Impact of magnetic resonance imaging on preoperative planning for breast cancer surgery

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**Key words**
Breast neoplasms; Magnetic resonance imaging; Preoperative care

*Original Article*

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**Objectives** To review the impact of preoperative breast magnetic resonance imaging on the management of planned surgery, and the appropriateness of any resulting alterations.

**Design** Retrospective review.

**Setting** A private hospital in Hong Kong.

**Patients** For the 147 consecutive biopsy-proven breast cancer patients who underwent preoperative magnetic resonance imaging to determine tumour extent undergoing operation by a single surgeon between 1 January 2006 and 31 December 2009, the impact of magnetic resonance imaging findings was reviewed in terms of management alterations and their appropriateness.

**Results** The most common indication for breast magnetic resonance imaging was the presence of multiple indeterminate shadows on ultrasound scans (53%), followed by ill-defined border of the main tumour on ultrasound scans (19%). In 66% (97 out of 147) of the patients, the extent of the operation was upgraded. Upgrading entailed: lumpectomy to wider lumpectomy (23 out of 97), lumpectomy to mastectomy (47 out of 97), lumpectomy to bilateral lumpectomy (15 out of 97), and other (12 out of 97). Mostly, these management changes were because magnetic resonance imaging showed more extensive disease (n=29), additional cancer foci (n=39), or contralateral disease (n=24). In five instances, upgrading was due to patient preference. In 34% (50 out of 147) of the patients, there was no change in the planned operation. Regarding 97 of the patients having altered management, in 12 the changes were considered inappropriately extensive (due to false-positive magnetic resonance imaging findings). In terms of magnetic resonance imaging detection of more extensive, multifocal, multicentric, or contralateral disease, the false-positive rate was 13% and false-negative rate 7%. Corresponding rates for sensitivity and specificity were 95% and 81%, using the final pathology as the gold standard.

**Conclusions** Preoperative magnetic resonance imaging had a clinically significant and mostly correct impact on management plans. Magnetic resonance imaging should be included as part of the preoperative investigation in patients planned for breast-conserving surgery, in whom there are doubts about the extent of the tumours based on conventional assessment.

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**New knowledge added by this study**
- Magnetic resonance imaging (MRI) significantly impacted preoperative breast cancer surgery planning.
- Most alterations in planned management were considered appropriate.
- MRI demonstrated high sensitivity and moderate specificity in detecting additional cancer foci.

**Implications for clinical practice or policy**
- Preoperative MRI should be considered in patients with suspected additional disease foci or indeterminate tumour margins, in addition to conventional imaging by mammography and ultrasonography.
Introduction

The selection of optimal treatment for breast cancer patients, namely breast-conservative treatment (BCT) or mastectomy, is often difficult. Apart from mammography and ultrasound, breast magnetic resonance imaging (MRI) is emerging as a useful preoperative adjunct to assist surgeons facing this decision. Thus, MRI provides additional information on the precise extent of disease, including index tumour size, location, and margin; the lesion-to-breast-size ratio; invasion to nipple or chest wall; and whether there was multifocal (additional foci in the same quadrant of index tumour), multicentric (additional foci in a different quadrant of index tumour), or contralateral disease. Not uncommonly, mammography and ultrasonography miss additional ipsilateral foci (reported frequency, 11-57%) and contralateral foci (reported frequency up to 10%). All of these observations are important in preoperative planning.

The use of MRI was not without controversy, however. Several reviews by Houssami et al argued that consistently, MRIs changed surgical management, usually from breast conservation to more radical surgery, but there was no evidence of associated improved surgical outcomes or prognosis. More importantly, the recent randomised COMICE trial concluded that MRI might be unnecessary as a means of reducing reoperation rates.

Asian patients are well known to have higher breast densities than their counterparts, making differentiation of normal from abnormal breast tissue more difficult and challenging. The usefulness of preoperative breast MRI in our locality is still unknown. This is the first large series to address the usefulness of MRI in an Asian population. In particular, the present study aimed to review the impact of preoperative breast MRI on altering management and the appropriateness of such alterations.

Methods

All consecutive biopsy-proven breast cancer patients managed by a single surgeon from 1 January 2006 to 31 December 2009 at the Hong Kong Sanatorium and Hospital were reviewed. Patients who had undergone preoperative MRI were selected for analysis.

All the patients had undergone standard preoperative workup, including triple assessment consisting of (1) clinical examination, (2) imaging using mammography and ultrasonography, and (3) cytohistological diagnosis by fine-needle aspiration or core-needle biopsy. The primary tumour was confirmed by cytolgy or biopsy. Patients with an index tumour deemed suitable for breast-conserving surgery but features suspicious for multicentric disease were selected to undergo breast MRIs.

Details of these indications are listed in Table 1.

A 3T Siemens MR Scanner (MAGNETOM Tim Trio) was used with a 4-channel phased array coil. The protocol for breast MRI entailed imaging as follows:

### Table 1. Indications for magnetic resonance imaging

<table>
<thead>
<tr>
<th>Indication*</th>
<th>No. (%) of patients (n=147)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodular breast on clinical examination</td>
<td>11 (7)</td>
</tr>
<tr>
<td>MMG showed multiple pleomorphic microcalcification</td>
<td>6 (4)</td>
</tr>
<tr>
<td>MMG showed dense tissue</td>
<td>3 (2)</td>
</tr>
<tr>
<td>USG showed ill-defined border</td>
<td>28 (19)</td>
</tr>
<tr>
<td>USG showed multiple indeterminate shadows</td>
<td>78 (53)</td>
</tr>
<tr>
<td>Suspicion for multi-tumour on core-needle biopsy</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Discordance between clinical, imaging, and histological finding</td>
<td>9 (6)</td>
</tr>
<tr>
<td>To locate occult primary focus with positive axillary LN</td>
<td>1 (1)</td>
</tr>
<tr>
<td>To search for residual tumour after excisional biopsy</td>
<td>7 (5)</td>
</tr>
<tr>
<td>Previous injection mammoplasty</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

* MMG denotes mammography, USG ultrasound, and LN lymph node
Results
A total of 659 breast cancer patients were managed in the relevant time period, out of which, 147 had preoperative MRIs and hence were included in the current study. As shown in Table 1, the most frequent indication for breast MRI was multiple indeterminate shadows on ultrasound scans (53%) followed by ill-defined borders around the main tumour (19%). The median age of these 147 patients was 47 (range, 30-70) years. All were female and 77% (n=113) were premenopausal; 91% (n=134) were Asians and the remainder Caucasians.

In 66% (97 out of 147) of these patients, the extent of the previously planned operation was upgraded from lumpectomy to a wider lumpectomy (23 out of 97), mastectomy (47 out of 97), bilateral lumpectomy (15 out of 97), and other (12 out of 97) [Fig 1]. Such upgrading was mainly based on MRI findings showing more extensive disease (n=29), additional cancer focus/foci (n=39), and contralateral disease (n=24). In five patients, the decision was based on patient preference for mastectomy even after detailed counselling that the MRI showed additional benign lesions only. Examples are shown in Figures 2 to 4. In 34% (50 out of 147) of these patients, there was no change in planned operation.

Regarding 97 of these patients for whom management was altered, in 12 the change was considered inappropriately extensive due to false-positive MRI findings. Thus, in 85 (88%) out of 97 patients, the altered management was regarded as appropriate (Fig 1).

In all, 89 patients underwent breast-conserving surgery (BCT) while 58 underwent mastectomy. Despite MRI use, 18% (16 out of 89) of those undergoing BCT underwent re-excision (Fig 1), because of close in-situ tumour margins in the final paraffin section (ie resection margin of less than 5 mm). None of these patients had surgery in which the margins were found to be positive for in-situ or invasive cancer.

In terms of MRI detection of more extensive, multifocal/multicentric, or contralateral disease, the false-positive rate was 13% and the false-negative rate was 7%, with a corresponding sensitivity of 95% and specificity of 81% (Table 2).

Discussion
In addition to clinical evaluation, conventional triple assessment uses mammography and ultrasonography as imaging modalities. The accuracy of such imaging in determining the extent of operations on breast cancers may be compromised in younger patients with dense breasts or multiple indeterminate shadows on ultrasound scans. Breast MRI provides additional information on tumour size, location,
Preoperative planning for breast cancer surgery

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border, multifocality, multicentricity, and whether there was contralateral disease. This should translate into a theoretical benefit in preoperative surgical planning for patients being considered for BCT.1,2,17

Contrast-enhanced breast MRI has been demonstrated to outperform mammography and ultrasonography in evaluating index tumour size as well as in detecting additional ipsilateral and contralateral tumours, and shows otherwise undetected multifocal/multicentric and contralateral cancers. Meta-analyses showed that in about 11% of patients having planned ipsilateral surgical treatment, MRI-detected additional cancers resulted in changed management,11 and 3 to 4% of patients also had MRI-detected contralateral cancers.12 A recently published meta-analysis confirmed these data, showing similar percentages (12% and 3%, respectively) based on a larger number of studies.18

Asian breast density is known to be greater than in Caucasians, which is evident on both physical examination and imaging.15,16 Moreover, MRI further enhances the distinction between normal and diseased breast tissue. This is the first large series describing such MRI findings in Asians.

Given the theoretical benefit of MRI in preoperative planning, previous papers identified two main study end-points; the first was a short-term benefit via reducing the re-excision rate19-26; the second was long-term benefit resulting in improved disease recurrence rate and survival.27 In view of disease recurrence and mortality being so rare in the modern era, most studies were unable to provide data on the second end-point. Thus, only data on alteration in surgical extent/planning are available.

Similar to others, our study demonstrated alteration in the extent of surgery in a significant number of patients after undergoing breast MRI. Whether this translates into improvements in recurrence and/or survival rates will be revealed by future data.

Several review articles published by Houssami et al11-13 strongly maintained that breast MRI would only cause more patients suitable for BCT to undergo more radical surgery without evidence to indicate improved survival. However, missed multicentric disease may be responsible for future recurrences. Studies have also shown that MRI measurement of tumour size was closest to histological findings. One of the aims of breast MRI was to reduce re-excision rates. This rate was 18% (n=89) in our cohort, which

<table>
<thead>
<tr>
<th>Magnetic resonance imaging</th>
<th>Final pathology</th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td></td>
<td>80</td>
<td>12</td>
<td>92</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td>4</td>
<td>51</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>84</td>
<td>63</td>
<td>147</td>
</tr>
</tbody>
</table>

FIG 1. Patient flowchart
MRI denotes magnetic resonance imaging
was similar to rates quoted worldwide.

If the whole cohort (n=147) is considered as a group, only 11% underwent repeated operations; in other words, 89% could achieve a single-stage procedure, which was a satisfactory result in this group of complex patients.

Despite there being no current evidence to support breast MRI on a routine basis as shown in our patient cohort, it may nevertheless be useful under special circumstances, which include dense breasts with dubious shadows on ultrasound, tumours masked by dense mammography findings, or discordance in triple assessment. Other indications include occult primary tumour in a patient presenting with axillary lymphadenopathy, to differentiate scar tissue or foreign body granuloma from tumour, and previous breast augmentation.

Breast MRI consistently demonstrated high sensitivity and moderate specificity for the detection of additional foci. Our study used the final histology of the surgical specimen as the gold standard for calculation of false-positive and -negative rates, as well as sensitivity and specificity. The false-positive rate should be reliable. However the false-negative rate needs cautious interpretation, because a large portion of patients with negative MRI findings will not undergo more extensive operations and hence histological proof of the negative MRI may be lacking. However, none of our patients had an early recurrence on follow-up (within 4-7 years).

The pathology of all four cases with false-negative findings (Table 2) were reviewed. Three of them had ductal carcinoma in situ (DCIS), while the remaining one had DCIS with a small focus of invasive cancer. They were offered operations despite the MRI showing benign lesions, because screening mammography showed suspicious micro-calcifications. Therefore although MRI provides invaluable additional information, it cannot replace mammography for detecting DCIS, which usually presents as micro-calcification.

**Conclusion**

Preoperative MRI in selected cases had a significant and mostly correct impact on management plans, and should be included as part of preoperative staging in complex cases indeterminate for breast-conserving cancer surgery.

**References**

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