# The Need for MRI Before Breast-Conserving Surgery

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MRI has gained acceptance as a highly sensitive imaging modality for the detection of breast disease, with a potential role for surgical staging of patients with newly diagnosed breast cancer. Published literature suggests that MRI can detect additional cancer in the ipsilateral and contralateral breasts, thus supporting the use of MRI as a tool for the staging of patients considered for breast conservation therapy. Although the potential to provide relevant information is present, current MRI limitations involve the lack of specificity to differentiate between malignant versus high-risk and benign disease. For a small percentage of patients to benefit from the impact of MRI on surgical management, a larger percentage would need to undergo unnecessary biopsy or more extensive surgery. Given these caveats and lack of prospective trials demonstrating evidence of efficacy, caution should be exercised when deciding to routinely integrate MRI into the preoperative staging process.

## Introduction

The role of breast imaging at the initial staging workup of patients with newly diagnosed breast cancer is to accurately assess the size of the index lesion, quantify the extent of disease by assessing for multifocal and multicentric disease, screen for synchronous contralateral breast cancer, and assess the regional nodal basins. Staging with conventional imaging is based on the morphology of the lesion, using mammography and/or ultrasound. In the past decade, breast MRI (bMRI) has emerged as a powerful imaging tool facilitating visualization of anatomical details, with a potential role in providing relevant functional information that may increase the technique's sensitivity and specificity. To date, the potential benefits of this highly sensitive imaging modality as an effective staging tool have been offset by the historically variable specificity leading to increased false-positive lesion detection, as well as inconsistent examination quality among different institutions.

Several randomized trials have demonstrated equivalent long-term survival benefits in patients with early breast cancer who underwent less invasive breast conservation treatment (BCT) to those who underwent conventional mastectomy [1,2]. Accurate preoperative staging is essential in determining the most appropriate surgical and oncologic management of patients, and it is to this end that advanced imaging techniques, such as MRI, may help. As with traditional imaging, the role of bMRI in the staging evaluation before surgery includes accurate identification and measurement of the primary tumor size, detection of multifocality and multicentricity, and evaluation for synchronous contralateral breast disease.

## MRI Assessment of Primary Tumor Size and Extent

Among nonhistopathologic methods, bMRI has been shown to be superior to mammography and ultrasound for quantifying the index carcinoma [3–5]. Current reports of the sensitivity of bMRI are between 89% and 100% for all invasive cancers and between 93% and 100% for invasive lobular carcinoma [3,4]. However, the sensitivity for ductal carcinoma in situ (DCIS) is generally more variable (between 38% and 100%) [5–7]. This may be explained by the fact that intraductal carcinoma encompasses a wide spectrum of pathologic features, with the more aggressive or high-grade DCIS demonstrating abnormal enhancement on MRI and low-grade DCIS having similar to no enhancement compared with the adjacent benign proliferative breast tissue.

Studies examining the tumor size of invasive carcinomas have reported that MRI results correlate favorably to size assessed at pathology [3–9]. As early as 1995, Boetes et al. [9] compared the accuracy of MRI with that of mammography and ultrasound in 60 women with 61 cancers. The investigators found that MRI was more accurate than mammography or ultrasound in assessing the size of the index lesion. However, all three imaging modalities missed some index tumors. A similar obser-

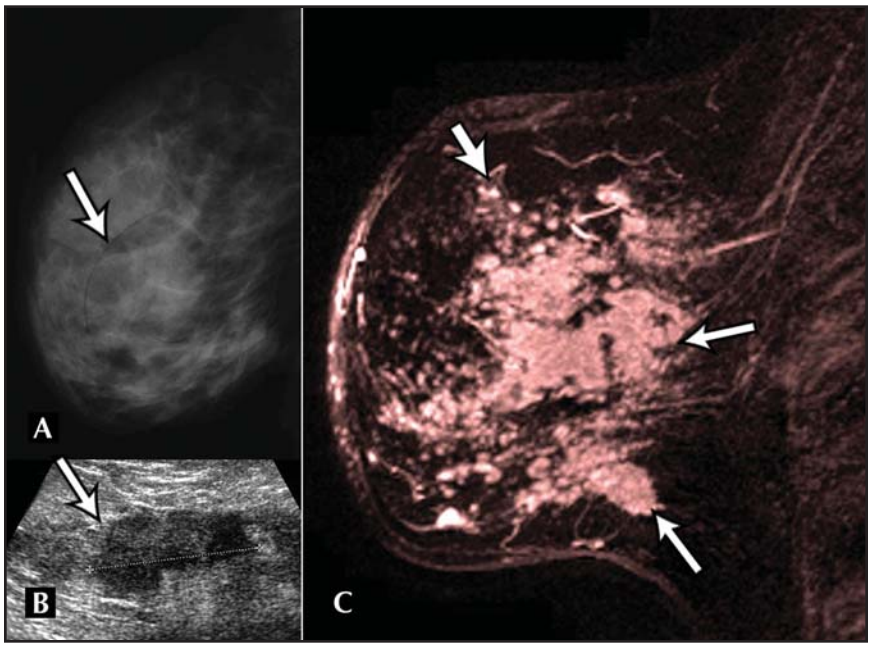


**Figure 1.** A 44-year-old woman with a diagnosis of invasive lobular carcinoma. **A**, Medial lateral oblique view mammogram (M) demonstrates an obscured 2 cm breast mass (*arrow*). **B**, Ultrasound (US) demonstrates two irregular breast masses at 3 and 6 o'clock positions, measuring 4 cm each (*arrow* points to one of the masses). **C**, Contrast-enhanced MRI demonstrates innumerable enhancing masses, extending over a 12 cm area (*two longer arrows* point to masses seen on M and US*; shorter arrow* points to additional lesions seen only on MRI). Final pathology of mastectomy specimen revealed 18 cm invasive lobular carcinoma.

vation was recently reported by Yao et al. [10] in 89 patients with breast cancer who underwent preoperative MRI. MRI predicted the tumor size and number of foci more accurately than mammography or ultrasound (Fig. 1). Even in patients with a diagnosis of invasive lobular carcinoma, preoperative MRI best reflected the true pathologic size, as described in a literature review of six studies examining the correlation of MRI and pathologic size measurement [11]. Whereas both mammography and ultrasound tend to underestimate tumor size, MRI tends to slightly overestimate it [11–13,14•]. A retrospective study of 65 patients with invasive cancers corroborated this finding. Mammography underestimated lesion size in 57% of cases, ultrasound in 40% of cases, and MRI in 13% of cases [5]. Conversely, MRI overestimated tumor size in 14% of patients with invasive and noninvasive breast cancer, compared with 10% of patients for mammography and 8% for ultrasound in a retrospective single-institution study [10].

MRI technology, especially bMRI, has experienced tremendous advancement in technology over the past 10 years. New software, hardware, and acquisition techniques (eg, multi-channel phased arrays, parallel imaging, and higher field strengths) have facilitated improvements in the spatial and temporal resolution of images, as well as volume coverage for bilateral screening examinations. The technological improvement may help decrease the difference between size estimated by MRI and pathologic size by enabling simultaneous optimization of spatial and temporal resolution of the images. Current imaging techniques are slanted toward high spatial resolution images for morphology, at the expense of temporal resolution, during acquisition of serial contrast-enhancing images. It is worth noting that a recent review of the correlation in tumor size among 460 women with newly diagnosed breast cancer reported that the mean difference in size between the preoperative MRI and the actual pathologic size was only 2.4 mm [8]. Although the small difference is impressive, the take-home message with respect to current imaging technology remains that caution should be exercised when factoring bMRI-determined lesion size into the selection of patients for BCT.

## MRI Assessment for Multifocal or Multicentric Disease

MRI can detect breast cancers that are clinically occult and not identified by mammogram. In a recent meta-analysis of 19 studies involving 2610 women with breast cancer, Houssami et al. [15] reported that MRI detected additional lesions in 16% of the women with primary breast cancer not seen by conventional imaging. Other investigators, who looked at the MRI detection rate of additional ipsilateral lesions specifically in patients with invasive lobular carcinoma, reported a higher detection rate of 32% [4]. This result is not unexpected, as invasive lobular carcinoma tends to be infiltrative and spread in a single cell file within the breast parenchyma.

The invasive carcinoma is often surrounded by intraductal malignancy, such as DCIS, or high-risk lesions, such as lobular carcinoma in situ. These high-risk lesions overlap with malignant lesions in bMRI appearance, resulting in multiple false-positive lesions and an overestimation of disease extent by bMRI. Unfortunately, the benefit of detecting additional malignant lesions by the enhanced sensitivity of bMRI is offset by the lack of specificity, compared with ultrasound. Berg et al. [16] reported that 17 of 96 (18%) additional lesions were detected by ultrasound, whereas bMRI detected an additional 29 of 96 (30%). However, the rate of overestimating

disease extent was lower for ultrasound (12%) than for bMRI (21%). In addition to the presentation of high-risk lesions, some benign breast lesions have an MRI appearance that is similar to that of malignant lesions [16,17]. The false-positive findings of high risk and benign lesions may account for the variable specificity of MRI reported in the literature. Approximately one third to half of additional lesions detected by MRI are benign or high-risk lesions. Therefore, it is critical to attain histologic confirmation of any suspicious MRI finding that may affect surgical treatment planning.

## Contralateral Breast Cancer

Bilateral synchronous breast cancers remain uncommon, with a frequency of less than 3%. In general, the prognosis for women with bilateral breast cancers is considered worse than for women with unilateral breast cancer, and detection impacts management decisions. Therefore, a sensitive and reliable technique for the detection of a contralateral breast malignancy would be expected to be beneficial in women with newly diagnosed unilateral breast cancer. MRI has been reported to detect clinically and mammographically occult lesions in the contralateral breast of these patients in approximately 3% to 5% of cases [3,18•,19–21]. The American College of Radiology Imaging Network (ACRIN) Trial 6667 Investigators Group recruited 1007 women from 25 academic and private practices who had a recent diagnosis of unilateral breast cancer. These patients received an MRI examination within 60 days of their diagnosis. The investigators detected a rate of 3.1% (30 of 969) clinically and mammographically occult contralateral breast cancers, with a mean diameter of 10.9 mm [18•]. By contrast, in patients with a diagnosis of invasive lobular carcinoma, the reported rate of clinically and mammographically occult contralateral breast cancer from a meta-analysis of published studies was 7%, double the rate reported in the ACRIN trial [4].

Liberman et al. [22] reported a cancer-detection rate of 5% (12 of 223) in clinically and mammographically normal contralateral breasts. Approximately half of these cancers were DCIS and the other half were invasive carcinoma. However, abnormal MRI findings led to biopsy recommendations in 32% of cases [22]. This is because benign or high-risk lesions can be difficult to differentiate from small malignant lesions, leading to false positive findings on MRI and increased recommendations for biopsy. Common benign and high-risk lesions, which tend to result in false-positive MRI findings, include fibroadenomas, fibrocystic changes, lobular carcinoma in situ, and atypical ductal hyperplasia [19,20,23,24]. Additionally, it has been hypothesized that these increased false-positive findings from bMRI may contribute to the increasing rate of contralateral prophylactic mastectomy, observed in the United States within a 6-year study period [25]. This increasing trend toward the more invasive approach of mastectomy in the face of the success of BCT is concerning. Further, it emphasizes the need for further evaluation on the impact of bMRI on the current surgical management of breast cancer.

## Impact on Surgical Management

The ultimate goal of preoperative imaging is to improve local staging and provide beneficial information to the making of surgical management decisions. MRI has been shown to detect clinically and mammographically occult foci of breast cancer in both the ipsilateral and contralateral breasts, with a better correlation to histopathologic results than mammography or ultrasound. Only a few isolated studies have reported the impact of bMRI findings on clinical outcome or local recurrence rates. There have been no published prospective randomized trials on the long-term effect or survival outcome for patients who receive preoperative MRI.

The first large series on the changes in surgical management by bMRI, published by Bedrosian et al. [26] in 2003, reported a management change in 26% (69 of 267) of cases, with 17% (44) of cases converting from BCT to mastectomy. Of the additional MRI findings, 71% were malignant and 29% were benign on final pathologic evaluation. Other investigators reported similar changes in management of 23.2% (36 of 155) due to the additional MRI findings, with the conversion from BCT to wider local excision being more common than the conversion from BCT to mastectomy. Beneficial or appropriate changes in surgical management from bMRI occurred in only 9.7% of these newly diagnosed breast cancer cases [27]. This implies that fewer than half of these MRI findings resulted in beneficial impact, and only 1 of 10 women who receives an MRI examination would benefit or receive the appropriate and necessary change in management from this technology for this indication. Similar results corroborating these observations were described in a prospective trial of 160 patients who were eligible for BCT and received preoperative MRI. Only half of the 41% additional MRI findings proved to be malignant and resulting in beneficial changes in management [28]. More patients in this trial converted from BCT to mastectomy (15.5%) than those who received wider local excision (6%). Mann et al. [4] performed an analysis of six studies of patients with a diagnosis of invasive lobular carcinoma, and they reported a 28.3% change (44 of 160 patients) in surgical management, which is similar to the other studies discussed above. Their results were more optimistic for MRI, with 88% of these changes being appropriate. Over half of these patients (24 of 44) had conversion from BCT to mastectomy.

In a larger nonrandomized study of 349 women with biopsy-proven invasive cancer, 173 patients underwent preoperative MRI and 176 patients did not. MRI detected additional malignancy in 19 women (11%),

**Table 1. Additional lesions identified on MRI: effect on management**

| Study | Patients, *n* | Patients with additional lesions, *n (%)* | Management altered, *n (%)* | Beneficial changes, *n (%)* | Non-beneficial changes, *n (%)* | Change from breast conservation treatment to mastectomy, *n (%)* |
|---|---|---|---|---|---|---|
| Fischer [34] | 463 | 89 (19) | 82 (18) | 66 (14) | 16 (4) | – |
| Tan et al. [35] | 83 | – | 15 (18) | 7 (8) | 8 (10) | 3 (4) |
| Tillman et al. [36] | 207 | – | 43 (20) | 24 (11) | 19 (9) | – |
| Bedrosian et al. [26] | 267 | – | 69 (26) | 49 (18) | 20 (8) | 44 (17) |
| Liberman et al. [17] | 223 | 72 (32) | 61 (27) | 12 (5) | 49 (22) | – |
| Lee et al. [37] | 82 | 19 (23) | 24 (29) | – | – | 9 (11) |
| Deurloo et al. [28] | 116 | 48 (41) | 25 (22) | 24 (21) | 1 (1) | 18 (16) |
| Braun et al. [38] | 160 | – | 44 (27) | 30 (19) | 14 (9) | 12 (8) |
| Schelfout et al. [39] | 204 | 33 (16) | 60 (29) | 42 (21) | 12 (6) | 18 (9) |
| Pediconi et al. [23] | 164 | 34 (21) | 32 (19) | – | – | 5 (3) |
| Bilimoria et al. [27] | 155 | 73 (47) | 36 (23) | 20 (13) | 16 (10) | 10 (6) |

8.7% of whom converted from BCT to mastectomy and 2.3% of whom chose wider local excision [29]. Patients who chose preoperative MRI had a lower mean age than those who did not undergo MRI [29,30•]. Other groups have also observed that a change in surgical management from BCT to mastectomy occurs most often in patients with a diagnosis of invasive carcinoma and DCIS [31,32].

To date, the only study with long-term follow-up (mean, 4.6 y) of patients who did or did not receive bMRI before BCT with radiation therapy consisted of a retrospective review of 756 women with stage I or II invasive carcinoma or DCIS. No difference in the rates of local failure was reported between women who received bMRI and those who did not [30•]. Thus, the use of preoperative MRI was not associated with any improved outcome in this population.

In view of the current understanding, it appears that the preoperative use of bMRI is more likely to have a positive impact on patient outcome in subsets of patients, such as those with newly diagnosed invasive lobular carcinoma in a background of heterogeneously dense to dense breast parenchyma, patients with mammographically occult primary breast carcinoma, or patients with confirmed diagnosis of genetic mutations. The clinical significance of detecting small subclinical foci of cancer remains unclear. The results of the prospective randomized COMICE (Comparative Effectiveness of Magnetic Resonance Imaging in Breast Cancer) trial in the United Kingdom may answer many questions regarding the impact of bMRI on clinical management after the use of preoperative staging MRI [33]. The true impact of bMRI on patient outcome in the preoperative staging of newly diagnosed breast cancer cases still requires future randomized controlled trials with longer follow-up periods to distinguish how bMRI-induced changes in patient management actually impact patient outcomes.

## Conclusions

MRI allows more accurate visualization of the primary tumor lesion and the detection of additional tumor foci than conventional breast imaging. Despite the high sensitivity of this imaging modality and current state-of-the art bilateral scanning technique, breast MRI applied to the preoperative assessment of patients for breast conservation therapy still tends to overestimate lesion size, multicentricity, and contralateral involvement. The full impact of this has yet to be fully studied, but involves potentially eliminating some patients from considering BCT who may have benefited from this less invasive approach to the management of breast cancer (Table 1). For the full potential of breast MRI to realize a favorable impact on clinical outcomes, the number of false positives must be reduced and the overall specificity of this expensive and powerful imaging modality must improve from reported rates for the detection of multicentric and contralateral disease. Developing MR technologies for bMRI that may help facilitate higher temporal and spatial resolution, as well as integrate functional imaging techniques, include spectroscopy, diffusion, and elastography. These advanced imaging techniques are targeted at increasing specificity to contrast-enhanced bMRI. Ultimately, the ability to more accurately differentiate enhancing benign and high-risk lesions from invasive and noninvasive cancers should reduce the rate of false-positive lesion detection by bMRI and reduce the unnecessary conversion from BCT to mastectomy. However, to demonstrate a positive impact on survival rate, long-term follow-up of a prospective multi-institution randomized trials, similar to that performed with mammography, would be required.

## Disclosure

No potential conflicts of interest relevant to this article were reported.

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