Which Patients With Newly Diagnosed Breast Cancer Benefit From Preoperative Magnetic Resonance Imaging?

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Objective: The aim of this study was to identify the effectiveness and selective applications of preoperative magnetic resonance imaging (MRI) by investigating clinicopathologic factors of the index tumor with or without false lesions on MRI.

Summary of background data: Preoperative MRI is commonly performed in patients with newly diagnosed breast cancer, but its clinical significance is unclear.

Methods: A total of 103 breast cancer patients who had undergone MRI or ultrasound followed by mastectomy were included in this retrospective investigation of pathologic, clinical, and imaging findings.

Results: MRI showed 29 false-positive lesions in 57 patients, 5 false-negative lesions in 5 patients, and 69 true-positive lesions in 103 patients. More false lesions on MRI were found in patients with more lesions on ultrasound, small-sized index tumors on ultrasound, or early-stage cancer. The sensitivity of MRI and ultrasound were 96.5% and 92.3% (P = 0.119), respectively, and the positive predictive value of them were 71.5% and 72.5% (P = 0.828), respectively.
Conclusions: Preoperative MRI is more useful in patients with newly diagnosed breast cancer who have large-sized or more advanced cancers or fewer lesions on ultrasound.

Key words: Breast neoplasm – Magnetic resonance imaging – Ultrasonography

Preoperative magnetic resonance imaging (MRI) has been increasingly performed in patients with newly diagnosed breast cancer because its detection capability improves the surgical treatment and clinical outcome, owing to higher sensitivity and accuracy than those of traditional breast imaging modalities and the visualization of additional and occult lesions at a rate ranging from 10% to approximately 30%. However, a recent study showed that MRI leads to more women being treated with extensive surgery, without improvement in the surgical outcome or prognosis. Furthermore, MRI is considered to be superior to other modalities in assessing residual tumor size, planning the optimal surgical strategy after neoadjuvant chemotherapy, and detection of additional malignant lesions in high-risk patients with a family history of cancer. Therefore, the application of MRI to almost all women newly diagnosed with breast cancer has been questioned. However, the detection of occult or additional malignant lesions using any imaging modality is the first step to optimal tumor control. Therefore, recognizing the types of breast cancer that present with more false lesions on MRI and providing recommendations on selectively performing MRI help prevent unnecessary examination and incomplete or excessive surgery. The aim of this study was to identify the effectiveness and provide suggestions for selective applications of preoperative MRI by investigating the sensitivity, positive predictive value, and clinicopathologic factors associated with false positivity and negativity of preoperative MRI in patients with newly diagnosed breast cancer.

Materials and Methods

Records of all patients who had undergone mastectomy and were referred to the multidisciplinary breast clinic at our institute between January 2007 and January 2014 were reviewed for demographic data and characteristics at presentation. The Institutional Review Board approved the study protocol (2020GR0196). All patients had been diagnosed with malignancy based on core needle or excisional biopsy and evaluated by a multidisciplinary team. All patients wanted to undergo mastectomy because of delayed surgery, reluctance to biopsy, and personal needs. Medical records were reviewed for imaging and pathologic findings. Two experts in breast radiology interpreted the breast imaging scans. A total of 103 patients had undergone imaging, including MRI and ultrasound. Depending on whether a false or true lesion was found on MRI, patients were categorized under the true-positive, false-positive, or false-negative group. Continuous variables were tested with the independent t test or Mann–Whitney U test. The chi-square test or Fisher’s exact test was used for the categoric variables. The correlation analysis was performed to investigate the correlation between continuous data. The multivariate logistic regression was used to investigate the factors associated with false lesions on MRI. All statistical analyses were performed using R, version 3.2.2.

Results

The pathologic analysis of index malignant tumors in 103 patients revealed 26 multiple (25.2%) and 3 bilateral (2.9%) cancers. These index tumors included 96 invasive (94.1%) and 7 in situ (6.9%) cancers. The number of patients with true-positive, false-positive, and false-negative lesions on MRI was 69, 29, and 5, respectively. Table 1 shows patient characteristics and details of index cancer lesions. Table 2 shows the difference in characteristics between true-positive and false-positive lesions. Table 3 shows the difference in characteristics between true-positive and false-negative lesions. Table 4 shows the results of the multivariate logistic regression analysis. More false-positive lesions on MRI were found in patients with more number of lesions on ultrasound [odds ratio (OR), 2.95; 95% confidence interval (CI), 1.54–6.58; P = 0.004] or with a smaller size of the index tumor on ultrasound (OR, 0.54; 95% CI, 0.34–0.79; P = 0.005). More false-negative lesions on MRI were found in patients with a less advanced cancer (OR, 0.11; 95% CI, 0.00–0.54; P = 0.048). The sensitivity of MRI and ultrasound were 96.5% and 92.3% (P = 0.119; 95% CI, -1.27–10.1), respectively, and the positive predictive value of
them were 71.5% and 72.5% ($P = 0.828$; 95% CI, -8.02–9.91), respectively (Table 5).

**Discussion**

The globally increasing tendency for conservative breast surgery places great emphasis on the need to precisely assess the full extent of cancer and additional malignant lesions in the affected and contralateral breasts because remnant, additional, and occult malignant lesions may show high incidences of local recurrence. Preoperative MRI could help decrease recurrence and distant metastasis owing to the superiority to other traditional breast imaging modalities in detecting local and additional lesions of the ipsilateral and contralateral breasts. Therefore, to date, preoperative MRI has been performed to detect additional and occult cancers and decrease the re-excision rate. However, it is controversial whether or not preoperative MRI has advantages of fewer local re-excision, improved local control, and reduced rates of contralateral breast cancer. Therefore, the aim of this study was to investigate whether preoperative MRI is effective or traditional imaging is sufficient in treating newly diagnosed breast cancers in the current scenario. Notably, unlike other studies, the reason for focusing on the characteristics of index tumors with additional lesions rather than the additional lesions found on MRI was to use the information on index tumors detected on ultrasound to determine whether to perform MRI.

In our study, the sensitivity of MRI and ultrasound were 96.5% (143/148) and 92.3% (132/143) ($P = 0.119$; 95% CI, -1.27–10.1), respectively, and the positive predictive value of them were 71.5% (143/200) and 72.5% (132/182) ($P = 0.828$; 95% CI, -8.02–9.91), respectively (Table 5). In other words, ultrasound and MRI showed no statistically significant difference in the detection rate of additional malignant lesions or differentiation capability between malignant and benign lesions. In addition, the ipsilateral breast tumor recurrence or re-excision rate did not differ between patients who underwent

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**Table 1 Patient demographics (n = 103)**

| Age (years, mean ± SD) | 51.5 ± 10.7 |
|------------------------|-------------|
| Index tumor size in MRI (cm, mean ± SD) | 3.8 ± 2.3 |
| Index tumor size in ultrasound (cm, mean ± SD) | 3.6 ± 2.2 |
| Index tumor pathologic size (cm, mean ± SD) | 3.4 ± 2.3 |
| Conversion of breast conserving surgery to modified radical mastectomy by MRI interpretations | |
| No | 95 (92.2%) |
| Yes | 8 (7.8%) |
| Multiplicity | |
| No | 77 (74.8%) |
| Yes | 26 (25.2%) |
| Bilaterality | |
| No | 100 (97.1%) |
| Yes | 3 (2.9%) |
| Tumors in MRI (n, mean ± SD) | 1.9 ± 1.5 |
| Tumors in pathology (n, mean ± SD) | 1.4 ± 0.9 |
| Tumors in ultrasound (n, mean ± SD) | 1.8 ± 1.2 |
| TNM stage | |
| 0 | 7 (6.6%) |
| I | 27 (26.2%) |
| IIA | 24 (23.3%) |
| IIB | 16 (15.5%) |
| IIIA | 18 (17.5%) |
| IIIB | 2 (1.9%) |
| IIIC | 9 (8.7%) |
| Extensive intraductal component (n) | |
| No | 72 (69.9%) |
| Yes | 31 (30.1%) |
| Lymphovascular invasion (n) | |
| No | 74 (71.8%) |
| Yes | 29 (28.2%) |
| Extramodal extension (n) | |
| No | 88 (85.4%) |
| Yes | 15 (14.6%) |
| Histologic grade (n) | |
| Good | 27 (26.2%) |
| Moderate | 43 (41.7%) |
| Poor | 33 (32.0%) |
| Nuclear grade (n) | |
| Good | 18 (17.5%) |
| Moderate | 45 (43.7%) |
| Poor | 40 (38.5%) |
| Estrogen receptor (n) | |
| Negative | 34 (33.0%) |
| Positive | 69 (67.0%) |
| Progesterone receptor (n) | |
| Negative | 45 (43.7%) |
| Positive | 58 (56.3%) |
| HER2/neu overexpression (n) | |
| Negative | 56 (54.4%) |
| Positive | 47 (45.6%) |
| EGFR (n) | |
| Negative | 80 (77.7%) |
| Positive | 23 (22.3%) |
| CK5/6 (n) | |
| Negative | 88 (85.4%) |
| Positive | 15 (14.6%) |
| p53 (n) | |
| Negative | 48 (46.6%) |
| Positive | 55 (53.4%) |

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**Table 1 Continued**

| Ki67 (n) | |
| ≤14% | 59 (57.3%) |
| >14% | 44 (42.7%) |

CK, cytokeratin; EGFR, epidermal growth factor receptor; SD, standard deviation; TNM, tumor, node, metastasis (AJCC 8th).
Table 2  Comparison of characteristics of breast carcinoma between true- and false-positive lesions

| Characteristics                                    | True positive (N = 69) | False positive (N = 29) | P     |
|----------------------------------------------------|------------------------|-------------------------|-------|
| Age [years, median (range)]                        | 50.0 [44.0; 57.0]      | 50.0 [44.0; 57.0]       | 0.596 |
| Age 31–40                                          | 10 (14.5%)             | 4 (13.8%)               | 0.943 |
| Age 41–50                                          | 26 (37.7%)             | 12 (41.4%)              |       |
| Age 50–                                            | 33 (47.8%)             | 13 (44.8%)              |       |
| The index tumor size in MRI [cm, median (range)]   | 3.5 [2.2; 5.0]         | 2.6 [2.0; 3.5]          | 0.005 |
| The index tumor size in ultrasound [cm, median (range)] (a) | 3.2 [2.0; 4.7]         | 2.4 [1.9; 3.5]          | 0.010 |
| The index tumor size in ultrasound [cm, median (range)] (b) | 3.0 [2.0; 4.8]         | 2.0 [1.8; 3.4]          | 0.003 |
| The index tumor pathologic size [cm, median (range)] (b) | 3.0 [2.0; 4.8]         | 2.0 [1.8; 3.4]          | 0.003 |
| The index tumor pathologic size [cm, median (range)] (b) | 0.6 [0.4; 1.2]         | 0.5 [0.2; 0.9]          | 0.244 |
| Multiplicity                                       |                        |                         |       |
| No                                                 | 67 (97.1%)             | 23 (79.3%)              |       |
| Yes                                                | 2 (2.9%)               | 6 (20.7%)               |       |
| Bilaterality                                       |                        |                         |       |
| No                                                 | 67 (97.1%)             | 28 (96.6%)              | 1.000 |
| Yes                                                | 2 (2.9%)               | 1 (3.4%)                |       |
| Tumors in MRI [n, median (range)] (c)              | 1.0 [1.0; 2.0]         | 2.0 [2.0; 4.0]          | 0.001 |
| Tumors in pathology [n, median (range)] (d)        | 1.0 [1.0; 2.0]         | 1.0 [1.0; 2.0]          | 0.594 |
| Tumors in ultrasonography [n, median (range)] (e)  | 1.0 [1.0; 2.0]         | 2.0 [1.0; 3.0]          | 0.001 |
| Extensive intraductal component(+) (n)             |                        |                         | 0.873 |
| No                                                 | 17 (24.6%)             | 6 (20.7%)               |       |
| Yes                                                | 52 (75.4%)             | 23 (79.3%)              |       |
| Lymphovascular invasion(+) (n)                     |                        |                         | 0.214 |
| No                                                 | 53 (76.8%)             | 18 (62.1%)              |       |
| Yes                                                | 16 (23.2%)             | 11 (37.9%)              |       |

Int Surg 2021;105 579
MRI and those who did not in the previous studies. A positive correlation was found between the number of lesions on ultrasound and false-positive lesions on MRI (Spearman’s rank correlation coefficient = 0.38; \( P < 0.001 \)). In addition, more number of lesions found on ultrasound lead to detection of more number of false-positive lesions on MRI (OR, 2.95; 95% CI, 1.54–6.58; \( P = 0.004 \)). Patients with 3 or more lesions on ultrasound [area under the receiver operating characteristic (ROC) curve (AUC), 0.576 [0.487–0.648]; \( P = 0.012 \); ROC curve not shown] showed a higher probability of false positivity. This suggested that if many lesions are found on ultrasound, the likelihood of false-positive lesions on MRI increases, and, therefore, MRI could be omitted.

The size of the index tumor on ultrasound showed a significant difference between the 2 groups (with or without false-positive lesions on MRI). It was significantly smaller in the false-positive group than in the true-positive group (OR, 0.54; 95% CI, 0.34–0.79; \( P = 0.005 \)). Moreover, the index tumors on ultrasound measuring 2.4 cm or less [AUC, 0.649 (0.535–0.76); \( P < 0.001 \)] had a higher probability of false positivity. In other words, if the index tumor is larger, the true positivity or cancer detection rate increases. A positive correlation was found between the size of the index tumor on ultrasound and that on pathology (Spearman’s rank correlation coefficient = 0.80; \( P < 0.001 \)). Similarly, Girardi et al found that the cancer detection rate was 27% in the subgroup of index cancers \( >2 \) cm and 8% in the subgroup of index cancers \(<2 \) cm, showing a statistically significant difference (\( P = 0.001 \)). This may be attributable to the fact that patients with larger index tumors are more likely to have additional or satellite malignant lesions detected on MRI or ultrasound.

### Table 2 Continued

| Characteristics                  | True positive (N = 69) | False positive (N = 29) | \( P \) |
|----------------------------------|-----------------------|-------------------------|-------|
| Extraneural extension (+) (n)    | 56 (81.2%)            | 27 (93.1%)              | 0.233 |
| Yes                              | 13 (18.8%)            | 2 (6.9%)                |       |
| Histologic grade (n)             |                       |                         | 0.792 |
| Good                             | 18 (26.1%)            | 6 (20.7%)               |       |
| Moderate                         | 29 (42.0%)            | 12 (41.4%)              |       |
| Poor                             | 22 (31.9%)            | 11 (37.9%)              |       |
| Nuclear grade (n)                |                       |                         | 0.941 |
| Good                             | 13 (18.8%)            | 5 (17.2%)               |       |
| Moderate                         | 30 (43.5%)            | 12 (41.4%)              |       |
| Poor                             | 26 (37.7%)            | 12 (41.4%)              |       |
| Estrogen receptor (+) (n)        | 23 (33.3%)            | 8 (27.6%)               | 0.749 |
| Negative                         | 46 (66.7%)            | 21 (72.4%)              |       |
| Positive                         |                       |                         | 0.028 |
| Progesterone receptor (+) (n)    | 35 (50.7%)            | 7 (24.1%)               |       |
| Negative                         | 34 (49.3%)            | 22 (75.9%)              |       |
| Positive                         |                       |                         | 0.122 |
| HER2/neu overexpression (+) (n)  | 42 (60.9%)            | 12 (41.4%)              |       |
| Negative                         | 27 (39.1%)            | 17 (58.6%)              |       |
| Positive                         |                       |                         | 0.110 |
| EGFR (+) (n)                     | 50 (72.5%)            | 26 (89.7%)              |       |
| Negative                         | 19 (27.5%)            | 3 (10.3%)               |       |
| Positive                         |                       |                         | 0.564 |
| CK5/6 (+) (n)                    | 57 (82.6%)            | 26 (89.7%)              |       |
| Negative                         | 12 (17.4%)            | 3 (10.3%)               |       |
| Positive                         |                       |                         | 0.831 |
| p53 (+) (n)                      | 30 (43.5%)            | 14 (48.3%)              |       |
| Negative                         | 39 (56.5%)            | 15 (51.7%)              |       |
| Positive                         |                       |                         | 0.975 |
| Ki67 (n)                         | \( \leq 14\%)         | 40 (58.0%)              |       |
| Positive                         | 29 (42.0%)            | 13 (44.8%)              |       |

CK, cytokeratin; EGFR, epidermal growth factor receptor; TNM, tumor, node, metastasis (AJCC 8th).
### Table 3 Comparison of characteristics of breast carcinoma between true-positive and false-negative lesions

| Characteristics                                           | True positive (N = 69) | False negative (N = 5) | P       |
|-----------------------------------------------------------|------------------------|------------------------|---------|
| Age [years, median (range)]                               |                        |                        |         |
| 31–40                                                     | 10 (14.5%)             | 2 (40.0%)              | 0.312   |
| 41–50                                                     | 26 (37.7%)             | 1 (20.0%)              |         |
| 50–                                                      | 33 (47.8%)             | 2 (40.0%)              |         |
| The index tumor size in MRI (cm, median [range])          |                        |                        |         |
| 2                                                         | 14 (20.3%)             | 1 (20.0%)              | 0.354   |
| 2.1–4                                                    | 27 (39.1%)             | 1 (20.0%)              |         |
| 4.1–6                                                    | 14 (20.3%)             | 1 (20.0%)              |         |
| 6.1–                                                    | 14 (20.3%)             | 2 (40.0%)              |         |
| The index tumor size in MRI [cm, median (range)] (a)      |                        |                        |         |
| –2                                                      | 3.2 [2.3; 5.1]         | 4.3 [3.8; 5.7]         | 0.453   |
| 2.1–4                                                    | 28 (40.6%)             | 1 (20.0%)              |         |
| 4.1–6                                                    | 16 (23.2%)             | 1 (20.0%)              |         |
| 6.1–                                                    | 13 (18.9%)             | 2 (40.0%)              |         |
| The index tumor pathologic size [cm, median (range)] (b)  |                        |                        |         |
| –1                                                      | 3 (4.3%)               | 1 (20.0%)              | 0.344   |
| 1.1–2                                                    | 16 (23.2%)             | 0 (0.0%)               |         |
| 2.1–5                                                    | 36 (52.2%)             | 3 (60.0%)              |         |
| 5–                                                      | 14 (20.3%)             | 1 (20.0%)              |         |
| (a)–(b) [cm, median (range)]                             | 0.6 [0.4; 1.2]         | 1.8 [0.5; 2.7]         | 0.364   |
| Multiplicity in MRI                                     |                        |                        |         |
| No                                                       | 67 (97.1%)             | 5 (100.0%)             | 0.052   |
| Yes                                                      | 2 (2.9%)               | 0 (0.0%)               |         |
| Bilaterality                                             |                        |                        | 1.000   |
| No                                                       | 67 (97.1%)             | 5 (100.0%)             |         |
| Yes                                                      | 2 (2.9%)               | 0 (0.0%)               |         |
| Tumors in MRI [n, median (range)] (c)                    | 1.0 [1.0; 2.0]         | 1.0 [1.0; 1.0]         | 0.201   |
| Tumors in pathology [n, median (range)] (d)              | 1.0 [1.0; 2.0]         | 2.0 [2.0; 2.0]         | 0.003   |
| Extensive intraductal component(+) (n) (e)               | 17 (24.6%)             | 2 (40.0%)              | 0.025   |
| Match of axillary LN metastasis interpretation between MRI and pathology |                       |                        | 0.819   |
| No                                                       | 17 (24.6%)             | 2 (40.0%)              |         |
| Yes                                                      | 52 (75.4%)             | 3 (60.0%)              |         |
| TNM stage                                                |                        |                        | 0.417   |
| 0                                                       | 5 (7.2%)               | 1 (20.0%)              |         |
| I                                                        | 15 (21.7%)             | 3 (60.0%)              |         |
| IIA                                                      | 18 (26.1%)             | 1 (20.0%)              |         |
| IIB                                                     | 11 (15.9%)             | 0 (0.0%)               |         |
| IIIA                                                    | 12 (17.4%)             | 0 (0.0%)               |         |
| IIIB                                                    | 2 (2.9%)               | 0 (0.0%)               |         |
| IIIC                                                    | 6 (8.7%)               | 0 (0.0%)               |         |
| Lymphovascular invasion(+) (n)                           |                        |                        | 0.345   |
| No                                                       | 48 (69.6%)             | 5 (100.0%)             |         |
| Yes                                                      | 21 (30.4%)             | 8 (27.6%)              |         |
When the TNM stage was lower, the rate of false negativity increased (OR, 0.11; 95% CI, 0.01–0.54; \( P = 0.048 \)). Breast MRI is considered to have high false-negative rates because of its inability to identify microcalcifications.\(^{18}\) It is controversial whether MRI is an effective diagnostic tool in ductal carcinoma in situ (DCIS) or early breast cancer, although several recent studies have shown the superiority of MRI over mammography for DCIS detection (sensitivity 92% versus 56%, respectively) and determination of the extent of DCIS through technical advancements in MRI, such as high spatial resolution, morphologic features, etc.\(^{19,20}\)

In addition, similar to the aforementioned results, the size of the index tumor on pathology tended to show a strong positive correlation with the size of

| Table 3 Continued |
|-------------------|
| Characteristics   | True positive (N = 69) | False negative (N = 5) | \( P \) |
| Extralongal extension (+) (n) | | | |
| No                | 56 (81.2%) | 5 (100.0%) | 0.645 |
| Yes               | 13 (18.8%) | 0 (0.0%) | |
| Histologic grade (n) | | | 0.175 |
| Good              | 18 (26.1%) | 3 (60.0%) | |
| Moderate          | 29 (42.0%) | 2 (40.0%) | |
| Poor              | 22 (31.9%) | 0 (0.0%) | |
| Nuclear grade (n) | | | 0.540 |
| Good              | 13 (18.8%) | 0 (0.0%) | |
| Moderate          | 30 (43.5%) | 3 (60.0%) | |
| Poor              | 26 (37.7%) | 2 (40.0%) | |
| Estrogen receptor (+) (n) | | | 0.471 |
| Negative          | 23 (33.3%) | 3 (60.0%) | |
| Positive          | 46 (66.7%) | 2 (40.0%) | |
| Progesterone receptor (+) (n) | | | 1.000 |
| Negative          | 35 (50.7%) | 3 (60.0%) | |
| Positive          | 34 (49.3%) | 2 (40.0%) | |
| HER2/neu overexpression (+) (n) | | | 0.655 |
| Negative          | 42 (60.9%) | 2 (40.0%) | |
| Positive          | 27 (39.1%) | 3 (60.0%) | |
| EGFR (+) (n)      | | | 1.000 |
| Negative          | 50 (72.5%) | 4 (80.0%) | |
| Positive          | 19 (27.5%) | 1 (20.0%) | |
| CK5/6 (+) (n)     | | | 0.696 |
| Negative          | 57 (82.6%) | 5 (100.0%) | |
| Positive          | 12 (17.4%) | 0 (0.0%) | |
| p53 (+) (n)       | | | 0.264 |
| Negative          | 30 (43.5%) | 4 (80.0%) | |
| Positive          | 39 (56.5%) | 1 (20.0%) | |
| Ki67 (n)          | | | 1.000 |
| \( \leq 14\% \)    | 40 (58.0%) | 3 (60.0%) | |
| >14%              | 29 (42.0%) | 2 (40.0%) | |

\( \text{CK, cytokeratin; EGFR, epidermal growth factor receptor; TNM, tumor, node, metastasis (AJCC 8th).} \)

Table 4 Multivariate logistic regression analysis

|                      | Estimate | SE | \( z \) value | \( \text{Pr(>|z|)} \) | OR | 95% CI |
|----------------------|----------|----|---------------|------------------------|----|--------|
| False positive       |          |    |               |                        |    |        |
| (Intercept)          | −1.9602  | 0.8932 | −2.19         | 0.0282                 | 0.14 | 0.02–0.77 |
| Tumors on ultrasound (n) | 1.0802  | 0.3709 | 2.91          | 0.0036                 | 2.95 | 1.54–6.58 |
| The index tumor size on ultrasound (cm) | −0.6146 | 0.2162 | −2.84         | 0.0045                 | 0.54 | 0.34–0.79 |
| False negative       |          |    |               |                        |    |        |
| (Intercept)          | −1.6535  | 1.1682 | −1.42         | 0.1569                 | 0.19 | 0.01–1.42 |
| TNM stage            | −2.1860  | 1.1072 | −1.97         | 0.0483                 | 0.11 | 0.01–0.54 |

\( \text{CI, confidence interval; OR, odds ratio; SE, standard error.} \)
the index tumor on ultrasound. Furthermore, pathologic factors identified after surgery suggested that the number of additional lesions suspected to be malignant on ultrasound showed a strong positive correlation with the number of false-negative lesions on MRI.

In the previous study, although the decision whether to perform breast conserving therapy or mastectomy is based on not only the imaging findings but also on other factors such as breast size, surgeon preference, and expected cosmetic results, the use of preoperative MRI for a change in the management of breast cancer could be recommended especially for patients with pathology of invasive lobular carcinoma, and tumors in the lower inner quadrant. Weclser et al reported that the African-American race, heterogeneously or extremely dense mammographic density, and progesterone receptor-positivity were associated with additional biopsy-proven cancers based on the preoperative MRI for occult lesions in breast cancer. These confirm that a larger number of patients, more accurate analyses, and more advanced imaging techniques are likely to lead to the expansion of the preoperative MRI for occult lesions in breast cancer. These confirm that a larger number of patients, more accurate analyses, and more advanced imaging techniques are likely to lead to the expansion of the preoperative MRI for occult lesions in breast cancer. In conclusion, the number of false lesions on MRI increases with increasing number of lesions on ultrasound and decreasing size or TNM of the index tumor on ultrasound. Preoperative MRI may be more useful in those patients with newly diagnosed breast cancer who have large-sized or more advanced cancers or fewer lesions on ultrasound.

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Table 5  Diagnostic performances of magnetic resonance imaging and ultrasound

| Features                  | MRI (no. of lesions) | Ultrasound (no. of lesions) | P (95% CI<sup>a</sup>) |
|---------------------------|----------------------|----------------------------|------------------------|
| True positive             | 143                  | 132                        |                        |
| False positive            | 57                   | 50                         |                        |
| False negative            | 5                    | 11                         |                        |
| Overall sensitivity (%)   | 96.5 (143/148)       | 92.3 (132/143)             | 0.119 (–1.27–10.1)    |
| Positive predictive value (%) | 71.5 (143/200)   | 72.5 (132/182)             | 0.828 (–8.02–9.91)    |

CI, confidence interval.
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