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Magnetic Resonance Imaging (MRI): keeping abreast of current use

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One of the most topical issues in Breast Surgery currently is the use of magnetic resonance imaging (MRI). Uncertainties exist amongst doctors regarding the use of MRI in clinical practice for breast cancer patients. There is a need for critical analysis of the current guidelines and close scrutiny of best available evidence to ensure appropriate use.

MRI basics

MRI technology was developed in the 1980s and uses radiofrequency pulses in a strong magnetic field to generate detailed cross-sectional imaging. The brightness of tissue in the images produced depends on the spin of hydrogen atoms and on the imaging sequence used (T1 or T2 weighted). Angiogenesis in tumours produce abnormal vessels and shunts. After injection of intravenous gadolinium, breast cancers exhibit rapid enhancement and often a washout effect, allowing its differentiation from adjacent benign tissue.

There are few contraindications to MRI and these are highlighted in most MRI request forms. Patients are required to lie prone during the scan and those suffering from anxiety or claustrophobia may require sedation or additional assistance. Anaphylactic reactions to gadolinium contrast are rare.

Increased breast parenchymal enhancement is normal during the secretory phase of the menstrual cycle and can give rise to false positive MRI scans. Breast MRI scans are thus recommended during the second week of the menstrual cycle (days 6–14).

Of all the imaging modalities for breast cancer, MRI is the most sensitive (92–98%) and reproducible across centres as long as contrast is used. Unlike mammography, the sensitivity of imaging is not affected by density, scar tissue, radiation therapy, implants (if MRI-compatible) or reconstruction.

Current guidelines for use

In 2008 the American College of Radiology (ACR) provided revised guidelines for MRI indications.[1] These ACR guidelines form the basis of Health Insurance Companies coverage policies[2] and relate to its use in screening, providing additional radiological evaluation to conventional imaging, and determining extent of disease.

Screening

The use of MRI in high-risk groups significantly improves detection of otherwise clinically and mammographically occult breast cancers. Such high risk groups include; genetic predispositions (e.g. BRCA 1 or 2, Li-Fraumeni syndrome, Cowden syndrome); women who have received radiation treatment to the chest between ages

10 and 30, such as for Hodgkin Lymphoma; any women with lifetime risk greater than 20% determined by standard risk assessment models (e.g. by the National Cancer Institute Risk Calculator[3]). MRI is also indicated in screening patients with prior breast augmentation or reconstruction.[1]

Cancer is detected in 5 to 7 of every 1000 women on the first screening mammogram and in 2 or 3 of every 1000 women who undergo regular screening mammography. In high-risk women, screening MRI significantly increases cancer detection—average 22 cancers per 1000 women screened. In women with inherited high risk for breast cancer, the accurate detection of number of malignant lesions was reported as 59% for mammography, 65% for ultrasonography, and 94% for MRI.[4] The reported rate of multifocal and multicentric cancers in high-risk women is as high as 45–50%.

Extent of disease

Breast MRI is useful in determining the extent of neoplastic disease (both invasive and intra-ductal) and in evaluating residual disease in patients whose pathology specimens demonstrate close or positive margins for disease that is mammographically occult. MRI also detects occult malignancy in the contralateral breast (in 3 to 5%), and is useful in evaluating treatment response with neoadjuvant chemotherapy.

A recent meta-analysis of 22 studies showed 35% of new contralateral cancers seen on MRI were ductal carcinoma in-situ (DCIS) with a mean diameter of 7 mm, 65% were invasive with a mean diameter of 9.3 mm, and the majority of the latter were node negative.[5]

In a recent systematic review of patients with invasive lobular cancer, additional ipsilateral lesions were detected with MRI in 32% of cases, contralateral lesions in 7%, while surgical management was changed in 28%.[6]

Studies focusing on the accuracy of assessing the size of DCIS and extensive intra-ductal component (EIC) have shown that MRI (38–64% correct assessment) appears to be more accurate that mammography (27–43%), but neither method can be considered completely reliable.[7] Intermediate, and especially low grade, DCIS may not be apparent on MRI.

Preoperative use of MRI—the evidence

Patients with the most potential benefit from a preoperative MRI include those with: mammographically dense breasts; a unilateral multifocal/multicentric cancer or synchronous bilateral cancers; lobular invasive cancer; cancers with >1 cm size discrepancy between mammographic and ultrasonographic imaging; or under consideration for partial breast irradiation.[8]

More limited evidence exists in favour of MRI in evaluating candidates for total skin sparing mastectomy or for patients with Paget's disease.

The potential outcome benefits include possible reduction in rates of the following events:

- Surgical intervention needed to achieve free margins,
- Ipsilateral recurrences,
- Secondary mastectomies, and
- Contra-lateral malignancy.[7]

There is however a known increase in rate of the following events:

- Additional biopsies (up to 25% in some series, of which at least half will be found to be benign disease),
- Rate of mastectomy (a small but significant percentage of patients) and
- Delay to definitive surgery (median 17 days).

In a meta-analysis of 19 studies for the breast harbouring a proven index cancer, the impact of preoperative MRI on surgical planning was evaluated for 12 studies reporting surgical outcomes as follows:[9]

- 8.1% conversion from wide local excision to mastectomy due to true positive findings;
- 1.1% conversion from wide local excision to mastectomy due to false positive findings;
- 3.0% conversion from wide local excision to wider/additional excision due to true positive findings;
- 4.4% conversion from wide local excision to wider/additional excision due to false positive findings.

The results of two Randomised Controlled Trials—the COMICE and the MONET studies—are awaited, although very early data from COMICE have not indicated survival benefit from preoperative MRI[10] or reduced re-operation rates in women scheduled for wide local excision.[11]

Current use

We have performed a retrospective review of prospectively collected data to evaluate the use of MRI in our own surgical setting for preoperative surgical planning in patients with breast cancer.[12] Over a 12-month period from March 2009 a total of 33 MRI scans were performed.

Preoperative pathological diagnoses were: invasive lobular cancer 56%, DCIS 22%, invasive ductal cancer 19% and other 4%. Cases were discussed in a multidisciplinary forum. The imaging allowed 30% of patients with invasive lobular cancer to confidently undergo breast conserving surgery. There were no non-definitive resections or unnecessary mastectomies in patients who had undergone preoperative MRI. There were no additional biopsies following MRI in our series.

In 50% of cases, the reported size of *in situ* lesions on MRI was more than 5 mm greater than the measured pathological tumour size. This over-estimate did not result

in compromised definitive surgery. We found the use of MRI complimented conventional triple assessment and improved surgical decision making in appropriately selected cases.

Future use

There is a learning curve for the use of MRI within the radiological-surgical team. Issues regarding clinical efficacy/effectiveness and cost-benefit are still under investigation. Technological improvements, such as diffusion weighted imaging and proton spectroscopy, are expected to enter clinical practice soon.[7]

Breast Surgery units will need to develop practices that ensure MRI is used according to evidence-based guidelines and also taking into account local experience.

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