Effect of Breast Magnetic Resonance Imaging on the Clinical Management of Breast Cancer

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Abstract

Background: Mammography is the principal breast cancer imaging technique; however, sensitivity is reduced, especially in dense breast tissue. Magnetic resonance imaging is increasingly used in the detection and characterization of breast cancers. The high sensitivity (95–100%) of MRI is consistently observed, and in many situations, MRI is proving superior to classical forms of imaging. Assessment of its impact on management and outcome is vital if MRI is to become standard in the management of breast cancers.

Objectives: To establish the impact of breast MRI on women undergoing testing in our institution.

Methods: We analyzed 82 cases that underwent MRI between January 2001 and April 2003. Analysis appraised the clinical impact of MRI testing in cases where medical summaries were available.

Results: Studies were categorized into five indications: a) screening in high risk women (n=7), b) search for primary disease in the presence of disease (n=5), c) monitoring of chemotherapy (n=2), d) postoperative assessment of tumor bed (n=9), and e) diagnostic/characterization of primary or recurrent breast cancer (n=59). Results were defined as negative, positive, or no impact on clinical management. MRI testing had a positive impact in 62 cases, affecting measurable change in 9 cases. Benefit was seen in screening, diagnosis and postoperative cases. In 15 cases, MRI stimulated investigations.

Conclusion: MRI is a valuable tool in breast imaging and affects management. Further trials are necessary to clearly define the role of MRI and to ascertain whether in cases where beneficial impact on management is noted, there is ultimate impact on outcome.

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Breast mammography has long been established as a valuable tool in the diagnosis and assessment of breast cancer. It is the only test that has been proven to reduce mortality from breast cancer and remains the only licensed imaging tool in breast cancer screening. However, mammography is limited in certain clinical situations such as dense breasts, augmented breasts and breasts following conservation and radiation treatment. The false-negative rate of mammography, ranging from 5% to 15% [1], has led to the development of complementary imaging techniques such as ultrasound and magnetic resonance imaging. MRI has the highest sensitivity and can provide valuable information that is not apparent from the mammogram. As a potential solution to the low sensitivity of standard imaging techniques, MRI has become an increasingly used tool in the management of breast cancer. Reports note sensitivity of 95–100% for breast MRI, in comparison to 85% for mammography [2]. MRI is indicated in the following areas of breast cancer diagnosis: a) in the diagnosis of primary tumor in the context of "dense" breast tissue, b) evaluation of the possibility of residual disease postoperatively, c) assessment of the possibility of recurrent disease, d) in the search for primary origin of disease in the face of evident metastases, and e) screening for breast cancer in the high risk population.

Trials assessing the impact of breast MRI on clinical management are invaluable for encouraging the correct use of this modality [3]. Ultimate use of breast MRI will depend on proof of measurable advantage in terms of clinical decision-making and ultimately on outcome in individuals undergoing such testing.

Our study assesses the use of breast MRI at the Hadassah University Hospital for all indications relating to the screening, diagnosis and evaluation of breast cancers. We address the value of breast MRI testing with regard to clinical impact and attempt to ascertain whether breast MRI is of particular use in certain clinical contexts.

Patients and Methods

We included 82 cases of breast MRI investigations undertaken in our institution over a 27 month period. Only women whose entire medical history was available to us were included in the analysis.

Breast MR imaging protocol

MRI was performed on a 1.5T Signa scanner (General Electric Medical Systems, Milwaukee, WI, USA) using a bilateral phased-array breast coil. The imaging protocol corresponded to the standard bilateral, dynamic, subtraction technique. Both breasts were examined on a sagittal and axial Fast Spin Echo T2-weighted imaging with fat suppression (TR/TE 102/4000-6000); the field of view was adjusted to cover both breasts (260–320 mm) with slice thickness of 4 mm, and an acquisition matrix of 256x192, and number of excitations 2. A dynamic T1-weighted three-dimensional, fat-suppressed fast-spoiled gradient-echo sequence (17/2.4, flip angle 35°, bandwidth 31.25, slice thickness 2–3 mm with no intersection gap) was then performed before and three times after a rapid bolus injection of 0.1 mmol/kg gadolinium-DTPA (gadopentatate dimeglumine, Magnetol®,

Soreq Radiopharmaceuticals, Yavne, Israel). Image acquisition began immediately after administration of the contrast material and saline bolus. Images were obtained sagittally for each breast or in axial plane for both breasts. Subtraction images were obtained by subtracting the precontrast images from the postcontrast images.

MRI examinations were interpreted by breast imaging specialists in conjunction with clinical history and other breast imaging studies including mammograms and sonograms when available. Case notes were reviewed to categorize cases into the following five categories:

- Screening in high risk women (n=7)
- Search for primary disease in the presence of metastatic disease (n=5)
- Monitoring of neoadjuvant chemotherapy (n=2)
- Postoperative assessment of tumor bed (n=9)
- Diagnosis/characterization of primary or recurrent breast cancer (n=59).

A score relating to the clinical impact of MRI use was assigned to each case. Scores were allocated according to the scale illustrated in Table 1. In addition, patients were further classified into positive, negative and no clinical impact groups, correlating to the initial MRI score. A score of 1+2 correlated with an overall "negative impact" on clinical management. A score of 3 correlated with "no impact" on clinical management, while a score of 4 or 5 was indicative of a "positive clinical impact" as a result of MRI testing.

Results

The 82 cases assessed were subdivided into five categories as follows:

- High risk screening (8.5%)
- Detection of primary disease in presence of metastatic disease (6%)
- Monitoring of neoadjuvant chemotherapy (2.5%)
- Postoperative assessment of tumor bed (11%)
- Diagnosis/characterization of lesion (72%).

Tables 2 and 3 show the results in terms of clinical impact of MRI testing using the scoring system shown in Table 1. Table 3 shows that MRI improved diagnostic impact in 62 (75.6%) of cases. Of these 62 cases, MRI improved the confidence in the original therapy plan in 53 (64.6%), while conferring a measurable change in treatment policy in 9 (11%). Upon further subanalysis the following results were seen. In the category of diagnosis and characterization of lesions, 44 of 59 cases (74.5%) reaped benefit from the use of MRI. In six cases MRI resulted in a definitive change in management. In two of these, MRI raised suspicions of disease presence in spite of negative conventional imaging techniques. Two further cases were undertaken to assess the extent of disease at diagnosis and in both cases MRI helped ascertain correct surgical management or the need for radiation treatment. Where pathologic evaluation was undertaken, the results corroborated the MRI suspicions. Within the subgroup for assessing disease remnants following definitive surgery, MRI was of positive influence in 7 of 9 cases (77.7%) [Figure 1]. In six of these cases MRI confirmed suspicions regarding the use of conventional imaging techniques. In one case, it suggested the presence of remaining disease when other imaging failed to do so. Results were confirmed on pathologic examination of the removed specimen. MRI was carried out on seven women considered at high risk for the development of breast cancer. MRI results proved of high sensitivity in this group, according to follow-up of 24 months.

It is difficult to ascertain in which subgroups MRI appeared to be of most benefit due to the relatively small numbers in certain categories, but it appears that MRI may be of most use in the postoperative assessment of tumors, in the diagnostic setting, and for high risk screening. Recently published reports analyzing the use of MRI in the high risk population have confirmed that MRI seems to be more sensitive than mammography in detecting invasive breast carcinoma in women with an

Table 1. Patient MRI results

		Value of MRI testing				
Patient subgroup	No. of patients	1	2	3	4	5
High risk screening	7	1	–	–	–	–
Detection of primary	5	–	–	2	2	1
Chemo-surveillance	2	–	–	–	1	1
Postoperative assessment	9	1	1	–	38	6
Diagnosis/characterization	59	13	–	2	38	6
Total	82	15	1	4	53	9
Total %	–	18.3%	1.2%	4.9%	64.6%	11%

Table 2. Impact score of MRI imaging

Score	Clinical impact	MRI result
1	Negative	MRI equivocal and resulted in ultimately unnecessary investigations
2	Negative	MRI equivocal but did not result in further unnecessary tests
3	None	MRI had no impact on original therapy plan
4	Positive	MRI caused no change in the original plan but increased confidence in that plan
5	Positive	MRI caused a measurable change in the original treatment plan

Table 3. Results of clinical impact of MRI

	Clinical impact score		
Patient category	Negative (1+2)	None (3)	Positive (4+5)
High risk screening	14%		86%
Detection of primary disease		40%	60%
Chemo-surveillance			100%
Postoperative tumor assessment	22%		78%
Diagnosis/characterization of lesion	22%	3%	75%

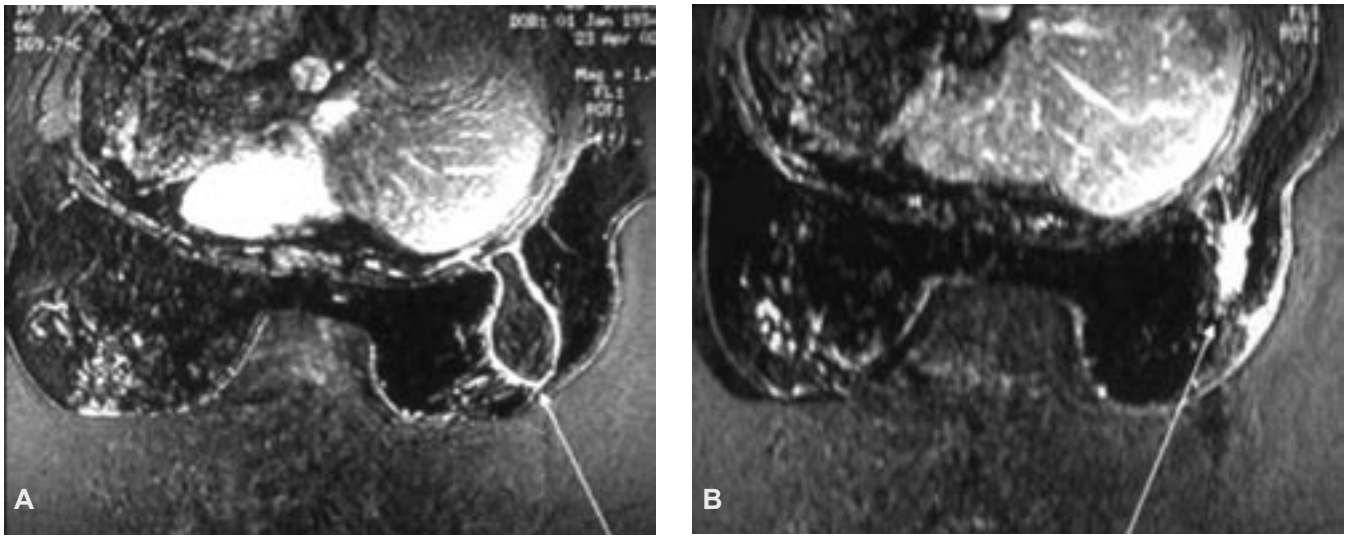

Figure 1. Post-lumpectomy MRI of 62 year old patient showing **[A]** post-lumpectomy seroma and **[B]** residual tumor in the outer lower quadrant of the right breast.

inherited susceptibility to breast cancer [4,5]. It is important to note that those subgroups showing a positive impact as a result of MR testing comprise relatively more cases. It is possible that significant results favoring MRI might be illustrated in other groups were they of a larger sample size.

Important to note are the cases in which MRI testing had a negative impact on clinical management. Overall, 16 cases (19.5%) were negatively affected by the use of MRI. Within the diagnostic category, a negative clinical impact was observed in 22% of cases. This negative impact was manifest by further investigations as a result of equivocal findings reported in the MRI test. Owing to suspicion of disease remnants following conservative surgery with close margins, one MRI that raised suspicions as to the evidence of disease led to further surgery which, upon pathologic evaluation, was clear of disease. Within the diagnostic group 13 cases resulted in further testing. Of note, only three of the above cases resulted in invasive biopsies. The remaining cases where MRI tests evoked further investigations were all followed by imaging techniques, with no invasive procedures being undertaken. They remain clear of disease at follow-up.

Discussion

We considered the clinical impact of MRI testing on breast cancer screening, detection and management in 82 cases in our institution. It is well established that MRI breast imaging is more sensitive than mammography in the diagnosis and characterization of breast lesions [2]. Evaluation of specificity of MRI testing, however, has raised questions about unnecessary interventions undertaken as a result of MRI imaging [2]. The above observations, as well as the high cost of MRI testing, emphasize the need for radiologists and clinicians to ascertain the most appropriate role of MRI breast imaging in breast cancer management. Studies evaluating the clinical impact and ultimate outcome are paramount within this goal.

In the category of high risk screening for breast cancers, 85% benefited from MRI testing in the sense that MRI proved itself a highly sensitive tool in the assessment of breast tissue in this subgroup. There were no positive findings in our sample group, but all those found by MRI to be without disease remain free of disease after 24 months of follow-up. This group of women is generally younger than the average-aged woman screened for breast cancer. As such, these women often constitute a subpopulation that corresponds with low sensitivity on mammography. Previous results have shown particular sensitivity of MRI among women shown to be *BRCA* mutation carriers [6]. Of significance is long-term follow-up of hereditary cancers detected by MRI and the proportion that will ultimately be cured as a result of earlier detection.

The pathologic assessment of mastectomy specimens deemed eligible for conservative breast surgery has illustrated the presence of disease foci at distances beyond those routinely included in the surgical volume of lumpectomies [7]. Increased accuracy in the assessment of possible multifocal and multicentric disease may be valuable for the decision process with regard to surgical treatment. In the category of cases assessed by MRI postoperatively, 6 of 9 cases (66%) benefited from MRI in terms of assessing the need for further surgical treatment. In two of them further surgery was performed following suspicious MRI findings. In one of these cases margins of the original conservative surgery were involved and therefore surgery was indicated regardless of MRI findings. In both cases pathology confirmed suspicions. If MRI is successful in assessing additional macroscopic postoperative disease, it may potentially improve mortality rates for women with otherwise undetected macroscopic disease. Results to date suggest that MRI increases our ability to adequately assess for multifocal and multicentric disease [8]. Whether changes in clinical management as a result

of MRI findings translate into improved outcome, remains to be seen.

The increased sensitivity of MRI can be applied to the initial assessment of breast lesions as well as to their assessment postoperatively. The evaluation of multifocal and multicentric disease prior to surgery is of even greater significance for the patient. Our analysis showed that 38 of 59 cases (64%) benefited from the inclusion of MRI in the initial evaluation of their tumors. This finding can be corroborated by several similar prospective studies.

Although MRI had a positive clinical impact in most cases (75%), it was only in far fewer cases (11%) that MRI caused a measurable change in treatment plan rather than concurring with other more conventional imaging techniques. This point is important when considering the additional cost involved in MRI testing [9]. Noteworthy is the small sample size of the study, which considerably restricts our ability to illustrate statistical significance.

Of particular concern is the relatively low specificity of MRI testing and the consequent unnecessary testing that this leads to. Such testing not only increases hospital costs but also adds significant psychological stress for many patients. In our cohort, MRI testing led to unnecessary interventions in 16 of 82 cases (19.5%). It should be noted that although unnecessary investigation causes unnecessary stress among individuals, in many cases the equivocal MRI findings resulted in further imaging rather than invasive biopsies. Nonetheless, the rate of further interventions instigated by the MRI highlights the need for further evaluation of MRI testing in breast cancer management to ascertain its most appropriate role in clinical practice [10,11].

Conclusions

MRI remains a highly sensitive modality in breast cancer management. Its high cost limits its ability to replace more conventional imaging techniques. Results from our study and other similar cohorts suggest that MRI testing confers a positive effect on clinical management in the majority of cases, with hints that it may be of particular benefit for high risk screening, diagnosis and postoperative assessment of tumors where highly sensitive information may avoid unnecessary operations and the resultant morbidity. Additional trials are needed to further assess breast MRI testing to firmly establish its use in the best possible clinical contexts.

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