MR Imaging Findings in the Contralateral Breast of Women with Recently Diagnosed Breast Cancer

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OBJECTIVE. The purpose of this study was to determine the frequency and positive predictive value of biopsy performed on the basis of MR imaging findings in the contralateral breast in women with recently diagnosed breast cancer.

MATERIALS AND METHODS. We performed a retrospective review of records of 1336 consecutive breast MR imaging examinations over a 2-year period. Of these examinations, 223 imaged the asymptomatic, mammographically normal contralateral breast in women whose breast cancer was diagnosed within 6 months preceding MR imaging. Records of these 223 examinations were reviewed to determine the frequency of recommending contralateral breast biopsy and the biopsy results.

RESULTS. Contralateral breast biopsy was recommended in 72 (32%) of 223 women and performed in 61 women. Cancer occult to mammography and physical examination was detected by MR imaging in 12 women, constituting 20% (12/61) of women who underwent contralateral biopsy and 5% (12/223) of women who underwent contralateral breast MR imaging. Among these 12 cancers, six (50%) were ductal carcinoma in situ (DCIS) and six (50%) were infiltrating carcinoma. The median size of infiltrating carcinoma was 0.5 cm (range, 0.1–1.0 cm). Contralateral biopsy revealed benign (n = 31) or high-risk (n = 18) lesions in 49 women, constituting 80% (49/61) of women who underwent contralateral biopsy and 22% (49/223) of women who underwent contralateral MR imaging.

CONCLUSION. In women with recently diagnosed breast cancer, MR imaging of the contralateral breast led to a biopsy recommendation in 32%. Cancer was found in 20% of women who underwent contralateral breast biopsy and in 5% of women who underwent contralateral breast MR imaging.

For women with breast cancer, the contralateral breast is at high risk [1]. A synchronous contralateral cancer, variably defined as occurring within 3 months [2], 6 months [3], or 1 year [4] after diagnosis of the index cancer, is found by mammography, physical examination, or both in approximately 2% of women with breast cancer [5]. Women with synchronous bilateral breast cancer are more likely to have a genetic predisposition to breast cancer [6], multicentric disease in the index cancer [7], and a trend toward decreased local control and overall survival [4].

For women with unilateral breast cancer, a subsequent (metachronous) contralateral cancer develops in 0.5–1.0% per year, with a cumulative risk of 15% [8, 9]. Sixteen percent of metachronous contralateral cancers metastasize, and 7% are fatal [1]. Management options for the asymptomatic contralateral breast have included close observation, blind contralateral biopsy, chemoprevention, and prophylactic mastectomy [1].

Breast MR imaging may provide more accurate assessment of the extent of disease than mammography or physical examination for women with breast cancer [10]. MR imaging of the breast with proven cancer may identify otherwise unsuspected areas of multifocality or multicentricity, potentially changing treatment to wider excision or mastectomy [10–12]. Fewer data address the utility of MR imaging of the contralateral breast [11, 13–16]. This study was performed to determine the frequency and positive predictive value of biopsy performed on the basis of MR imaging findings in the contralateral breast in women with recently diagnosed breast cancer.

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Materials and Methods

Breast MR Imaging Studies and Mammograms

Retrospective review was performed of records of 1336 breast MR imaging examinations performed at our institution from January 1, 2000, through December 31, 2001. Among these, 223 examinations in 223 women met all of the following criteria: unilateral breast cancer was diagnosed within 6 months before MR imaging; contralateral breast was asymptomatic; and a mammogram of the contralateral breast obtained within 6 months of MR imaging showed no evidence of carcinoma. The median interval between mammography and MR imaging was 33 days (range, 0–163 days). The median interval between diagnosis of the index cancer and MR imaging was 27 days (range, 0–167 days).

Breast MR Imaging Technique

At our institution, diagnostic MR imaging examinations were performed with the patient prone in a 1.5-T commercially available system (Signa; General Electric Medical Systems, Milwaukee, WI) using a dedicated surface breast coil (Breast Array Coil for General Electric Signa System; MRI Devices, Waukesha, WI). Our imaging sequence includes a localizing sequence followed by a sagittal fat-suppressed T2-weighted sequence (TR/TE, 4000/85). A T1-weighted three-dimensional, fat-suppressed fast spoiled gradient-echo sequence (17/2.4; flip angle, 35°; bandwidth, 31.25) is then performed before and three times after a rapid bolus injection of 0.1 mmol/L gadopentetate dimeglumine (Magnevist; Berlex, Wayne, NJ) per kilogram of body weight, delivered through an indwelling IV catheter.

Image acquisition was started immediately after injection of contrast material and saline bolus. Images were obtained sagittally, for an acquisition time per volumetric acquisition of less than 2 min each. For bilateral examinations, the left side was imaged first, with the sequence of image acquisitions after contrast injection being first contrast-enhanced left, first contrast-enhanced right, second contrast-enhanced left, second contrast-enhanced right, third contrast-enhanced left, and third contrast-enhanced right. Section thickness was 2 mm without gap, using a matrix of 256 × 192 and field of view of 16–18 cm. Frequency was in the anterior–posterior direction. After the examination, the unenhanced images were subtracted from the first contrast-enhanced images on a pixel-by-pixel basis.

Interpretation of Breast MR Imaging Examinations in Clinical Practice

In our practice, MR imaging examinations were interpreted by breast imaging specialists. During the study period, examinations were reviewed on soft copy using a picture archiving and communication system (PACS; General Electric Medical Systems) that allowed manual windowing and optimization of parameters. MR imaging examinations were interpreted in conjunction with clinical history and other breast imaging studies, including mammograms and sonograms when available.

Level of suspicion was reported on a scale of 0 to 5, analogous to the Breast Imaging Reporting and Data System [17], as 0, needs additional imaging evaluation; 1, no abnormal enhancement; 2, benign enhancement; 3, probably benign, recommend short-term follow-up (specified as either at different time in the patient's menstrual cycle or in 6 months); 4, suspicious; or 5, highly suggestive of malignancy.

MR imaging-detected lesions referred for biopsy had morphologic features that included spiculated or irregular margins, irregular shape, heterogeneous or rim enhancement, or clumped enhancement in a ductal or segmental distribution. Other lesions were referred for biopsy at the discretion of the interpreting radiologist in conjunction with clinical history and other imaging studies. Tiny (1 mm) foci of enhancement or diffuse stippled enhancement generally did not prompt biopsy. Classification was based primarily on lesion morphology; however, kinetic features were visually assessed on the three contrast-enhanced image acquisitions, with quantitative kinetic curves generated in specific cases at the request of the interpreting radiologist.

Biopsy Methods

For nonpalpable, mammographically occult, MR imaging–detected lesions warranting biopsy, correlative sonography was performed at the discretion of the interpreting radiologist to determine whether the lesion was sonographically evident and thereby amenable to tissue sampling under sonographic guidance. If the lesion was not seen on sonography, MR imaging–guided needle localization for surgical excision was performed using previously described methods [18], with a commercially available MR imaging grid-localizing system (Biopsy-System No. NMR NI 160; MRI Devices) and MR imaging–compatible hookwires (18- or 20-gauge Tumor Localizer, Daum Medical, Schwerin, Germany; 20-gauge E-Z-EM, MRI Breast Lesion Marking System, Westbury, NY; or 20-gauge MR-eye Modified Kopans Spring Hook Localization Needle, Cook, Bloomington, IN).

Data Collection and Analysis

We reviewed the records of the 223 women with recently diagnosed breast cancer who underwent MR imaging of the asymptomatic, mammographically normal, contralateral breast. Family history of breast cancer was noted, including whether the relative who had breast cancer was a first-degree relative (mother, sister, or daughter).

Mammographic parenchymal density was recorded according to the Breast Imaging Reporting and Data System lexicon as class 1 (fatty), class 2 (mildly dense), class 3 (moderately dense), or class 4 (dense) [17]. For women with MR imaging–detected lesions referred for biopsy, the reported level of suspicion was noted on a scale analogous to the Breast Imaging Reporting and Data System lexicon as 4 (suspicious) or 5 (highly suggestive of malignancy) [17].

The histology of the index cancer, the interpretation of contralateral breast MR imaging examination, and the method and histologic results of contralateral biopsy (if performed) were also recorded. The quadrant of the index cancer and the contralateral cancer, if present, were noted. The stage of cancer was determined according to the American Joint Committee on Cancer [19].

Breast MR imaging studies were reviewed on a PACS monitor by one radiologist, who was unaware of the histologic outcome. Lesions were classified as having mass or nonmass enhancement; other features for masses (margins, shape, and enhancement) and nonmass lesions (type and enhancement), T2 signal intensity, and visually assessed kinetic features were further classified in accordance with previously defined terminology [20]. MR imaging findings were then correlated with histologic results. For all women with MR imaging–detected lesions referred for biopsy, mammograms were reviewed in conjunction with the MR images to assess for the presence of a mammographic correlate to the MR imaging–detected lesion. Sonograms, if obtained, were also reviewed to assess for the presence of a sonographic correlate.

Data were entered into a spreadsheet (Excel; Microsoft, Redmond, WA). Statistical analyses were performed using the chi-square and Fisher's exact tests with statistical software (Epi-Info; Centers for Disease Control, Atlanta, GA), with p less than 0.05 considered significant.

Results

Baseline Characteristics

These 223 MR imaging examinations occurred in 223 women with a median age of 48 years (range, 28–79 years). Menopausal status was premenopausal in 130 women (58%) and postmenopausal in 93 women (42%). Among these 223 women with breast cancer, 107 (48%) had a family history of breast cancer, including 46 with a family history of breast cancer in a first-degree relative. There was no family history of breast cancer in 114 (51%) women. Two women were adopted, and their family histories were unknown.

The mammographic parenchymal density in these 223 women was class 4 (dense) in 62 (28%), class 3 (moderately dense) in 133 (60%), class 2 (mildly dense) in 27 (12%), and class 1 (fatty) in one (<1%).

The histologic findings of the index cancer, known in 222 women, were infiltrating ductal carcinoma in 137 (62%), 123 of whom had associated ductal carcinoma in situ (DCIS); infiltrating lobular carcinoma in 31 (14%), nine of whom had associated DCIS; infiltrating ductal and infiltrating lobular carcinoma in 18 (8%), 15 of whom had associated DCIS; and pure DCIS in 36 (16%). The stage of the index cancer, known in 207 women, was stage 0 in 36 (17%), stage I in 73 (35%), stage II in 76 (37%), stage III in 15 (7%), and stage IV in seven (3%).

Contralateral Breast Biopsy: Frequency and Methods

Biopsy of the contralateral breast for a lesion detected on MR imaging was recommended in 72 (32%) of 223 women and performed in 61 women. Sonography, performed in 37 of these 61 women, revealed a sonographic correlate in seven (19%). None of the lesions had a mammographic correlate.

Among the 61 women who underwent contralateral biopsy, biopsy was performed by MR imaging–guided needle localization in 47 (77%); two of these women also underwent prophylactic contralateral mastectomy, during the same procedure in one and at a later date in the other. Six (10%) of 61 women underwent sonography–guided core biopsy. Three (5%) of 61 women underwent surgical excision without localization guided by the reported MR imaging findings, at the preference of the treating surgeon. The remaining five (8%) of 61 women chose to have prophylactic contralateral mastectomy without any preceding diagnostic biopsy procedure.

Of the 11 women in whom contralateral biopsy was recommended but not performed, four had stage IV disease; three went elsewhere for their care; two declined biopsy; one had chemotherapy for the index cancer, and the contralateral lesion was not seen on follow-up MR imaging; and one was scheduled for MR imaging–guided localization, but the lesion was no longer evident.

Contralateral Biopsy Histology

Contralateral breast biopsy yielded cancer in 12 women, constituting 20% (12/61) of women who underwent contralateral biopsy and 5% (12/223) of women who underwent MR imaging of the contralateral breast (Table 1). These cancers were diagnosed at MR imaging–guided localization in nine, sonography–guided core biopsy in one, surgery without localization based on adjacent landmarks in one, and prophylactic mastectomy in one. The median interval between mammography and MR imaging in these 12 women was 15 days (range, 3–61 days).

The median age of the 12 women with contralateral cancer was 58 years (range, 46–65 years). Six (50%) of these 12 women had a family history of breast cancer in a first-degree relative; six (50%) had no family history of breast cancer. These 12 contralateral cancers were located in the upper outer quadrant in five women (42%), the lower outer quadrant in three women (25%), the upper inner quadrant in two women (17%), and the lower inner quadrant in two women (17%).

TABLE 1 **Histologic Findings at Biopsy in Women Who Underwent Contralateral Breast MR Imaging**

Histologic Findings	Occurrence Among Women Who Underwent Biopsy		Occurrence Among All Women Who Had Contralateral MR Imaging	
	No.	%	No.	%
Benign[a]	31/61	51	31/223	14
High-Risk[b]	18/61	30	18/223	8
Malignant	12/61	20	12/223	5
Ductal carcinoma in situ	6/61	10	6/223	3
Infiltrating carcinoma	6/61	10	6/223	3

[a] Dominant findings in these 31 women with benign lesions were fibrocystic change in 10, ductal hyperplasia in six, stromal fibrosis in five, fibroadenoma in four, papilloma in four, sclerosing adenosis in one, and benign breast tissue in one.

[b] Dominant findings in these 18 women with high-risk lesions were lobular carcinoma in situ in seven, atypical ductal hyperplasia in six, and radial scar in five.

The histologic findings of contralateral cancer in the 12 women were ductal carcinoma in situ (DCIS) in six (50%) and infiltrating carcinoma in six (50%), including infiltrating ductal carcinoma and DCIS in four, infiltrating ductal and infiltrating lobular carcinoma and DCIS in one, and infiltrating lobular carcinoma in one (Figs. 1–4). The median histologic size of infiltrating cancer, known in five women, was 0.5 cm (range, 0.1–1 cm). Axillary surgery, performed in five contralateral infiltrating carcinomas, showed no axillary metastases. The stage of contralateral cancer, known in 11 women, was stage 0 in six and stage I in five. Treatment of the contralateral cancer, known in 11 women, was breast-conserving surgery in eight (73%) and mastectomy in three (27%).

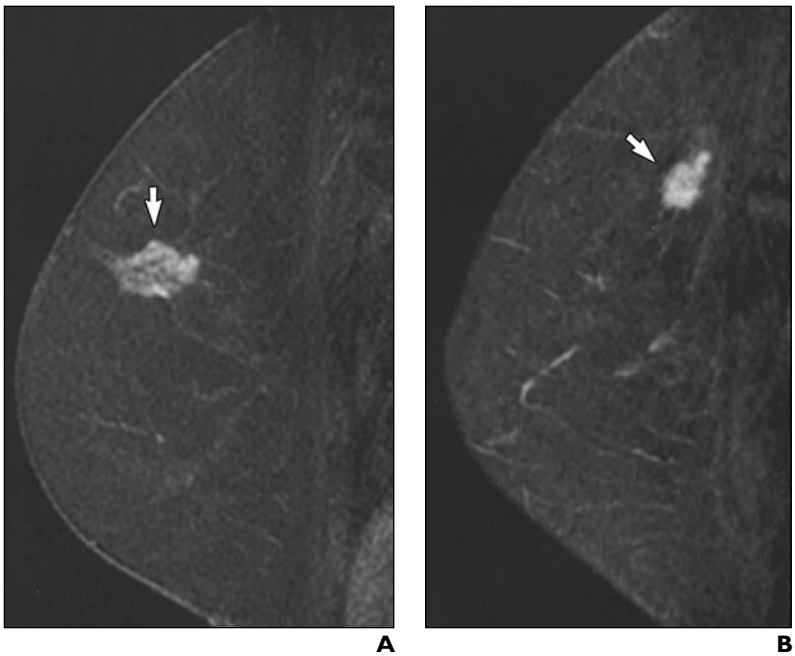

Fig. 1.— 61-year-old woman whose recent core biopsy of palpable lump in right upper outer quadrant yielded infiltrating lobular carcinoma. Mammogram (not shown) revealed moderately dense breasts without suspicious findings.
A, Sagittal T1-weighted contrast-enhanced MR image of right (ipsilateral) breast shows irregularly shaped, irregularly marginated, heterogeneously enhancing mass (*arrow*) in upper outer quadrant measuring 2.4 cm at maximal diameter, corresponding to palpable cancer.
B, Sagittal T1-weighted contrast-enhanced MR image of left (contralateral) breast shows irregularly shaped, irregularly marginated, heterogeneously enhancing mass (*arrow*) in left upper outer quadrant measuring 1.6 cm at maximal diameter. MR imaging–guided needle localization showed multifocal infiltrating carcinoma with mixed lobular and ductal features.

TABLE 2 MR Imaging Morphologic Findings in Lesions That Underwent Biopsy: Frequency and Positive Predictive Value

Morphologic Findings	Lesions		Cancers		Cancer Histology			
	No.	%[a]	No.	%[b]	No. Invasive	%[c]	No. DCIS	%[d]
All masses	48	67	9	19	4	44	5	56
Margin								
Irregular	34	47	8	24	4	50	4	50
Smooth	12	17	1	8	0	0	1	100
Spiculated[e]	2	3	0	0	0	0	0	0
Shape								
Irregular	24	33	6	25	3	50	3	50
Lobular	20	28	3	15	1	33	2	67
Round	1	1	0	0	0	0	0	0
Oval	3	4	0	0	0	0	0	0
Enhancement								
Heterogeneous	36	50	7	19	4	57	3	43
Rim	7	10	1	14	0	0	1	100
Homogeneous	4	6	1	25	0	0	1	100
Nonenhancing internal septations	1	1	0	0	0	0	0	0
All nonmasses	24	33	4	17	2	50	2	50
All ductal	16	22	3	19	2	67	1	33
Clumped	8	11	2	25	1	50	1	50
Irregular	8	11	1	13	1	100	0	0
Regional	7	10	0	0	0	0	0	0
Segmental	1	1	1	1	0	0	1	100
All lesions	72	100	13	18	6	46	7	54

Note.—DCIS = ductal carcinoma in situ.

[a] Percentage reflects proportion of 72 lesions detected on MR imaging that had features indicated.

[b] Percentage reflects proportion of lesions with features indicated that were cancer.

[c] Percentage reflects proportion of lesions with features indicated that were invasive cancer.

[d] Percentage reflects proportion of lesions with features indicated that were ductal carcinoma in situ.

[e] Both spiculated masses were radial scars.

TABLE 3 Kinetic Features, T2 Signal Intensity, and Level of Suspicion in Lesions Detected on MR Imaging That Underwent Biopsy: Frequency and Positive Predictive Value

Kinetic Pattern	Lesions		Cancers		Cancer Histology			
	No.	%[a]	No.	%[b]	No. Invasive	%[c]	No. DCIS	%[d]
Kinetic features (n = 70)[e]								
Washout	12	17	4	33	3	75	1	25
Plateau	57	81	8	14	3	38	5	62
Progressive	1	1	0	0	0	0	0	0
T2 signal intensity (n = 72)								
Isointense	57	79	9	16	4	44	5	56
Hyperintense	15	21	4	27	2	50	2	50
Level of suspicion (n = 72)								
5 (highly suggestive)	6	8	4	67	3	75	1	25
4 (suggestive)	66	92	9	14	3	33	6	67

Note.—Scale for levels of suspicion is analogous to that of Breast Imaging Reporting and Data System [17]. For purposes of this study, kinetic curves were visually assessed on contrast-enhanced images. DCIS = ductal carcinoma in situ.

[a] Percentage reflects proportion of lesions detected on MR imaging that had features indicated.

[b] Percentage reflects proportion of lesions with features indicated that were cancer.

[c] Percentage reflects proportion of lesions with features indicated that were invasive cancer.

[d] Percentage reflects proportion of lesions with features indicated that were ductal carcinoma in situ.

[e] Data refer to lesions in which at least two contrast-enhanced images were available; excluded were two lesions (one ductal carcinoma in situ and one benign) for which only one enhanced image was available.

Contralateral breast biopsy yielded benign (n = 31) or high-risk (n = 18) lesions in 49 women, constituting 80% (49/61) of women who had biopsy and 22% (49/223) of women who had MR imaging of the contralateral breast (Table 1). Follow-up MR imaging, performed in 13 of these 49 women at a median of 6 months (range, 1–12 months) after biopsy, confirmed lesion retrieval in 12 women who had MR imaging–guided localization and showed stability in one woman who had sonography–guided core biopsy.

MR Imaging Lesion Findings

Biopsy was performed for 72 contralateral lesions in 61 women (mean, 1.2 lesions per woman; range, 1–3 lesions per woman). Among these 72 lesions, 66 (92%) were classified as suspicious (Category 4) and six (8%) were classified as highly suggestive of malignancy (Category 5). The median size of MR imaging–detected lesions that underwent biopsy was 1.1 cm (range, 0.3–4.3 cm).

Cancer was found in 13 of 72 lesions (18%), of which seven (54%) were DCIS and six (46%) were infiltrating cancer. These 13 malignant lesions occurred in 12 women, including one woman who had multifocal DCIS with microscopic invasion. The median size of MR imaging–detected lesions yielding benign results was 1.1 cm (range, 0.3–4.3 cm), and the median size of MR imaging–detected lesions yielding carcinoma was 1.3 cm (range, 0.6– 3.7 cm).

Among 72 contralateral lesions that underwent biopsy, findings on MR imaging included mass in 48 (67%) and nonmass enhancement in 24 (33%) (Table 2). Cancer was present in nine of 48 masses (19%) versus four of 24 nonmass lesions (17%; p = 1.0). A mass was present in four of six infiltrating cancers (67%) and in five of seven DCIS lesions (71%; p = 1.0). Lesion type (mass versus nonmass) did not reliably distinguish benign from malignant lesions or invasive from in situ carcinoma. The features most commonly seen in carcinomas were irregular margins, irregular shape, and heterogeneous enhancement for masses, and ductal enhancement for nonmass lesions (Table 2).

Carcinoma was present in 67% (4/6) of lesions classified as highly suggestive of malignancy versus 14% (9/66) of lesions classified as suspicious (p <0.01) (Table 3). Visually assessed kinetic features and T2 signal intensity were not significant predictors of carcinoma (Table 3).

Comparison of Index and Contralateral Cancers

Among 12 women with contralateral cancer, the median interval between diagnosis of

TABLE 4 Biopsy Rate, Positive Predictive Value, and Frequency of Detecting Contralateral Cancer Using MR Imaging

Patient History	Biopsies Recommended		Positive Predictive Value of Biopsies Performed		Contralateral Cancers Detected on MR Imaging	
	No.	%	No.	%	No.	%
Menopausal status						
Premenopausal	34/93	37	8/29	28	8/93	9
Postmenopausal	38/130	29	4/32	13	4/130	3
Family history of breast cancer						
Yes	39/107	37	6/31	19	6/107	6
No	33/114	29	6/30	20	6/114	5
Unknown	0/2	0	NA	NA	0/2	0
Family history of breast cancer in first-degree relative						
Yes	17/46	37	6/15	40	6/46	13
No	55/175	31	6/46	13	6/175	3
Unknown	0/2	0	NA	NA	0/2	0
Mammographic density						
1	1/1	100	1/1	100	1/1	100
2	6/27	22	1/6	17	1/27	4
3	50/133	38	10/41	24	10/133	8
4	15/62	24	0/13	0	0/62	0
Index cancer histology						
Infiltrating lobular carcinoma[a]	10/31	32	4/10	40	4/31	13
Infiltrating ductal carcinoma and infiltrating lobular carcinoma[a]	7/18	39	1/7	14	1/18	5
Infiltrating ductal carcinoma[a]	43/137	31	5/33	15	5/137	4
Ductal carcinoma in situ	12/36	33	2/11	18	2/36	6
Unknown	0/1	0	NA	NA	0/1	0
Index cancer stage						
0	12/36	33	2/11	18	2/36	6
I	26/73	36	5/24	21	5/73	7
II	24/76	32	4/22	18	4/76	5
III	2/15	13	0/2	0	0/15	0
IV	4/7	57	NA	NA	0/7	0
Unknown	4/16	25	1/2	50	1/16	6
Total	72/223	32	12/61	20	12/223	5

Note.—NA indicates not applicable because no biopsies were performed.

[a]With or without ductal carcinoma in situ.

the index cancer and the contralateral cancer was 38 days (range, 12–253 days). In 11 (92%) of 12 women, the contralateral cancer was diagnosed within 3 months of diagnosis of the index cancer.

The quadrant of the contralateral cancer was the same as that of the index cancer in five (42%) of 12 women and different in seven (58%). Among nine women with contralateral cancer in whom MR imaging of the index cancer was performed before surgery, the imaging features of the index lesion and the contralateral cancer were the same in six (67%), including mass enhancement in five women and nonmass enhancement in one woman, and different in three (33%).

The histologic findings of the index tumor and the contralateral cancer were the same in eight (67%) of these 12 women: ductal in seven and mixed ductal and lobular in one. In four women (33%), the histologic findings of the index cancer and contralateral cancers differed, including three women with mixed ductal and lobular histology in the index cancer and pure ductal histology in the contralateral cancer, and one woman with lobular histology in the index cancer and mixed ductal and lobular histology in the contralateral cancer. In 11 women in whom the stages of both the index cancer and the contralateral cancer were known, the stage of the contralateral cancer was lower than that of the index cancer in seven (64%), the same in two (18%), and higher in two (18%).

Statistical Analyses

The frequency with which MR imaging identified a contralateral cancer occult to mammography and physical examination was significantly higher in women who had a family history of breast cancer in a first-degree relative than in women who did not have this strong family history (13% versus 3%, $p = 0.02$; Table 4). A trend was found toward higher frequency of identifying a mammographically and clinically occult contralateral cancer in women whose index tumor was infiltrating lobular carcinoma rather

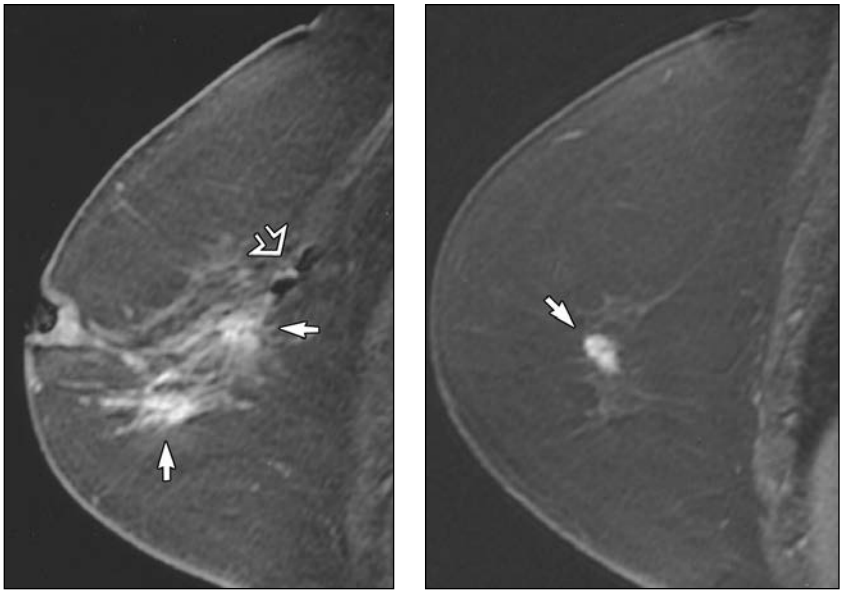

Fig. 2.— 63-year-old woman 2 years after excision of ductal carcinoma in situ (DCIS) in left upper outer quadrant. Mammogram (not shown) revealed moderately dense breasts with two spiculated masses in left breast at 3:00 and 5:00 axes. Sonography-guided core biopsy yielded infiltrating mammary carcinoma with ductal and lobular features from both sites.
A, Sagittal T1-weighted contrast-enhanced MR image of left (ipsilateral) breast shows signal void from clips at lumpectomy site (*open arrow*). Corresponding to core biopsy–proven carcinoma are two irregular spiculated masses (*solid arrows*) with heterogeneous enhancement in left 3:00 axis measuring 1.3 cm and in left 5:00 axis measuring 2.2 cm, with clumped linear enhancement extending between and anterior to masses.
B, Sagittal T1-weighted contrast-enhanced MR image of right (contralateral) breast shows irregular, spiculated heterogeneously enhancing mass (*arrow*) measuring 1.3 cm. Sonography-guided core biopsy (not shown) yielded infiltrating mammary carcinoma with ductal and lobular features and DCIS.

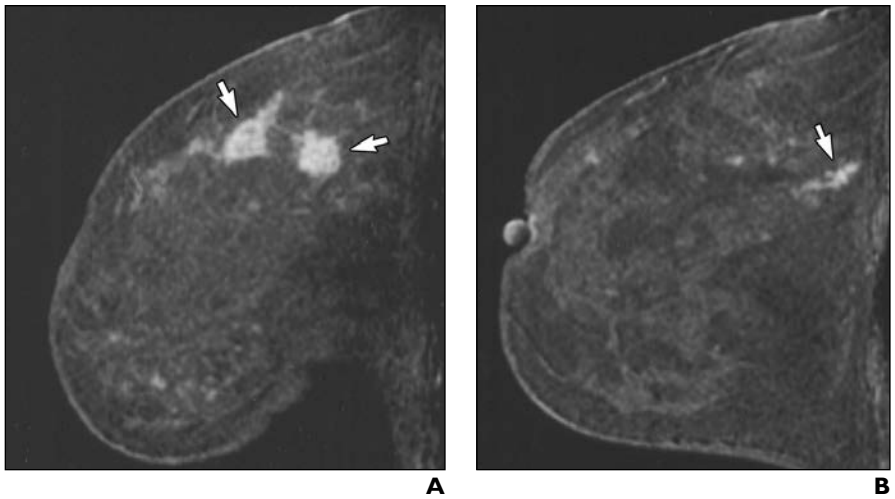

Fig. 3.—47-year-old woman with palpable lump in right upper outer quadrant for which core biopsy revealed infiltrating ductal carcinoma and ductal carcinoma in situ (DCIS). Mammogram (not shown) revealed moderately dense breasts without suspicious findings.
A, Sagittal T1-weighted contrast-enhanced MR image of right (ipsilateral) breast shows irregularly shaped, irregularly marginated, heterogeneously enhancing masses (*arrows*) spanning 3.2 cm in upper outer quadrant, corresponding to palpable cancer.
B, Sagittal T1-weighted contrast-enhanced MR image of left (contralateral) breast shows clumped linear enhancement (*arrow*) spanning 1.6 cm in 12:00 axis. MR imaging–guided needle localization yielded DCIS.

than other diagnoses (13% versus 4%, $p < 0.07$; Table 4).

The frequency of identifying a mammographically and clinically occult contralateral cancer was higher in postmenopausal women as compared with premenopausal women, but this difference did not achieve statistical significance (9% versus 3%, $p = 0.13$; Table 4). No significant difference was observed in the frequency of finding contralateral cancer by MR imaging as a function of mammographic parenchymal density (Table 4), but most women (87%) had either moderately dense or dense breasts.

Prophylactic Mastectomy

Prophylactic contralateral mastectomy was performed in 5% (12/223) of the women (Fig. 5). Seven (58%) of the 12 women who had prophylactic contralateral mastectomy had a family history of breast cancer, including four with a family history of breast cancer in a first-degree relative. A prophylactic contralateral mastectomy was performed in 9% (7/75) of women referred for contralateral breast biopsy on the basis of MR imaging findings versus 3% (5/148) of women who were not referred for biopsy on the basis of MR imaging ($p = 0.11$).

Prophylactic mastectomy revealed cancer in two women (14%), both of whom had been referred for biopsy on the basis of MR imaging findings. In one of these two women, surgery revealed node-negative infiltrating ductal carcinoma measuring 0.5 cm and DCIS, corresponding to the MR imaging–detected lesion. In the other woman, the MR imaging–detected lesion was benign, but two microscopic foci of DCIS measuring 0.2 and 0.3 cm were found at mastectomy.

Discussion

MR imaging of the breast has high sensitivity in breast cancer detection, reported as high as 94–100%, but lower specificity, ranging from 37–97% [10]. Although the expense and relatively low specificity limit the utility of breast MR imaging as a screening test in the general population, it may be useful in select women who are at high risk, such as women who have had prior breast cancer, who have a genetic predisposition or strong family history of breast cancer, who have had a biopsy diagnosis of atypia or lobular carcinoma in situ, or who have recently diagnosed cancer in the contralateral breast [21–26].

In our study, MR imaging detected a cancer that was occult to physical examination and

mammography in the contralateral breast in 5% of women with recently diagnosed breast cancer. This rate is comparable to those of prior reports of women with breast cancer, in which MR imaging detected an otherwise occult cancer in the contralateral breast in 4–24% [11, 13–16] (Table 5) and other high-risk breast screening MR imaging studies, in which MR imaging identified a cancer occult to mammography and physical examination in 2–4% [22–26]. The frequency of contralateral cancer in our study does not differ significantly (p = 0.12) from the 3% (26/871) prevalence of cancer at blind contralateral upper outer quadrant surgical biopsy reported by Cody [27]. However, all of the patients in Cody's study underwent contralateral breast biopsy; in our study, MR imaging enabled diagnosis of these contralateral cancers while only requiring biopsy in one third (32%) of women.

Cancer was found in 20% of women who had contralateral breast biopsy. This positive predictive value is lower than the 49–80% range of positive predictive values previously reported for biopsy performed on the basis of MR imaging findings in the contralateral breast in women with known breast cancer [14–16] and on the low end of the 18–64% range of positive predictive values reported for biopsy performed on the basis of MR imaging findings in women at high risk for developing breast cancer [22–26]. The low positive predictive value may reflect several factors, including MR imaging technique, learning curve, and our radiologists' low threshold for recommending a biopsy in a woman with recently diagnosed breast cancer. The 20% positive predictive value is also at the low end of the 20-40% range of positive predictive values for mammography–guided needle localization and surgical excision in the general population [28].

Neither the location nor the MR imaging pattern of the index cancer was reliably predictive of the pattern of cancer in the opposite breast. Among our MR imaging–detected contralateral cancers, 67% had similar MR imaging patterns to those of the index cancer. In previous studies of mammographic patterns of bilateral breast cancer, the index cancer and contralateral cancer had similar mammographic patterns in 33–36% [2, 3]. A mirror image location was noted in 42% of our patients, as compared with the 53% frequency of mirror image location in the prior mammographic study of Murphy et al. [3]. The histologic findings of the index cancer and the contralateral cancer were similar in 67% of the women in our study. In a prior report of bilateral breast cancers, histologic findings were similar in 57% of the patients [5]. Our findings regarding the comparison of index and contralateral cancers are limited by the small sample size and should be confirmed in larger studies.

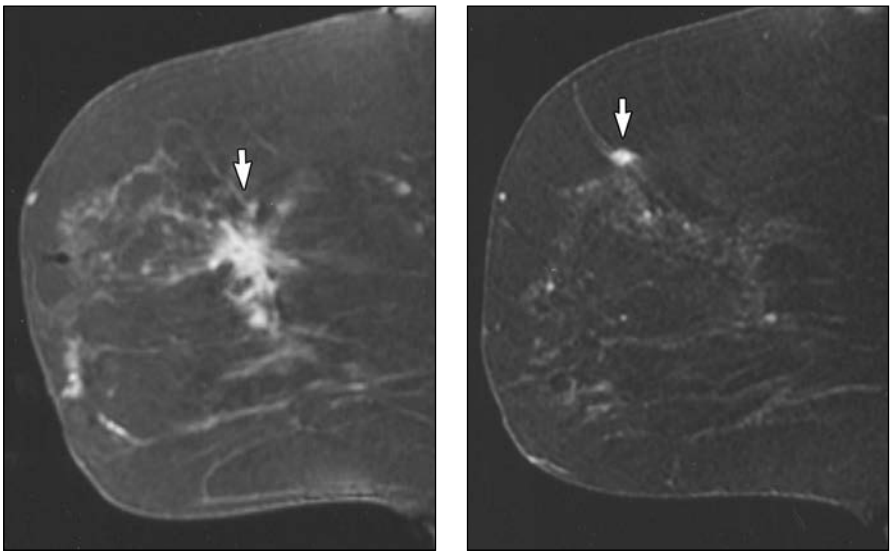

Fig. 4.—66-year-old woman after core biopsy of palpable mass in right upper outer quadrant yielded infiltrating lobular carcinoma and in situ carcinoma with mixed ductal and lobular features. Mammogram (not shown) revealed mildly dense breasts with irregular spiculated mass in right upper outer quadrant.
A, Sagittal T1-weighted contrast-enhanced MR image of right (ipsilateral) breast showed irregular, spiculated, heterogeneously enhancing mass (*arrow*) in right upper outer quadrant measuring 2.5 cm, corresponding to palpable cancer.
B, Sagittal T1-weighted contrast-enhanced MR image of left (contralateral) breast shows irregularly shaped, irregularly marginated, heterogeneously enhancing mass (*arrow*) measuring 0.6 cm in left upper outer quadrant. MR imaging–guided needle localization (not shown) yielded ductal carcinoma in situ.

Half of the MR imaging–detected contralateral cancers in our study were DCIS. In previous studies, DCIS accounted for 0–60% of contralateral cancers found at MR imaging [11, 13, 14]. MR imaging can detect DCIS that is not seen on the mammogram; the reported sensitivity of MR imaging for DCIS has ranged from 40–100% [29]. Although Ernster et al. [30] believe that detection of DCIS by screening may lead to overtreatment of an innocuous disease, published data sup-

TABLE 5 MR Imaging of Contralateral Breast in Women with Breast Cancer

Investigator	No. of Women	Biopsies[a]		Positive Predictive Value of Biopsies[b]		Cancers Detected by MR Imaging Only[c]	
		No.	%	No.	%	No.	%
Rieber et al. [13]	34	Not stated	Not stated	Not stated	Not stated	3/34	9
Fischer et al. [11]	336	Not stated	Not stated	Not stated	Not stated	15/336	4
Woo et al. [14]	90	10	11	5/10	50	5/90	6
Kuhl et al. [15]	710[d]	91	13	45/91	49	45/710	6
Slanetz et al. [16]	17	5	29[e]	4/5	80[e]	4/17	24
This study	223	72	32	12/61	20	12/223	5

[a] Refers to number of women for whom contralateral biopsy was recommended.

[b] Refers to number of women in whom contralateral biopsy showed cancer divided by number of women who underwent contralateral biopsy.

[c] Refers to number of women with mammographically occult, nonpalpable cancers detected on MR imaging divided by number of women in study.

[d] Includes women with synchronous and prior cancer in contralateral breast.

[e] Ten contralateral lesions were identified in five women; nine lesions in four women were malignant.

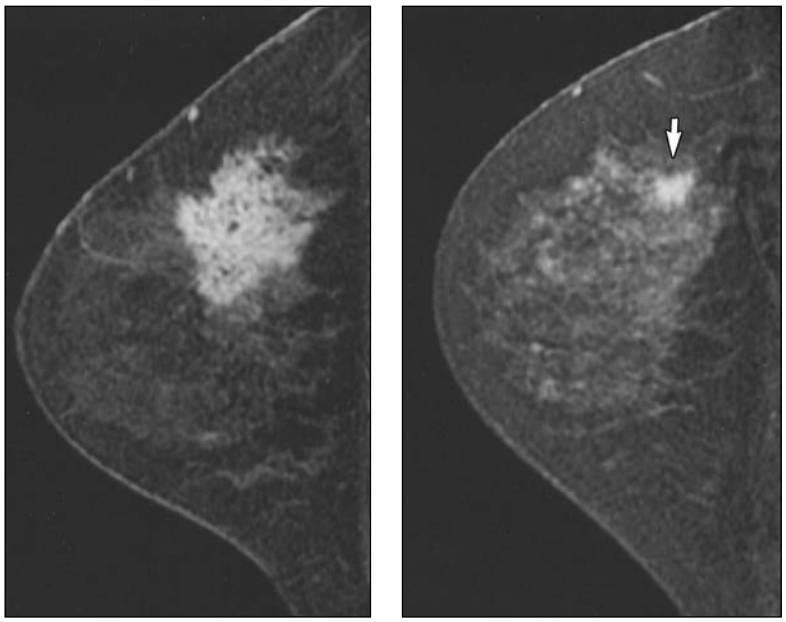

Fig. 5.—34 year-old woman with palpable mass in upper outer quadrant of right breast in whom core biopsy yielded ductal carcinoma in situ (DCIS). Mammogram (not shown) revealed moderately dense breasts and irregular, spiculated mass with pleomorphic calcifications in right upper outer quadrant.
A, Sagittal T1-weighted contrast-enhanced MR image of right (ipsilateral) breast shows irregular, spiculated, heterogeneously enhancing mass measuring 4.2 cm, corresponding to palpable cancer. Extensive residual DCIS was found at mastectomy.
B, Sagittal T1-weighted contrast-enhanced MR image of left (contralateral) breast shows irregularly shaped, irregularly marginated, heterogeneously enhancing 1.5 cm mass *(arrow)* in upper outer quadrant. MR imaging–guided needle localization (not shown) yielded proliferative fibrocystic change. Patient chose to undergo prophylactic left mastectomy during same procedure, which revealed no evidence of carcinoma.

port the benefit of detecting and treating DCIS. Long-term follow-up studies of women with untreated DCIS showed subsequent development of ipsilateral invasive breast cancer in 28–32%, of whom 56–57% had distant metastases [31, 32]. These studies suggest that inadequately treated DCIS can progress to invasive cancer, with its associated potential for morbidity and mortality.

We found subgroups of women in whom contralateral MR imaging was most likely to identify an otherwise occult cancer. The frequency of finding cancer on contralateral MR imaging was significantly higher for women with a history of breast cancer in a first-degree relative than in women without this strong family history (13% vs 3%, $p = 0.02$). Contralateral cancer was more often identified in women whose index cancer was infiltrating lobular as compared with other diagnoses (13% vs 4%, $p < 0.07$). The latter finding is consistent with prior reports indicating that a higher frequency of synchronous contralateral cancer may exist among women whose index cancer is infiltrating lobular as compared with other diagnoses [7] as well as with prior studies showing that MR imaging provides more accurate assessment of the extent of disease than mammography in women with infiltrating lobular carcinoma [33–35].

Breast sonography, which is fast, inexpensive, and useful for guiding biopsies, may be helpful in assessing the extent of disease in women with breast cancer [12]. If sonography had been performed after MR imaging in more patients, more sonographic correlates may have been identified; it is also possible that sonography may have identified some of these cancers even without MR imaging. However, Panizza et al. [36] found that "second look" sonography identified 11 MR imaging–depicted lesions (including five cancers) that were not seen on sonography before MR imaging. LaTrenta et al. [37] reported that a sonographic correlate was identified in only 23% of MR imaging–detected lesions referred for biopsy. Furthermore, MR imaging is more sensitive than sonography in the detection of DCIS [12], which accounted for half of our MR imaging–detected contralateral cancers. Additional study comparing sonography and MR imaging for evaluation of the contralateral breast is needed.

Our data suggest a potentially disturbing consequence of MR imaging of the contralateral breast. Prophylactic contralateral mastectomy was performed in 5% of our women. The frequency of prophylactic mastectomy was higher in women in whom a biopsy was recommended on the basis of MR imaging findings than among women who were not referred for biopsy, although this difference did not achieve statistical significance (9% vs 3%, $p = 0.11$). Identification of an abnormality on MR imaging may have contributed to the decision to perform prophylactic contralateral mastectomy. Prophylactic mastectomy can be a rational choice, but women and their physicians should be aware of the limited specificity of MR imaging to make an informed decision [38]: in our practice, findings on 80% of biopsies for MR imaging–detected contralateral lesions were benign.

In conclusion, MR imaging of the contralateral breast led to a biopsy recommendation in 32% of women with synchronous breast cancer. Cancer was found in 20% of women who underwent contralateral biopsy and in 5% of women who underwent contralateral breast MR imaging. Our data do not address the impact on survival of detecting these contralateral cancers. Furthermore, the benefit of detecting early contralateral cancers in 5% of women must be weighed against the added time, expense, and consequences of MR imaging and downstream examinations. Breast MR imaging may benefit from new sequences that allow rapid, high-resolution, simultaneous imaging of both breasts. Further work is necessary to determine the value of MR imaging screening in women with prior cancer as well as in other women at high risk.

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