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ORIGINAL ARTICLE – BREAST ONCOLOGY

The Influence of Preoperative MRI on Breast Cancer Treatment

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ABSTRACT

Background. Breast magnetic resonance imaging (MRI) is increasingly used for breast cancer treatment planning. The aim of this study was to evaluate rates of mastectomy and breast-conserving surgery (BCS) in patients who undergo preoperative MRI.

Methods. We retrospectively reviewed charts of patients who underwent surgical treatment of breast cancer at a single center between 2002 and 2009. Exclusion criteria included stage IV disease, previous breast cancer, Hodgkin lymphoma, and positive *BRCA* status. Univariate and multivariate analysis evaluated differences in patient demographics, surgical management, and tumor characteristics among women who underwent mastectomy compared to BCS.

Results. Patients who underwent MRI were more likely to have mastectomy than those without MRI (43 vs. 28%; $P = 0.002$). Multivariate analysis revealed that younger age, larger tumor size, positive lymph node status, infiltrating lobular carcinoma, and preoperative MRI were independent predictors for mastectomy ($P < 0.05$). MRI detected occult contralateral breast cancer in 2.7% of patients. Among patients treated with BCS, preoperative MRI was not significantly associated with lower reexcision rates (MRI, 14%; no MRI, 18%; $P = 0.34$).

Conclusions. Preoperative MRI was associated with higher rates of mastectomy and detection of occult contralateral breast cancer, but was not associated with lower reexcision rates.

Preoperative breast magnetic resonance imaging (MRI) has grown in popularity over the last decade and is increasingly used for breast cancer treatment planning. In 2008, Bassett et al. found that MRI was offered to patients diagnosed with breast cancer at 74% of breast imaging practices surveyed.[1] Similarly, Hulvat et al. demonstrated a 46% increase in the utilization of MRI from 1998 to 2008 at a large university hospital.[2]

Studies demonstrate that MRI is more sensitive than mammography in identifying additional disease in the ipsilateral and contralateral breast.[3–11] However, the additional information provided by breast MRI has not necessarily resulted in better surgical management or patient outcomes. In fact, some evidence suggests that utilization of preoperative MRI leads to more extensive surgery and increased mastectomy rates.[12–14] Moreover, a recent randomized trial found that preoperative MRI did not reduce the reexcision rate after breast-conserving surgery (BCS), and authors have demonstrated conflicting results concerning the impact of MRI on ipsilateral breast tumor recurrence (IBTR) rates after BCS.[15–18]

The aims of this study were to evaluate the rates of mastectomy and BCS in patients who underwent preoperative MRI for early stage breast cancer at a single institution, and to assess patient and tumor characteristics that predicted treatment choice. Additionally, we wanted to determine if preoperative breast MRI influenced reexcision rates and IBTR rates after BCS.

PATIENTS AND METHODS

After receiving approval from the institutional review board, we conducted a retrospective review of patients who underwent surgical management for breast cancer at the University of Minnesota Medical Center between 2002 and 2009. We included patients who received definitive surgical treatment for biopsy-proven ductal carcinoma-in-situ (DCIS) or stage I, II, and III breast cancer. Patients with Hodgkin lymphoma and positive *BRCA* status were excluded because they are routinely screened for malignancies with MRI. Additionally, all patients with breast cancer incidentally diagnosed with MRI were excluded.

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Further exclusion criteria included a personal history of breast cancer or a previous surgical treatment (BCS) for the index lesion. A single surgeon evaluated all patients preoperatively and performed all operations.

A cohort of 414 patients met inclusion criteria. Information collected from patient records included: patient age, family history of breast cancer (first-degree relative only), physical exam findings (palpable lump or skin changes) on initial presentation, type of surgical treatment (mastectomy vs. BCS), year of surgery, preoperative MRI use, reexcisions, tumor type, tumor size, tumor grade, lymph node status, estrogen receptor (ER) status, and HER-2 status. A negative margin was considered no ink on tumor.

Generally, MRI was obtained for younger patients, patients with a strong family history of breast cancer, and patients with dense breasts on mammography. However, many patients requested MRI and some had undergone MRI before evaluation at our institution. There is no standardized algorithm for obtaining preoperative breast MRI at our institution.

We reviewed MRI reports to determine if preoperative MRI detected additional lesions other than the known cancer (positive MRI) or not (negative MRI), and if MRI findings indicated further biopsy. All subsequent biopsy results were evaluated for this study.

Chi-square tests and Student's *t*-tests were performed as indicated to evaluate variables for statistical significance. Cochrane-Armitage trend analysis was used to assess the statistical significance of trends over time. Multiple logistic regression was performed to determine the association between preoperative MRI and mastectomy while adjusting for family history, tumor size, lymph node status, ER status, year of surgery, and infiltrating lobular carcinoma. Multiple logistic regression was performed by SAS software, version 9.1 (SAS Institute, Cary, NC). Results of logistic regression were reported with odds ratios and 95% confidence intervals (CI). *P* values less than 0.05 were considered to be statistically significant.

TABLE 1 Cohort characteristics

Characteristic	MRI ($n = 219$)	No MRI ($n = 195$)	*P*
Median age, years	51	56	<0.001
Family history			0.11
Yes	67 (30%)	46 (24%)	
Unknown	3 (1%)	2 (1%)	
Palpable lump	104 (47%)	78 (40%)	0.13
Tumor type			0.11
DCIS	31 (14%)	35 (18%)	
IDC	149 (68%)	135 (69%)	
ILC	27 (12%)	13 (7%)	
IDC and ILC	5 (2%)	3 (1%)	
Other	7 (4%)	9 (5%)	
Tumor size			0.74
<2 cm	147 (67%)	130 (67%)	
2–5 cm	61 (28%)	58 (30%)	
>5 cm	11 (5%)	7 (3%)	
Tumor grade			0.82
Low	45 (20%)	42 (22%)	
Intermediate	97 (45%)	85 (43%)	
High	77 (35%)	61 (31%)	
Unknown	0	7 (4%)	
Lymph node status			0.32
Positive	61 (28%)	46 (24%)	
ER status			0.48
Positive	179 (81.5%)	146 (76%)	
Negative	39 (18%)	38 (19%)	
Unknown	1 (0.5%)	11 (5%)	
HER-2 status			0.49
Positive	27 (12%)	28 (14%)	
Negative	155 (71%)	131 (67%)	
Unknown	37 (17%)	36 (19%)	
Mastectomy	94 (43%)	55 (28%)	0.002

IDC invasive ductal carcinoma, *ILC* invasive lobular carcinoma

RESULTS

At our institution, preoperative breast MRI use increased significantly from 9% in 2002 to 75% in 2009 ($P < 0.001$). Mastectomy rates increased slightly from 31% in 2002 to 38% in 2009, but this change was not statistically significant ($P = 0.06$).

In our cohort of 414 patients, 219 (53%) underwent preoperative breast MRI. Younger patient age was significantly associated with MRI on univariate analysis ($P < 0.001$) (Table 1). Characteristics not associated with preoperative MRI on univariate analysis included: family history of breast cancer, physical exam findings at initial presentation, tumor type, tumor size, tumor grade, lymph node status, ER status, and HER-2 status. We also found that patients who underwent MRI were more likely to be treated with mastectomy as compared to those not assessed with MRI (43 vs. 28%, respectively; $P = 0.002$).

Logistic regression analysis revealed that preoperative MRI, younger age, larger tumor size, positive lymph node status, and infiltrating lobular carcinoma were independent predictors for mastectomy ($P < 0.05$) (Table 2). Patients who had preoperative MRI were 1.8 times more likely to have a mastectomy than patients without MRI (95% CI 1.1–3.2). Family history of breast cancer, positive ER status, and year of surgery were not predictive for mastectomy.

Preoperative MRI findings were positive in 74 (34%) patients, while 145 (66%) had a negative preoperative MRI

TABLE 2 Multivariate logistic regression results for predictors of mastectomy

Characteristic	Odds ratio	95% CI	*P*
Age			
40–65 vs. <40 years	0.2	0.1–0.5	<0.001
>65 vs. <40 years	0.3	0.1–0.7	0.004
Family history			
Positive vs. negative	1.1	0.7–1.9	0.63
Unknown vs. negative	0.8	0.1–7.5	0.82
LN status			
Positive vs. negative	2.3	1.4–4.0	0.002
ER status			
Negative vs. positive	1.1	0.6–2.0	0.64
Unknown vs. positive	0.8	0.2–4.0	0.78
Tumor size			
<2 cm vs. 2–5 cm	0.5	0.3–0.9	0.01
>5 cm vs. 2–5 cm	27.6	3.3–227	0.002
MRI			
Yes vs. no	1.8	1.1–3.2	0.03
ILC			
Yes vs. no	3.4	1.6–7.2	0.001
Year			
2003 vs. 2002	0.7	0.2–2.4	0.59
2004 vs. 2002	1.5	0.5–4.7	0.49
2005 vs. 2002	0.8	0.2–2.5	0.67
2006 vs. 2002	1.1	0.4–3.2	0.93
2007 vs. 2002	1.7	0.6–5.0	0.31
2008 vs. 2002	1.2	0.4–3.5	0.80
2009 vs. 2002	1.5	0.5–4.4	0.50

LN lymph node, *ILC* invasive lobular carcinoma

(Fig. 1). Of patients with a negative MRI, 56 (39%) underwent mastectomy. The difference in mastectomy rates between women with no MRI and women with a negative MRI was statistically significant (28 vs. 39%, respectively; $P = 0.04$). Mastectomy was performed in 38 of 74 (51%) patients with a positive MRI. Of the 74 patients with a positive MRI, 48 (65%) underwent 54 additional biopsies on the basis of MRI findings. Among patients with positive MRI findings, 26 did not have a subsequent biopsy; 10 of those 26 (38%) patients elected to undergo mastectomy without further work-up of the suspicious lesions. Of the 48 patients with an additional biopsy, 26 (54%) had mastectomy. Overall, 6 patients underwent both ipsilateral and contralateral biopsies. We found that 16 of 25 (64%) ipsilateral biopsies and 6 of 29 (21%) contralateral biopsies were positive for DCIS or invasive cancer. Among 22 patients with a positive biopsy, 18 (82%) underwent mastectomy. However, just 8 of 26 (31%) women with negative biopsy findings had undergone mastectomy.

Preoperative MRI identified occult contralateral cancer in 6 patients (2.7%). Of patients with a contralateral cancer detected with MRI, 3 (50%) underwent bilateral mastectomy and 3 (50%) underwent bilateral BCS. All contralateral lesions identified by MRI were invasive cancer.

Among patients treated with BCS, preoperative MRI was not significantly associated with fewer reexcisions for close or positive margins as compared with patients without MRI (MRI, 14%; no MRI, 18%; $P = 0.34$). IBTR rates were also evaluated; 2 (1.6%) patients with preoperative MRI had IBTR, and 7 (5.0%) patients without MRI had IBTR ($P = 0.13$). Median follow-up after BCS in the MRI group was 25 months, and median follow-up in the no MRI group was 49 months.

DISCUSSION

Results of this study demonstrate that patients who underwent preoperative breast MRI at our institution were 1.8 times more likely to have mastectomy than patients who did not undergo MRI (95% CI 1.1–3.2). We also found that younger age, positive lymph node status, larger tumor size, and invasive lobular carcinoma were independent predictors for mastectomy. Neither reexcision rates

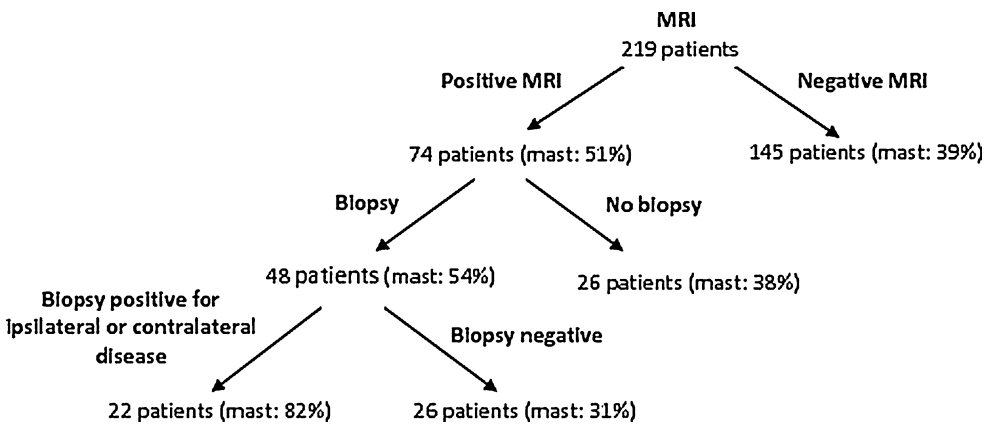

FIG. 1 MRI results and outcomes (mastectomy rates shown in parentheses)

nor IBTR rates were significantly associated with preoperative MRI.

The potential advantages of preoperative MRI rest primarily in its increased sensitivity in detecting occult disease not identified by mammography.[3–11] As a result, breast MRI may provide better assessment of tumor extent in the ipsilateral breast, and increased detection of ipsilateral multifocal disease and occult contralateral breast cancer compared to mammography alone. A meta-analysis of 19 studies (2610 patients) published by Houssami et al. determined that MRI detected additional lesions in the ipsilateral breast in 16% of women, with 66% of those lesions malignant on histology.[8] Additionally, a systematic review of 22 studies (3253 patients) published by Brennan et al. found the estimated cancer detection rate with MRI in the contralateral breast to be 4.1%.[10] In our cohort of 219 patients with preoperative MRI, the cancer detection rate was 7.3% in the ipsilateral breast and 2.7% in the contralateral breast. Moreover, all contralateral lesions identified with MRI were invasive cancer.

The potential disadvantages of preoperative breast MRI have recently been emphasized because studies have demonstrated that preoperative MRI is associated with higher rates of mastectomy.[12–15,19,20] In a single center study with 5405 patients, Katipamula et al. reported that 54% of patients receiving MRI had mastectomy, while just 36% of patients without MRI had mastectomy.[12] Bleicher et al. reported that MRI use predicted a 1.8-fold increase in the odds of undergoing mastectomy at a single institution.[13] Moreover, a randomized controlled trial published by Turnbull et al. found that women scheduled for BCS who were randomly assigned to receive MRI underwent more mastectomies at initial operation than those assigned to the no MRI group (7 vs. 1%, respectively).[15]

The association between MRI and mastectomy may be due to more aggressive treatment of additional disease detected by MRI; 82% of patients in this study with a positive MRI and a subsequent biopsy positive for malignancy underwent mastectomy. On the other hand, we found that women with a negative MRI were also more likely to undergo mastectomy than those without MRI (39 vs. 28%, $P = 0.04$). The reasons for these findings are not clear; perhaps preoperative MRI generates greater patient anxiety that leads to mastectomy over BCS. A step-wise progression in mastectomy rates is evident as women underwent further diagnostic tests or had positive test results. The progression in mastectomy rates was as follows: patients without MRI, 29% had mastectomy; patients with a negative MRI, 39% had mastectomy; patients with a positive MRI, 51% had mastectomy; patients with a positive MRI and a subsequent biopsy, 54% had mastectomy; patients with a positive MRI and biopsy positive for malignancy, 82% had mastectomy.

Breast MRI's detection capabilities provide more information for operation planning, but studies have not confirmed improved outcomes with preoperative MRI utilization. A randomized controlled trial (COMICE) published by Turnbull et al. in 2010 demonstrated that 19% of patients underwent reexcision after BCS regardless of MRI use.[15] These results are consistent with our findings.

Only a few studies have evaluated the relationship between preoperative MRI and IBTR rates. Fischer et al. demonstrated that patients with preoperative MRI had fewer IBTR than patients without MRI (1.2 vs. 6.8%, respectively; $P < 0.001$)[16] However, studies by Solin et al. and Hwang et al. reported no statistically significant difference in the 8-year IBTR rates between patients with MRI and those without MRI.[17,18] Likewise, we found no significant differences in IBTR rates after BCS, although the follow-up time was relatively short.

This study has several notable limitations. The design is retrospective and the results may simply be reflective of the experience at a single institution. Selection bias is also a potential concern because patients who underwent MRI may have been more likely to undergo mastectomy regardless of MRI findings. Additionally, the follow-up period for patients who underwent BCS was relatively short; thus, the ability to evaluate the influence of preoperative MRI on IBTR is limited.

Despite these potential limitations, the results of this study are consistent with earlier studies which demonstrated that breast MRI identifies more ipsilateral and contralateral disease. However, our results also confirm some disadvantages of breast MRI, including the association between preoperative MRI and higher mastectomy rates and no significant reduction in reexcision rates. These results, coupled with the increased costs associated with MRI, may indicate that routine preoperative MRI is not indicated for patients newly diagnosed with early-stage breast cancer. In the future, multicenter, prospective studies are needed to determine if changes in preoperative planning with breast MRI improve long-term outcomes and patient satisfaction.

DISCLOSURE Preoperative MRI and Breast Cancer Treatment

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