Published in final edited form as:

J Am Coll Surg. 2009 August ; 209(2): 180–295. doi:10.1016/j.jamcollsurg.2009.04.010.

Association of Routine Pretreatment MRI with Time to Surgery, Mastectomy Rate, and Margin Status

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Abstract

Background—The benefit of breast MRI for newly diagnosed breast cancer patients is uncertain. This study characterized those receiving MRI versus those who did not, and reports on their short term surgical outcomes, including time to surgery, margin status, and mastectomy rate.

Study Design—All patients seen in a multidisciplinary breast cancer clinic from July 2004 to December 2006 were retrospectively reviewed. Patients were evaluated by a radiologist, pathologist, and surgical, radiation, and medical oncologists.

Results—Among 577 patients, 130 had pre-treatment MRIs. MRI use increased from 2004 (referent, 13%) versus 2005 (24%, $p=0.014$) and 2006 (27%, $p=0.002$). Patients having MRIs were younger (52.5 vs 59.0 y, $p<0.001$), but its use was not associated with preoperative chemotherapy, family history of breast or ovarian cancer, presentation, or tumor features. MRI was associated with a 22.4-day delay in pre-treatment evaluation ($p=0.011$). BCT was attempted in 320 of 419 patients with complete surgical data. The odds ratio for mastectomy, controlling for T size and stage, was 1.80 after MRI vs. no MRI ($p=0.024$). Patients having MRIs did not have fewer positive margins at lumpectomy (21.6%-MRI vs. 13.8%-no MRI, $p=0.20$), or conversions from BCT to mastectomy (9.8%-MRI vs. 5.9%-no MRI, $p=0.35$).

Conclusions—Breast MRI use was not confined to any particular patient group. MRI use was not associated with improved margin status or BCT attempts, but was associated with a treatment delay and increased mastectomy rate. Without evidence of improved oncologic outcome as a result, our study does not support the routine use of MRI to select patients or facilitate the performance of BCT.

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Abstract presented at the American Society of Clinical Oncology Breast Symposium, Washington, DC, September 2008.

Keywords

Magnetic Resonance Imaging; Neoplasms, Breast; Cancer of the Breast; Mastectomy; Mastectomy, Segmental; Breast-Conserving Surgery; Outcome Measures; Neoplasm, Residual; Time Factors

Introduction

Multiple studies have demonstrated that breast magnetic resonance imaging (MRI) detects foci of cancer not seen with other imaging modalities in 10 to nearly 30% of cases.^{1, 2} This has resulted in its enthusiastic adoption in women with newly diagnosed breast cancer, although the rate of cancer detection with MRI significantly exceeds the risk of local recurrence in women selected for breast conserving therapy (BCT) without the use of MRI,^{3, 4} and BCT and mastectomy were notable for equivalent survival long before the use of breast MRI.⁵

Definition of the extent of cancer in the breast was the most common indication for MRI, endorsed by members of the Society of Breast Imaging in a recent survey.⁶ It has been presumed by advocates of MRI that its greater sensitivity for the detection of cancer will improve the selection of patients for BCT and increase the likelihood of obtaining negative margins at the first lumpectomy attempt. A recent meta-analysis suggests that MRI may lead to unnecessary mastectomies and extensive excisions to treat disease that is well controlled with radiotherapy.⁴ The purpose of this study was to determine the relationship of MRI as currently used in clinical practice with short term surgical outcomes, including time to treatment, margin status, and conversion rates from attempted BCT to mastectomy.

Methods

Patient Selection

The records of all patients referred to the multidisciplinary breast clinic at the Fox Chase Cancer Center between July 2004 and December 2006 were reviewed after Institutional Review Board approval. This clinic was chosen to minimize the effect of an individual practitioner's referral patterns, bias, and treatment practices on the outcomes observed. All patients had a diagnosis of malignancy prior to referral and were evaluated by a multidisciplinary team which included physicians from radiology, pathology, surgical oncology, medical oncology, and radiation oncology. Imaging and pathologic studies were reviewed by the group in order to formulate a treatment plan. None of the patients had MRIs performed as routine screening in an asymptomatic setting. There were 36 MRIs performed for an abnormality suspicious on clinical examination or other imaging studies prior to pathologic diagnosis of malignancy. The quality of the MRIs performed outside was variable, but as with other outside imaging studies, those studies considered unacceptable were repeated. Lesions of uncertain significance had additional imaging performed. When performed, MRIs were obtained prior to referral in 94.6% of cases (123/130). All outside MRI examinations were reviewed by breast imaging staff at the Fox Chase Cancer Center. Additional diagnostic work-up, including biopsy, was performed as indicated by the level of suspicion of the lesion. During the time period under study, three radiologists, five surgeons, three radiation oncologists and four medical oncologists participated in the evaluations.

Patient Review and Definitions

Patient charts were reviewed for demographic data and presentation characteristics, the listed indication for MRI, and surgical procedures prior to and after referral. All patients with a diagnosis of cancer were included and none excluded from study based upon any of these

presentation characteristics or based upon their method of diagnosis (*i.e.* excisional versus needle biopsy).

A family history of breast or ovarian cancer was defined as that occurring in the patient's first or second degree relatives. First therapeutic surgical procedure was defined as any excision after a pathologic diagnosis of cancer or a diagnostic excision accompanied by an axillary staging procedure. Margins were defined as *positive* when invasive or intraductal cancer touched an inked surface, *close* when tumor approached within 0.2 cm of an inked specimen edge, and *negative* when the distance from tumor to ink was 0.2 cm or greater. Margin status was only evaluated for the first therapeutic surgical procedure. Patients undergoing definitive excision at an outside facility without inking of margins were classified as unknown margin status and excluded from the analysis. Cases lacking documentation of the type of final surgical procedure (BCT versus mastectomy) performed elsewhere were characterized as unknown and excluded from that portion of the analysis. All staging was performed utilizing the AJCC (6th Ed.)⁷ staging system.

Statistical Analyses

Wald tests of means with robust standard errors and Fisher's exact tests were used to investigate whether unadjusted differences existed between those who did and did not have MRIs. Robust standard errors were used to account for skew in the data along with multiple logistic regression to determine which variables were associated with MRI use after controlling for the others. Tumor size, for example, was highly skewed. The multiple imputation method of Raghunathan and colleagues was employed⁸ using 10 datasets to account for missing symptom dates, and for tumor size data in 69 individuals where size was not documented (such as inflammatory lesions, as well as DCIS). Descriptive statistics for tumor size incorporated the imputed data. The criterion for statistical significance was set at $p \leq 0.05$. Because this was an exploratory and hypothesis-generating study, we did not account for multiple comparisons. In order to generate the imputed datasets, the IVEWARE package from the Survey Methodology Program at the University of Michigan's Survey Research Center (<http://www.isr.umich.edu/src/smp/ive/>) along with SAS version 9.1 (SAS Institute Inc., Cary, NC) was used, while all other analyses, used STATA version 10 (StataCorp, College Station, Texas). To combine the point estimates from the imputed datasets, we used the MICOMBINE command in STATA.

Results

Cohort Characteristics

The study included 577 patients among whom 130 (22.5%) had preoperative breast MRI studies. Mean patient age was 57.3 years, ranging from 24 to 98 years. The racial distribution of patients having MRIs was 81% white, 13% black, 2% Asian Indian 1% Asian, 1% Hispanic and 2% unknown, which is similar to our institutional patient population as a whole. The finding leading to a cancer diagnosis was an abnormal screening mammogram in 257 (44.5%) cases, a patient-detected finding in 290 (50.3%), and a physician-detected abnormality in 21 (3.6%) cases. There were 133 patients reviewed from 2004, with 227 and 217 patients seen in 2005 and 2006, respectively. A family history of breast cancer was present in 229 (39.7%), while a family history of ovarian cancer was present in 25 (4.3%) patients.

Core biopsy was the most common method of diagnosis (59.6%) with excisional biopsy used in 33.8% and fine needle aspiration in 5.4%. The remainder were diagnosed by axillary lymph node biopsy or incidentally at reduction mammoplasty. There were 430 (74.5%) cases of infiltrating ductal carcinoma, 70 infiltrating lobular carcinomas (12.1%), 30 (5.2%) patients with ductal carcinoma in situ, and other invasive histologies present in 47 (8.1%). The mean tumor size was 2.1 cm, ranging from 0–10.5 cm. The pathologic stage was 0 in 29 (5.0%)

patients, and 253 (43.8%) patients were stage I, 196 (34.0%) patients were stage II, 86 (14.9%) patients were stage III, and 13 (2.3%) patients had stage IV disease. One patient with DCIS was noted to have micrometastases in the sentinel node and was therefore Stage IIA. Patient characteristics separated by MRI usage are listed in Table 1.

Predictors and Pattern of MRI Use

MRI use was more frequent in younger women, and became more commonly performed in later years of the study, increasing from 17 (12.8%) of 133 patients seen in 2004 to 54 (23.8%) of 227 patients seen in 2005 and to 59 (27.2%) of 217 patients seen in 2006. In multiple logistic regression, the odds ratios of undergoing a pretreatment MRI in 2005 and 2006 were 2.2 (multivariable $p=0.014$ relative to 2004) and 2.7 (multivariable $p=0.002$ relative to 2004), respectively. Method of presentation or diagnosis, histologic subtype, margins at first procedure, preoperative chemotherapy use, tumor size and stage, and family history of breast or ovarian cancer were not significant predictors of pretreatment breast MRI use (Table 2). Review of the MRI reports revealed no indication for MRI performance given beyond “breast cancer” in 40 (30.8%) cases with a specific additional request to evaluate the extent of disease in 6 (4.6%) cases. There were 16 (12.3%) performed for an undiagnosed palpable abnormality, 6 (4.6%) that specified lobular carcinoma, 4 (3.1%) performed solely for an abnormal mammogram, and 7 (5.4%) with no indication listed. The remainder had a combination of one or more other factors listed ($n=23$), or the original reports could not be obtained ($n=28$).

Associations of MRI with Evaluation Time and Imaging

There was an overall mean and median pretreatment time of 112.6 and 87.0 days (d), respectively (SD 91 d, range 5–968 d) from the initial symptom or abnormal imaging study to multidisciplinary evaluation. The mean pretreatment time was 129.9 and 107.5 d in the MRI and non-MRI groups, respectively ($p=0.011$ after adjusting for tumor size and stage).

In order to eliminate bias due to inaccurate patient recollection of the first symptom date, the time from histologic diagnosis to the first therapeutic surgery was also calculated. Seven (5.4%) patients in the MRI group and 25 (5.6%) in the non-MRI group, who had neoadjuvant chemotherapy were excluded from this calculation. The interval from diagnosis to surgery was 56.9 d for the 64 patients having MRIs and 38.1 d for the 358 who did not (univariate, $p=0.010$).

Among those who had an MRI, 17 (13.1%) had additional imaging (mammogram, ultrasound, or both) due to findings on the MRI, 12 of which were performed prior to their multidisciplinary evaluation at Fox Chase Cancer Center. In 14 cases, MRI findings resulted in a core needle biopsy and in 2 cases a needle-localized excisional biopsy separate from the site of the known cancer. Information on additional imaging was not available for 3 patients in the MRI group.

Associations of MRI with Surgical Procedure Type

Thirty six (27.7%) of the 130 patients having MRIs, and 93 (19.5%) of the 477 patients without an MRI had mastectomy as the initial surgical procedure. The univariate rates of mastectomy did not change over the time period of the study in the group as a whole ($p=0.74$) or within the MRI ($p=0.13$) or non-MRI groups ($p=0.37$). When controlling for primary tumor size and stage, patients who underwent MRI had an odds ratio of 1.80 (95% CI 1.08–3.00, $p=0.024$) for undergoing mastectomy as the initial surgical therapy. Bilateral mastectomies were performed in 13 patients as their first therapeutic procedure; 6 (4.6%) in the MRI group, and 7 (1.6%) in the non-MRI group.

There were 419 patients for whom final surgical procedure type (mastectomy vs BCT) was known. These 419 patients were not statistically different from the remaining 158 in age, year, method of presentation, method of diagnosis, histology, or family history, although their tumor

sizes were slightly larger at 2.3 vs. 2.0 cm (univariate $p=0.045$). As with the entire cohort, MRI use in these 419 patients was increased in younger women and over time. The relationship of the other covariates with MRI use in the subgroup did not differ significantly from the full cohort, except for histology. On multiple logistic regression of the subgroup, those with infiltrating ductal carcinoma were less likely to have MRIs than those with DCIS (OR 0.28, 95% CI 0.09–0.89, $p=0.032$).

Associations of MRI with BCT Margins and Conversion to Mastectomy

The initial surgical treatment attempted and the final surgical therapy for patients with and without MRI are shown in Figure 1. A total of 320 patients (76.4%) initially underwent BCT, among whom 290 had documentation of their final surgery type. Positive margins were present after the initial therapeutic excision in 21.6% of those having pre-treatment MRIs and in 13.8% of those who did not. The univariate likelihoods of positive margins (13.8% vs. 21.6%, $p=0.20$) and overall margin status ($p=0.397$) at first lumpectomy were not different between the two groups. There was also no statistically significant difference in the percentage of patients who required conversion from BCT to mastectomy after adjusting for tumor size and patient age, with 9.8% of BCT patients having MRIs requiring conversion to mastectomy, vs 5.9% of BCT patients not having MRIs (multivariable $p=0.35$, Table 3).

Discussion

Breast MRI has a potential role in two distinct settings: screening and the evaluation of a newly diagnosed cancer. Based on data from prospective trials of screening in high risk women,^{9–11} there has been some consensus about the role of MRI as a screening modality, resulting in an American Cancer Society recommendation for its use in women with a lifetime risk of breast cancer of ≥ 20 –25%, with case-by-case determination in women whose risk is between 15% and 20%.¹² This recommendation attempted to account for the psychological impact,¹³ the false positives,⁹ and cost,¹⁴ relative to the benefits, resulting in the endorsement for screening a very limited group of women. In contrast, prospective data demonstrating improved outcomes with MRI use in patients with newly diagnosed cancer is lacking. In spite of this, guidelines support the use of MRI in either virtually all patients with cancer (the American College of Radiology,¹⁵ European Society of Breast Imaging¹⁶) or in specific subgroups (American Society of Breast Surgeons¹⁷) such as those with dense breasts or lobular histology.

Our study demonstrates an increasing use of MRI in cancer patients in the greater Philadelphia area between 2004 and 2006. MRI use was more common in slightly younger women, although women undergoing MRI were not especially young (mean age 52.5 y). Although the use of MRI in younger women with breast cancer might be justified by the higher incidence of BRCA1 and 2 mutations in this group, a family history of breast or ovarian cancer was not associated with MRI use in this study. The finding that lobular histology, tumor size, and preoperative chemotherapy also did not correlate with the use of MRI, suggests that it is being employed in the breast cancer patient population at large rather than in subgroups determined by genetic risk, tumor characteristics, or planned treatment. The observation that MRI use increased during the relatively brief time period of this study is consistent with the findings of a study from the Mayo Clinic Rochester¹⁸ and suggests that this pattern is not limited to a single geographic area.

Although some have recommended that breast MRI be used in patient selection for BCT,^{19–21} there are surprisingly little data to support this assertion and historical treatment data appear to contradict a need for routine breast MRI. Studies examining changes in surgical therapy due to MRI have demonstrated conversion from BCT to mastectomy as a result of MRI findings in 6.5% to 25% of cases, and performance of wider excisions in an additional 3 to 13.5% of cases.^{22–25} In a recent meta-analysis of 19 studies which included 2,763 patients undergoing

pretreatment MRI, additional disease was found in 16%. Changes in surgery due to cancer in the areas of MRI abnormalities occurred in 11.3%, and were due to false positive MRI exams in 5.5% of cases.⁴

The current literature supporting the use of MRI is based upon the assumption that changes in management due to true positive MRI findings are beneficial to patients.^{22, 24, 26} This study challenges that assumption by evaluating short-term surgical outcomes and demonstrating that surgical management, as measured by the rate of unplanned conversion from BCT to mastectomy and the ability to achieve negative margins with a single excision, is not associated with the use of MRI.

Others have attributed low rates of reoperation in patients undergoing preoperative MRI to its use, but the lack of control populations in these studies makes these claims difficult to validate.^{19, 21} The failure of breast conserving surgery (BCS) in 9.8% and 5.8% of the MRI and non-MRI groups in this study, respectively, is similar to the 12% failure rate of BCS observed in a population-based sample of women with stages 0–II breast cancer treated in 2005–2006.²⁷ This suggests that the lack of benefit observed for MRI in this retrospective study is not due to the selection of a particularly favorable subset of patients, and that these results can be generalized to other settings. In addition to its failure to improve the primary endpoints examined, several detrimental effects were observed as a consequence of MRI; most notably, a 1.8-fold increase in the odds ratio of undergoing mastectomy. In a Mayo Clinic series evaluating 5,596 stage 0–II patients, those undergoing preoperative breast MRI also had a significantly greater mastectomy rate than those not having MRIs (52% vs 38%, $p < 0.0001$).¹⁸ It is likely that the etiology of the increased mastectomy rate is multifactorial and is due to a combination of overestimation of the extent of disease by MRI and patient choice. Berg *et al*²³ noted a 12% rate of “unnecessary mastectomy” due to patients’ decisions to undergo mastectomy rather than additional imaging and biopsy of abnormal MRI findings.

Additionally, we found that MRI delayed surgical treatment whether the interval measured was from the first symptom or abnormal screening date to our multidisciplinary consultation, or from histologic diagnosis to definitive surgery. Krishnan *et al*²⁸ have also reported a delay from 27 to 41 days ($p < 0.001$) between the time of histologic diagnosis and surgical treatment in those undergoing MRI, a finding very similar to the 19–22 day increase we observed. Estimates of the length of delay in treatment that may cause a detrimental effect on breast cancer outcome vary between 3 and 8 months,^{29, 30} and there is little consensus on this issue. While we would not suggest that a 19–22 day delay decreases survival, it is anxiety-provoking to patients and contributes to the prolonged interval from first symptom to surgery that we observed. This delay may be, in part, a result of the additional imaging and biopsies prompted by MRI. Although we observed that 17 patients required additional imaging and 14 had a needle biopsy, such studies may, in reality, occur more frequently than we were able to measure in our cohort, as data on imaging prompted by MRI for those patients continuing care outside of Fox Chase Cancer Center could not be collected. The increased mastectomy rate, lack of impact on margin status and treatment delays observed with MRI would be of little import if MRI were known to decrease the rate of local failure in patients undergoing BCT. While this study was not designed to assess local recurrence, Solin *et al*³¹ found no difference in the 8-year rates of local recurrence in patients selected for BCT with and without MRI. Although additional follow-up studies are needed to address this important issue, the incidence of additional carcinoma detected by MRI is 2–3 times higher than rates of local failure observed in women selected for BCT without MRI,^{3, 4} suggesting that much of this disease is controlled with radiotherapy.

This study is limited by its retrospective nature, and selection bias may have contributed to the observed outcomes, however, the only significant difference between the MRI and non-MRI

groups was age which was controlled for in the analyses. The similarity of the conversion rate from BCT to mastectomy to that seen in other reports also suggests that this was not a highly selected patient population. Although a variety of physicians in different practice settings ordered the MRIs in the study population which should minimize bias, we cannot exclude unrecognized differences between the groups. We did note a slight nonsignificant excess of positive margins present in the MRI group, which could be due to the presence of more extensive DCIS in association with invasive cancer in that cohort. However, as the proportion of those with pure DCIS was not different between the groups, we do not believe it is likely that MRI was preferentially used in those having invasive cancer with associated DCIS but not in patients with pure DCIS or pure invasive cancer. The study was also limited by a need to exclude 158 patients from the surgical analysis because their final surgery type was not known, but MRI use in the subset with complete surgical data did not differ from the population as a whole, suggesting that this is unlikely to have confounded the results.

Of note, this study did not evaluate the positive predictive value and false negative rate of MRI by correlating imaging findings with pathology. MRI has been clearly shown to be more sensitive than other imaging modalities in detecting previously-unknown foci of cancer^{1, 2} and producing false positive results,⁹ and thus the purpose of this study was, instead, to determine whether that increased sensitivity improves short term surgical outcomes.

In summary, we observed that despite its greater sensitivity for cancer detection, MRI is not associated with a decrease in either the need for re-excision for positive margins or initial unsuccessful lumpectomy attempts in patients who ultimately require mastectomy. The use of MRI is significantly associated with a greater likelihood of treatment with mastectomy, and in the absence of data indicating that patient selection with MRI reduces the risk of ipsilateral breast tumor recurrence, we believe that routine use of MRI to select local therapy in early stage breast cancer is not warranted. Definitive data to address the benefits of MRI awaits the results of prospective studies. However, the very low rate of local recurrence observed in patients selected for BCT without MRI makes it unlikely that a study of sufficient size to definitively demonstrate (or exclude) a 1–2% improvement in local control will be done, making short term surgical outcomes of particular importance in evaluating the benefit of MRI. In the absence of prospective data addressing these outcomes, our study sounds a cautionary note that the “obvious” benefits of MRI may not be observed in clinical practice.

Acknowledgments

This work was supported, in part, by US Public Health Services grant 5P30 CA06927 and by an appropriation from the Commonwealth of Pennsylvania.

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Figure 1.

Breakdown of patients by MRI, initial surgical treatment, and final surgery data. Mtx, mastectomy; BCT, breast conservation therapy.

Table 1

Patient Characteristics

Variable	No MRI (column %) n=447	MRI (column %) n=130	p Value
Age, y (mean $\pm$ SD, median)	59.0 $\pm$ 13.0, 58	52.5 $\pm$ 10.3, 50	<0.001*
Method of presentation			
Patient self-exam/finding (n=290)	226 (50.6)	64 (49.2)	0.69
Physician exam/finding (n=21)	15 (3.4)	6 (4.6)	
Screening mammogram (n=257)	200 (44.7)	57 (43.9)	
Other (n=9)	6 (1.3)	3 (2.3)	
Method of diagnosis			
Core biopsy (n=344)	265 (59.3)	79 (60.8)	0.74
Excisional biopsy (n=195)	154 (34.5)	41 (31.5)	
Fine needle aspiration (n=31)	22 (4.9)	9 (6.9)	
Other (n=7)	6 (1.3)	1 (0.8)	
Histologic subtype			
DCIS [†] (n=30)	20 (4.5)	10 (7.7)	0.17
Infiltrating ductal carcinoma (n=430)	342 (76.5)	88 (67.7)	
Infiltrating lobular carcinoma (n=70)	50 (11.2)	20 (15.4)	
Other (n=47)	35 (7.8)	12 (9.2)	
Tumor size, cm (mean $\pm$ SD, median)	2.1 $\pm$ 1.6, 1.7	2.1 $\pm$ 1.5, 1.8	0.90*
Stage			
0 [†] (n=29)	19 (4.3)	10 (7.7)	0.43
I (n=253)	196 (43.9)	57 (43.9)	
II [†] (n=196)	153 (34.2)	43 (33.1)	
III (n=86)	67 (15.0)	19 (14.6)	
IV (n=13)	12 (2.7)	1 (0.8)	
Family history: breast cancer (n=229)	177 (39.6)	52 (40.0)	0.51
Family history: ovarian cancer (n=25)	22 (4.9)	3 (2.3)	0.33

* p Values for continuous variables are for comparisons of means.

[†] One patient with DCIS was Tis, N1mi and therefore Stage II.

DCIS, ductal carcinoma in situ.

Table 2**Multiple Logistic Regression of MRI Use**

Variable [Reference value]	Odds Ratio	95% Confidence Interval	p Value
Age (with each increasing year)	0.95	0.93–0.97	<0.001
Method of presentation [pt self-exam]			
Physician exam/finding	1.65	0.57–4.79	0.35
Screening mammogram	1.22	0.75–1.98	0.42
Other	1.84	0.36–9.27	0.46
Year of diagnosis [2004]			
2005	2.20	1.18–4.11	0.014
2006	2.70	1.43–5.07	0.002
Method of diagnosis [core biopsy]			
Excisional biopsy	0.93	0.54–1.61	0.81
Fine needle aspiration	1.32	0.53–3.25	0.55
Other	0.38	0.03–4.67	0.45
Histologic subtype [DCIS]			
Infiltrating ductal carcinoma	0.57	0.21–1.55	0.27
Infiltrating lobular carcinoma	1.16	0.37–3.60	0.80
Other	0.97	0.28–3.41	0.97
Margins at first procedure [negative]			
Close	0.88	0.47–1.64	0.69
Positive	1.07	0.57–1.99	0.84
Other	1.14	0.62–2.11	0.67
Tumor stage (0 through IV)	0.83	0.59–1.18	0.30
Family history of breast cancer	0.91	0.59–1.40	0.67
Family history of ovarian cancer	0.33	0.09–1.19	0.09
Tumor size (with each increasing cm)	0.98	0.83–1.17	0.86
Preoperative chemotherapy given	1.08	0.41–2.89	0.87

Estimates and p values are from the full-model to give inferences about the variables that are associated with MRI use after controlling for the others. The area under the curve (AUC) for this model is 0.71. AUCs are generally between 0.5 and 1.0 with 0.5 indicating poor model fit and 1.0 indicating good model fit.

BSE, breast self-examination; DCIS, ductal carcinoma in situ.

Table 3
Initial Margin Status in Patients Known to Have Undergone Breast Conserving Therapy

Variable	No MRI (%) n = 239	MRI (%) n = 51	p Values [*]
Margins at first procedure			
Negative	130 (54.4)	23 (45.1)	0.40
Close	73 (30.5)	17 (33.3)	
Positive	33 (13.8)	11 (21.6)	
Unknown	3 (1.3)	0 (0.0)	
Conversion from BCT to mastectomy	14 (5.9)	5 (9.8)	0.35

^{*} p Values are univariate.

BCT, breast conserving therapy.