer and occult malignancy. This study aimed to evaluate the added value of breast MRI compared to mammography and ultrasonography in surgical decision.

**Methods:** A cross-sectional study was conducted on 84 female patients with newly diagnosed breast cancer by ultrasonography and mammography where conservative breast surgery was initially considered, and then bilateral breast MRI was performed and the multidisciplinary decision was revised. The data was analyzed to determine the additional value of breast MRI in treatment planning.

**Results:** Eighty-four patients were included of whom 44 (52.4%) patients had additional findings on MRI. The treatment plan was changed after the second ultrasonography and histopathology in 44 patients (52.4%) with a remarkable increase in the rate of modified radical mastectomy after MRI.

**Conclusion:** Preoperative breast MRI has great value in defining the surgical decision in patients with early breast cancer.

### Introduction

Conservative and oncoplastic breast surgeries have become the standard treatment in early-stage breast cancer, as they have survival rates equivalent to mastectomy with better cosmetic and psychological outcomes.<sup>1</sup>

Conservative breast surgery is essentially the complete removal of the mass and some surrounding grossly normal tissue with negative histological margins to decrease the risk of local recurrence, as positive margins could result in further surgery either as re-excision or mastectomy with poor cosmetic outcome.<sup>1</sup>

Oncoplastic breast surgery is independent of adjuvant treatments; it is defined as surgical techniques which allows larger resections with acceptable cosmetic results with conservative forms of breast surgery in more advanced breast cancer with immediate breast reconstruction, where main procedures are volume displacement or volume replacement techniques.<sup>2</sup>

The primary aim of any diagnostic imaging procedure is accurate detection of the lesion and extent of the disease for optimization of the best treatment plan and surgical intervention.<sup>3</sup>

Breast ultrasonography (US) and mammography have been considered as primary imaging modalities for breast cancer diagnosis for a long time, but residual disease and the presence of extensive intraductal components after conservative breast surgery are considered the most important factors for local recurrence.<sup>4</sup>

Patients with newly diagnosed breast cancer are at risk of having another occult ipsilateral lesion or contralateral breast cancer which may be not

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detected accurately by ultrasonography and mammography; thus more sensitive methods are needed especially when breast conservation is considered.<sup>5</sup>

Contrast-enhanced breast magnetic resonance imaging (MRI) has been used as the most sensitive imaging modality for local staging of breast cancer especially in detection of multifocality, and multicentricity of breast cancer and the presence of contralateral breast disease. Numerous studies have confirmed the impact of MRI breast and its superiority in diagnostic performance compared to routine imaging procedures (US and mammography).<sup>6</sup>

This study aims to determine the extent to which the addition of breast MRI to the routine radiological assessment of breast cancer patients affects the overall surgical decision.

### Methods

This cross-sectional study was done on 84 female patients with breast cancer diagnosis from January 2019 to February 2020. Patients were referred from the general surgery outpatients' clinic to the radiology department at Assiut University Hospitals for ultrasound (US) and mammography assessment, and then magnetic resonance imaging of breast (MRI) was done for each patient.

#### *Ethics approval and consent to participate*

This study was approved by the research ethics committee of the Faculty of Medicine at Assiut University, and all patients included in this study gave written informed consent to participate in this research. All patients also gave written informed consent to publish the data contained within this study.

#### *Inclusion criteria*

Female patients with breast cancer who were considered for conservative or oncoplastic breast surgery were recruited for this study.

#### *Exclusion criteria*

The exclusion criteria included patients with general contraindication for MRI examination (as metallic prosthesis or pacemaker) and patients with advanced breast cancer.

#### *Breast lesions assessment by US and mammography*

Mammography examination was done using GE Alpha RT, and US examination was performed using Phillips IU22 ultrasound system (Philips Healthcare, Bothell, Wa, USA) according to breast imaging protocol, with a linear transducer 5-12 MHz. Scanning parameters were optimized for each case. Then breast MRI was performed for each patient.

#### *MRI imaging protocol*

MRI examination was performed in the prone

position using a 1.5 Tesla system (Avanto Siemens Healthcare), and a four-channel breast coil was used. The sequence was as follows: Axial 3D T1 weighted image TR/TE, 8.6/7.4, the field of view 400mm, slice thickness 1mm, acquisition time 1:34 minutes; Axial T2 fat suppression TR/TE, 5250/60, the field of view 380mm, slice thickness 4mm, acquisition time 2:44minutes; Axial diffusion-weighted imaging TR/TE, 5300/91, the field of view 460mm, slice thickness 4.5mm, acquisition time 2:39 minutes.

DWI was acquired before dynamic sequences with a spin-echo EPI (echo-planner imaging) in the axial plane, and sensitizing diffusion gradients were applied along the x, y, and z directions with b values of 50, 400, and 800 s/mm<sup>2</sup>. Intravenous injection of contrast agent (Gadolinium-dimeglumine) (Gd-DTPA) (Magnevist, Schering AG Berlin, Germany) using power injector at a dose of (0.1 mmol/kg) at a rate of 2ml/s, was followed by a 20 ml saline flush administered using an automatic injector.

#### *Data analysis and image interpretation*

All MRI images were transferred to the work station (Syngo Siemens Medical Solutions software) for image analysis by the expert radiology team. Tumor factors including size, number, and location of breast lesions, the density of breast, and presence or absence of calcification were detected by US and mammography, and accordingly, the initial surgical plan was firstly decided based on the findings of US and mammography.

Then MRI findings regarding tumor size, multifocality, multicentricity, and contralateral suspicious breast lesions were analyzed, followed by a second US and the final surgical decision was taken by the multidisciplinary team accordingly, based on MRI findings after histopathological correlation.

Breast cancer was treated with modified radical mastectomy, conservative breast surgery, and or oncoplastic breast surgery. The comprehensive treatment plan including Neo-adjuvant or adjuvant chemotherapy, radiotherapy, and hormone therapy was tailored according to histopathological results and tumor characteristics.

#### *Statistical analysis*

Data were collected and analyzed using the statistical package for social sciences, version 20 (IBM Corp., Armonk, New York, USA). Continuous data were expressed in the form of mean, SD, or median (range), frequency (percentage), FP: false positive; and FN: false negative.

### Results

Eighty-four female patients with histologically confirmed breast cancer were employed in this study. The age range was between 27 and 63 years.

**Table 1.** Characteristics data of the participants(n=84)

Variables		N= 84
Age (Range, years)		27-63
Mass laterality	Right breast mass	36 (43%)
	Left breast mass	48 (57%)
Ultrasound evaluation		
	Unifocal mass	84 (100%)
Mammography		
	Unifocal mass	84 (100%)
	Calcification	22 (26%)
	Density	
	ACR-A	16 (19%)
	ACR-B	32 (38%)
	ACR-C	33 (39.3%)
	ACR-D	3 (3.6%)

The majority (57%) of women had left breast mass. Based on mammography and breast ultrasound, all studied women had unifocal breast mass. The density of the breast was classified into ACR-A, ACR-B, ACR-C, and ACR-D (Table 1).

Regarding breast MRI findings, it was noticed that 44 (52.4%), 12 (14.3%), and 28 (33.3%) patients had unifocal, multifocal, and multicentric mass(es), respectively. In 44 (52.4%) women, MRI was able to detect additional findings while mammography and breast ultrasound failed to detect such findings as suspected enhancement in

the other contralateral breast, suspected enhancement in the same breast, suspicious small mass in the other breast, and retro-areolar segmental enhancement (Table 2).

Concerning the histopathological evaluation. 8 (9.5%), 6 (7.1%), and 70 (83.33%) women had ductal carcinoma in situ, invasive lobular carcinoma, and invasive ductal carcinoma respectively (Table 3).

Regarding the surgical decision among the participants, the initial decision was changed in 44 (52.4%) women based on MRI findings while the decision was not changed in 40 (47.6%) women.

**Table 2.** MRI findings of the participants (n=84)

Variables		N= 84
Pattern of the mass	Unifocal	44 (52.4%)
	Multifocal	12 (14.3%)
	Multicentric	28 (33.3%)
Presence of other findings		44 (52.4%)
	Suspected enhancement in another breast	12
	Suspected enhancement in the same breast	16
	Suspicious small mass in the other breast	12
	Retro-areolar segmental enhancement	4

**Table 3.** Histopathological evaluation of breast masses among the participants

Histopathology	N= 84
Ductal carcinoma in situ	8 (9.5%)
Invasive lobular carcinoma	6 (7.1%)
Invasive ductal carcinoma	70 (83.33%)

On subset analysis of those with the changed decision, twelve patients (27.2%) with an initial surgical decision of unilateral oncoplastic breast surgery based on the sono-mammographic findings finally underwent bilateral oncoplastic surgery after additional MRI findings and a second US in the form of contralateral breast solitary masses.

Four patients (9%) initially were planned for oncoplastic surgery but when MRI revealed retro-areolar segmental enhancements the decision was changed to modified radical mastectomy.

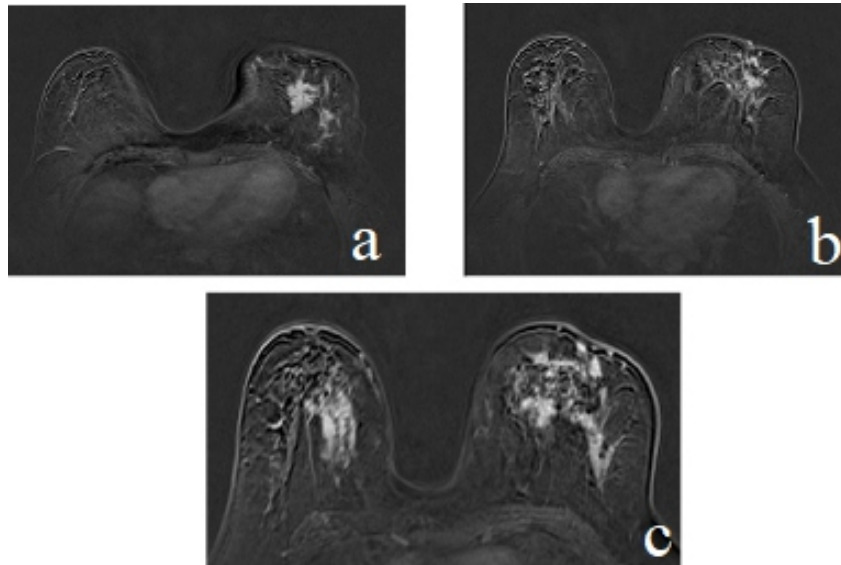
Sixteen (36.4%) women were initially planned for breast conservative surgery but based on additional MRI findings, the decision was changed to modified radical mastectomy due to multicentricity.

Regarding the postoperative histological

evaluation, this decision was appropriate in 12/16 (75%) women but in four women, the histopathology revealed more extensive lesions.

In twelve (27.2%) women, the initial decision was conservative breast surgery but this decision was changed to modified radical mastectomy with contralateral excisional biopsy based on MRI findings (Figure 1). Histopathological evaluation was in concordance with MRI findings in 10/12 but two women had benign lesions on the contralateral breast on histopathological evaluation.

According to our study, the utility of MRI in assessing the local extent of early breast cancer changed the surgical decision in 44 (52.4%) patients and these changes proved to be appropriate by the post-operative histopathological evaluation in 42



**Figure 1.** 37 year old female patient diagnosed with left breast cancer by US and mammography with extremely dense breast on mammography (ACR d), preoperative MRI was done and revealed

- a) Speculated outline malignant featuring left breast mass at about 6 o'clock.
- b) Multiple enhancing foci seen surrounding the mass with ductal enhancement denoting multicentricity.
- c) Suspicious non-mass enhancement at the upper inner quadrant of right breast. Histopathological examination proved multicentric invasive ductal carcinoma of the left breast and invasive ductal carcinoma of the right breast.

patients, and a final decision was still the same in 40 patients (Figure 2), (Table 4).

### Discussion

Breast conservation surgery and radiotherapy are considered as the standard therapy for early breast

cancer as it provides the same overall survival as mastectomy.<sup>7</sup>

Although triple assessment remains the standard practice, the advantageous impact of MRI on surgical management has been frequently investigated.<sup>2,3,10,14</sup>

In this study, we evaluated the added value of

**Table 4.** MRI findings of the participants (n=84)

Treatment change	Number	FP	FN
Modified radical mastectomy			
1- Alone	20/ 44(45.5%)	0	0
2- Excisional biopsy	12/44 (27.2%)	2	0
Bilateral oncoplastic surgery	12/44 (27.2%)	0	0
Total	44 (100%)	2 (4.5%)	0



**Figure 2.** Female patient, aged 57 years old, diagnosed as right breast cancer by US and mammography, and preoperative breast MRI revealed malignant featuring unifocal mass at the lower outer quadrant of right breast, no other enhancing lesions of right breast, normal left breast. Histopathological evaluation proved invasive ductal carcinoma of the right breast.



preoperative breast MRI in the surgical decision, and whether MRI could potentially lower the rate of incompletely excised malignant lesions by identifying another occult malignant lesion or contralateral lesions. The treatment plan based on US and mammography was changed based on MRI examination including conversion from oncoplastic breast surgery to mastectomy.

In the current study, 84 patients underwent preoperative breast MRI which detected findings that could not be detected by US and mammography in 44 (52.4%) patients. This agrees with the previous study showing that MRI detected 30% additional lesions not detected in conventional imaging.<sup>8</sup>

Our study has considered the correlation of histopathological assessment with the proposed surgical procedure.<sup>14</sup> The reported correlation of the final pathology with MRI findings in our study confirms its advantageous impact in 47.6% of our patients with minimal chance for over-treatment. Our results are consistent with earlier studies and reported a significant change in surgical management.<sup>2,3,10-14</sup>

According to our study, the utility of MRI in assessing the local extent of early breast cancer changed the surgical decision remarkably in 47.6% of cases, and this is slightly higher than previously published reports which demonstrated changes in 14-35 % of patients.<sup>9,10,11,12</sup>

In twelve patients (27.2%) from those with a changed decision in our study, the surgical decision was changed from oncoplastic surgery to bilateral oncoplastic surgeries due to detection of the contralateral lesion. This finding was higher than the results of a previous study that revealed contralateral breast lesions after MRI in 7%.<sup>13</sup>

In our study 16 patients (36.4%) were initially planned for breast conservative surgery but based on MRI finding the decision was changed to modified radical mastectomy due to multicentricity, and this was in agreement with results of an earlier study which revealed a potential increase in mastectomy rate after MRI to about (44%).<sup>14</sup>

In our study, a negative correlation (false-positive results) between MRI findings and final histopathological assessment was found only in less than 5% of cases (2/44) in the form of benign breast lesions, which is lower than earlier studies and did not result in undue mastectomy.<sup>3</sup>

The limitations of this current study were a small sample size due to the high cost of preoperative MRI which precludes its widespread use in the general population despite its great role in accurate evaluation of breast cancer.

Also, accurate determination of invasive versus in situ disease by MRI and estimating the extent of ductal carcinoma in situ (DCIS) was limited.

In conclusion, despite these limitations, our study confirmed the advantageous impact of MRI for

assessing early breast cancer disease and defining the surgical plan.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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