PAPER

The Role of Magnetic Resonance Imaging Mammography in the Surgical Management of the Index Breast Cancer

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Hypothesis: Preoperative magnetic resonance imaging (MRI) mammography, after positive fine-needle aspiration (FNA) or stereotactic biopsy, may alter surgical management of the index breast cancer.

Design: Review of MRI mammograms compared with conventional mammograms and clinical examination.

Setting: Rural community hospital.

Patients: Consecutive cohort of 27 patients with breast cancer who underwent prebiopsy or preoperative MRI mammography.

Intervention: Surgical management of breast cancer.

Main Outcome Measure: Change in surgical management prompted by findings on MRI mammography.

Results: Prebiopsy or preoperative MRI mammography changed surgical management in 13 (48%) of 27 patients with breast cancer by discovering multicentric cancers or more extensive cancer. Of the 27 patients, 9 with positive FNA biopsy results of palpable masses underwent preoperative MRI; in 6 of the 9, ipsilateral multicentric cancers or more extensive cancer was discovered that necessitated mastectomy rather than breast conservation. Eighteen of the 27 patients had category 4/5 mammograms. Ten of these patients had stereotactic biopsies followed by MRI; 4 of the 10 had changes on the MRIs that required mastectomy rather than breast conservation. Eight of the 27 patients had MRI before stereotactic biopsy; 3 of the 8 had MRI abnormalities that required mastectomy. One patient had contralateral, multicentric cancers not seen on conventional mammography, necessitating bilateral mastectomies.

Conclusions: We recommend that patients who desire breast conservation undergo MRI mammography before biopsy of a category 4/5 mammogram or immediately after a positive FNA biopsy result of a palpable mass.

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SURGEONS PLAY SEVERAL ROLES in the management of breast cancer. They perform procedures to diagnose the cancer, offer counseling on various therapeutic options, manage the primary site of the cancer, and surgically evaluate the regional lymph nodes. Of these services to the patient with breast cancer, none is more problematic for the surgeon and patient than how to manage the index cancer. The choice patients must make between breast conservation and mastectomy is often the most difficult decision they face.

It is therefore incumbent on the surgeon to be as accurate as possible about the status of the primary cancer: its size, location, potential for establishing a clear margin, and multicentricity, and the potential for noninvasive as well as invasive components. The more precise the surgeon can be with this information, the better informed the patient's choice will be on managing the primary cancer.

Magnetic resonance imaging (MRI) mammography is emerging as a valuable tool to assist the surgeon in this effort. First used in 1982,[1] breast MRI became a diagnostic reality with the introduction of bilateral breast coils in 1989,[2] allowing simultaneous imaging of both breasts. The addition of gadolinium scanning supplemented and clarified the images, improving both specificity and sensitivity.[3] Magnetic resonance imaging mammography has been shown to be a useful adjunct to conventional screening mammography in high-risk patients[4] and has been used to evaluate residual disease after breast conservation therapy,[5] to observe patients for in-breast recurrence,[6] and to evaluate the mammographically normal breast in patients with metastatic axillary adenopathy.[7]

The multidisciplinary breast care program at our rural community hospital has developed guidelines for MRI mammography. This study specifically looks at the role of MRI mammography in determining the surgical management of the index breast cancer.

METHODS

From May 1, 2001, through June 30, 2003, 411 patients underwent MRI mammography at our facility. Of these, 237 were from our primary service area; the others were referred for MRI but not for treatment. All patients underwent studies on a 1.5-T unit (LX i [Signa]; General Electric Co, Milwaukee, Wis) with the use of phased-array bilateral breast coils and 33-mT gradients. Coronal T1-weighted gradient echo images were followed by axial T2-weighted fast spin-echo imaging. Dynamic gadolinium scanning was performed with the technique of Kaiser.[8] After a 1-minute precontrast scan, gadopentetate dimeglumine, 0.1 mmol/kg, was injected at 3 mL/second followed by a isotonic sodium chloride solution flush of 20 to 30 mL, also at 3 mL/second. After a 20-second delay, the study was completed with seven 1-minute scans. Morphologic areas of abnormal enhancement were evaluated with FuncTool software (General Electric Co, Milwaukee, Wis) and were considered suspicious if at least 90% of the gadolinium uptake occurred in the first minute and promptly washed out thereafter.

Patients taking hormone therapy had their studies delayed until they had stopped taking the therapy for at least 6 weeks. Menstruating patients had their studies performed 7 to 10 days after cessation of menses. Studies were considered positive for invasive breast cancer only if both the morphologic images and the dynamic scan were positive.

RESULTS

Of our 237 patients, 27 patients had a total of 35 invasive breast cancers. None of the abnormal mammograms of these 27 patients demonstrated more than 1 cancer. The results are summarized in **Table 1**.

PATIENTS WITH PALPABLE MASSES

Nine patients had palpable masses, of which biopsy specimens had been obtained by fine-needle aspiration (FNA). Seven of these patients had category 4/5 mammograms and 2 had normal mammograms. Three of the patients had 2 ipsilateral cancers on the MRI mammogram, 3 had larger cancers than the clinical examination and/or mammogram suggested, and 3 had no additional abnormalities on the MRI beyond that known by clinical examination or mammogram. The 6 patients with multicentric or larger-than-anticipated cancers had mastectomy; the other 3 had breast conservation. One of the 3 patients who had 2 ipsilateral cancers also had 2 cancers detected in the contralateral breast, the mammogram of which was normal; she underwent bilateral mastectomy.

PATIENTS WITH NORMAL CLINICAL FINDINGS AND CATEGORY 4/5 MAMMOGRAMS

Ten patients had category 4/5 mammograms, normal results of clinical examinations, and positive results of stereotactic biopsies. The MRI mammography demonstrated multicentric cancers in 2 patients and larger-than-anticipated cancers in 2 additional patients; these 4 patients had mastectomy. The remaining 6 patients had solitary cancers on MRI and underwent breast conservation.

Table 1. Ability of MR Imaging to Detect Multicentricity, Compared With the Single Index Cancer, and to Predict Size, Compared With Mammography and/or Clinical Examination

Group	No. of Patients	No. of Patients		
		Multicentricity	Increased Size	Agreement
Positive FNA	9	3*	3	3
Positive stereotactic biopsy	10	2	2	6
Category 4/5 mammogram	8	1	2	5
Total	**27**	**6**	**7**	**14**

Abbreviations: FNA, fine-needle aspiration; MR, magnetic resonance.
*Includes 1 patient with 2 contralateral cancers.

MRI MAMMOGRAPHY BEFORE BIOPSY

Sufficient confidence in the value of MRI mammography in the latter portion of this study led us to use MRI before biopsy in selected patients whose screening mammograms were highly suggestive of cancer and who wished to have breast-conservation surgery should cancer be confirmed. Eight patents had category 4/5 mammograms and normal results of clinical examinations. One patient had 2 ipsilateral cancers demonstrated on MRI and 2 patients had larger-than-anticipated cancers; these 3 patients underwent mastectomy. The remaining 5 patients had single cancers on MRI and had breast conservation.

BIOPSY

Suggestive areas on MRI mammography, which were not seen on conventional mammography, were subjected to biopsy by means of a titanium needle localization device placed under MRI guidance before a decision was made regarding mastectomy.

PATHOLOGICAL FINDINGS

All 6 patients in whom the MRI predicted 2 ipsilateral cancers had this confirmed at pathological examination (**Table 2**). All second cancers were invasive, ranged in size from 0.6 to 1.7 cm, and were at least 2 cm from the index cancer. The patient in whom the MRI predicted 2 contralateral cancers had this confirmed by pathological examination (1 invasive, 1 ductal carcinoma in situ [DCIS] with extensive microinvasion). In the 7 patients in whom the MRI predicted a larger cancer than the mammogram or clinical examination, pathological review agreed with the MRI in 4. These 4 cancers were from 1.1 to 2.8 cm larger than anticipated. In 3 of these 7 pa-

Table 2. Accuracy of MR Imaging Compared With Pathological Findings

Group	Multicentricity, No. of Cancers		Larger Cancer Than Mammogram or Clinical Examination, No. of Cancers	
	MR Imaging Predicted	Pathologically Confirmed	MR Imaging Predicted	Pathologically Confirmed
Positive FNA	8*	8*	6	6
Positive stereotactic biopsy	4	4	8	8
Category 4/5 mammogram	2	2	7	4
Total	**14**	**14**	**21**	**18**

Abbreviations: FNA, fine-needle aspiration; MR, magnetic resonance.
*Includes 1 patient with 2 contralateral cancers.

tients, the MRI did not correlate with the size of the index cancer as measured by pathological examination. In the remaining 14 patients, pathological review agreed with the MRI and mammogram. No cancer at pathological review was larger than what the MRI predicted. Overall, the MRI accurately estimated the size of 32 (91%) of 35 invasive cancers.

COMMENT

Magnetic resonance imaging mammography is an emerging technology that will assist surgeons in advising patients with breast cancer of the probable outcome of attempted breast-conservation surgery. In our series of 27 patients, 13 (48%) chose mastectomy on the basis of the MRI discovery of multicentricity or increased size.

Six of the 27 patients chose mastectomy because of MRI evidence of multicentricity. All 6 patients had this predicted multicentricity confirmed by pathological examination, with all the second cancers being invasive and remote from the index cancer. One of these 6 patients had 2 contralateral cancers found by MRI, also confirmed by pathological examination.

Seven patients chose mastectomy over breast conservation because they and their surgeon feared adequate margins could not be obtained without either compromising the effort to eradicate the cancer or deforming the breast. Three of these patients had discordance between the MRI prediction of size and the pathological review of the mastectomy specimen. These 3 cases were early in our experience, and it is not clear whether the MRI overestimated or pathological examination undercalculated the size of the cancer. The MRI accurately predicted size in 32 (91%) of the 35 cancers in these 27 patients. Our results are in concert with those of other authors,[9] although some mature studies have reached levels of concordance between MRI and pathological examination approaching 99%.[10]

Our study can be criticized on the grounds that it is small and quite selected. Not all patients with breast cancer treated at our facility during this period had MRI mammography: (1) some patients with category 4/5 mammograms had excisional biopsies with needle localization to obtain tissue confirmation; biopsy site changes are known to obscure the MRI and therefore MRI was not performed; (2) some patients had only DCIS without invasion on excisional biopsy with adequate margins; (3) several patients were unwilling to stop taking hormone therapy long enough to obtain an accurate MRI; (4) some patients were unable to obtain insurance coverage for the study; (5) some of the patients may have chosen mastectomy even if the MRI yielded no additional areas of concern; (6) several patients were ineligible for MRI because of implanted ferromagnetic devices or were too claustrophobic to tolerate the procedure; and (7) the follow-up period to assess clinical outcome based on this decision making is short (median follow-up, 13 months), although to date no patient in whom the MRI predicted a single cancer has had an in-breast recurrence.

We do not know whether the 48% mastectomy rate in this series will be indicative of the mastectomy rate once MRI mammography becomes more widely used. Historically, our institution has had a 20% mastectomy rate in the period before MRI became available. Presumably most patients with multicentric synchronous cancers and many patients whose MRI predicts more extensive cancer than the mammogram or clinical examination will choose mastectomy. Other authors have noted that one fourth to one third of patients desiring breast conservation will be advised to have mastectomy on the basis of MRI mammography.[11]

There are other potential consequences of MRI mammography: (1) surgeons will be better able to anticipate margins with more accurate prediction of index tumor size, (2) patients with single cancers who have breast conservation and radiation therapy will be considerably more confident that there are no occult invasive cancers elsewhere in the breast, and (3) patients are reassured that their contralateral breast is normal by MRI.

Other, and as yet unresolved, issues are as follows: (1) Will in-breast recurrence be reduced as predictability of breast conservation improves? (2) Will the removal of otherwise undetected invasive synchronous cancers have an impact on survival? (3) Should all patients contemplating partial breast irradiation have MRI before initiating treatment? (4) Can the cost of MRI mammography be reduced (roughly 10 times the cost of routine mammography) and will insurance cover the procedure?

CONCLUSIONS

Twenty-seven patients with breast cancer underwent MRI mammography after FNA biopsy of a mass, after stereo-

tactic biopsy of a mammogram abnormality, or because of a category 4/5 mammogram. Thirteen (48%) of the 27 patients chose mastectomy on the basis of additional information obtained from the MRI.

It is recommended that patients who desire breast conservation have MRI mammography done before biopsy of a mass shown on a category 4/5 mammogram or immediately after FNA biopsy of a palpable mass yields a positive result.

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Larraine Chrystal, NP, contributed to the evaluation of data in this study.

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DISCUSSION

John E. Sutton, Jr, MD, Lebanon, NH: It is very nice to get an explanation of some of the newer technology and trying to figure out how to use it in our practices. My question for you, Fred, would be that you are suggesting that the mastectomy rate may go up as high as 50% or so in contrast to your previous rate, which was maybe in the 20% range. Most of us have noticed the fact that local recurrence and local failure rates are exceedingly low and so one observation would be, does this matter anyway? In other words, in those previous patients who are now being identified by MRI as mandating mastectomy, would radiation or additional therapy have somehow taken care of some of these other centers of cancer? You've also spoken about invasive cancer, but what about the issue of DCIS? Are some of these additional areas or expansive areas that you are identifying on MRI DCIS? Sloan-Kettering and other groups have suggested that, at least for the contralateral breast, the rate of finding occult cancers is about 5%, which I think corresponded to your one patient in whom you did find cancer on the other side, but I guess my question is, does it really matter in terms of making a prediction?

Dr Bagley: Larger series, including a recent study out of Memorial, indicated that their mastectomy rate is running in the 25% to 35% range based on women who desire breast conservation but are not recommended to have it with the additional information from the MRI mammogram. Our radiation therapist takes great heart in these numbers because he is confident that he is solving a lot of recurrent breast problems, whether we have identified them in the old study or not. In the women who have more extensive cancer, a lot of that is certainly DCIS with invasion, but in the women who have an additional synchronous invasive cancer at some distance from their index cancer, it is hard for me to imagine that a 1- or 1.5-cm undetected invasive cancer is going to be solved by radiation therapy. Ultimately it is probably going to play out that finding the additional second cancer is the most important role for MRI mammography. The presence of DCIS without invasion remains a decision that you have to deal with at surgery. The MRI can't help us there.

David W. Butsch, MD, Barre, Vt: You said you had to wait 2 months after a biopsy to do the MRI. I wonder if the women had any trouble waiting for 2 months and I wonder if you had any trouble asking women to.

Dr Bagley: We didn't have any patients in this series who had open biopsy and had to wait after their open biopsy. The patients in this series who had biopsy prior to their MRI mammogram had it either by FNA or by stereotactic, but we had women who were excluded because they were unwilling to wait for their MRI mammogram. They were unwilling to wait that additional time and I confess it is hard in many women for us to make a strong case to wait. On the other hand, the more desirous a woman is for breast conservation, the more she is willing to wait, and a surprising number of postmenopausal women on hormone replacement were very willing to wait the 6 weeks to allow the hyperemia from hormone replacement to subside so that we could do a competent MRI study. Some of them got the information that they really had to consider mastectomy since there was additional disease present. Many women were tremendously reassured that there was only the index cancer once all the information had been obtained.

Roger S. Foster, Jr, MD, Shelburne, Vt: I have actually the same question. You have presented an unusually high rate of finding lesions that discourage you from breast-conserving surgery. The one population where in-breast recurrence is very high is the young patient, so one of my questions is, what age population are you dealing with? Do you have a large number of patients under 40 in this group?

Do you have any experience with preoperative chemotherapy and response on MRI of such lesions? Thank you.

Dr Bagley: Boy, Roger, you got me on the age. I'm not sure, but I don't think the age distribution of this patient population is much different than our larger series. It was not specifically just younger women, but I will get you those numbers.

Certainly, some of these women probably could have been treated with neoadjuvant chemotherapy or radiation therapy in an effort to convert them from requiring mastectomy to possible conservation. We have not employed that at this point, but we probably will encounter women in whom the MRI shows more cancer in one area but who are still very desirous of breast conservation. In some of these cases, neoadjuvant therapy will still allow them to have breast conservation, whereas right now we may be unnecessarily recommending mastectomy.