**Review Article**

**Magnetic Resonance Imaging of the Breast: A Problem Solving Tool**

**Farheen Raza, Waseem Mehmood Nizamani**

**ABSTRACT**

Breast cancer is the most common malignant disease occurring in women with lifetime prevalence of 12.4%. Approximately one in every nine Pakistani women is likely to suffer from breast cancer. This is one of the highest incidence rates in Asia. Mammography and ultrasound are the basic imaging techniques for the detection and localization of breast tumors. Breast magnetic resonance imaging (MRI) has become increasingly important in the detection and delineation of breast cancer in daily practice. The utility of diagnostic value of MRI is mainly on specific situations such as detecting multifocal, multicentric or contralateral disease unrecognised on conventional imaging, assessing for the response to neoadjuvant chemotherapy, detection of cancer in dense breast tissue, recognition of an occult primary breast cancer. The standard breast MRI protocol includes T2 sequences (anatomy and signal analysis), TI gradient-echo sequences which can detect markers placed after biopsy, and injected dynamic 3D sequences for performing volume and multiparametric reconstructions, which are particularly useful for locating lesions. Good patient positioning is essential. These aspects limit movement artefacts which alter subtraction sequences, but limited with the native sequences. New functional imaging sequences are now appearing in an attempt to increase the specificity of MRI, which is one of its main limitations. Of these, magnetic resonance spectroscopy appears to be the most promising.

Key words: Magnetic resonance imaging; Breast Cancer; Mammography; Early detection; Diffusion-weighted imaging; Spectroscopy.

**INTRODUCTION**

Breast cancer is the most common malignant disease occurring in women with lifetime prevalence of 12.4%. Breast magnetic resonance imaging (MRI) has a sensitivity exceeding 90% for detecting breast lesions and is superior in measuring lesion size compared to mammography and ultrasound. Breast MRI is therefore, nowadays, is used for screening, in the preoperative and neoadjuvant setting.

The main additional diagnostic value of MRI relies on specific situations such as detecting multifocal, multicentric or contralateral disease unrecognised on conventional assessment (particularly in patients diagnosed with invasive lobular carcinoma), assessing the response to neoadjuvant chemotherapy, detection of cancer in dense breast tissue, recognition of an occult primary breast cancer in patients presenting with cancer metastasis in axillary lymph nodes.

This review included all articles that were used for the improvement of knowledge about MRI Breast. A literature search was conducted using the electronic databases of Pub Med, Google scholar, Elsevier from 1990 to 2014 for English-language articles. The search terms used were: Magnetic resonance imaging; Breast Cancer; Mammography; Early detection. The titles and abstracts of articles were examined. Full text and reviews of the articles were obtained when the abstracts matched the inclusion criterion.

**MRI (1.5 Tesla UNIT) PROTOCOLS**

**HISTORY:**

It is beneficial to have the patient a complete specific questionnaire aided by an experienced breast imaging assistant or a radiologist (Figure 1) like CHLM [10] has developed. This should include information on hormonal status (menopause, day of the menstrual cycle, pregnancy, breast feeding), the personal history of breast cancer (specifying the date of surgery, the date of the end of radiotherapy, the history of axillary lymph node dissection, the chemotherapy or hormone treatment) and any family history.

**SUITABLE PERIOD FOR EXAMINATION:**

The best time for MRI breast examination is during the second week of the menstrual cycle because normal breast tissue may interfere with accurately interpreting the MRI study, the timing of imaging during the menstrual cycle is important. This use of an automatic injector is recommended. Slice thickness should be less than or equal to 3 mm with pixel size less than 1 mm on each side. Finally, acquisition time should be less than 2 min as the mean enhancement time of a malignant tumor is between 95 and 120 sec.

**STANDARD SEQUENCES:**

The morphological sequences used in breast MRI are unenhanced high-spatial resolution T2 weighted fast spin-echo sequence without fat saturation in the axial plane for detecting the presence of cysts or microcalcifications. The European recommendations EUSOBI undertakes a T2W sequence. According to Kuhl et al at 10 T2W sequence can be performed without fat saturation because a T2 signal greater than that of non saturated fat has a higher predictive value for a benign cyst. S T2-weighted sequences with fat saturation are useful for creating indirect MRI ductography images where there is a discharge and seem to optimise the detection of small cancers.

<table>
<thead>
<tr>
<th>Patients Name</th>
<th>SEX</th>
<th>AGE</th>
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<tbody>
<tr>
<td>Patients Current Complaint</td>
<td></td>
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<tr>
<td>Previous Mammogram/Ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous MRI Breast</td>
<td>yes/no</td>
<td>findings</td>
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<tr>
<td>Where</td>
<td>Regular</td>
<td>Irregular</td>
</tr>
<tr>
<td>Date of Last Menstrual Cycle</td>
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<tr>
<td>Any previous surgical history</td>
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</tr>
<tr>
<td>If Post Menopausal? At what age Menstrual cycle stopped?</td>
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<tr>
<td>Personal medical History</td>
<td></td>
<td></td>
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<tr>
<td>Any previous surgical history</td>
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<td></td>
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<tr>
<td>Current medications</td>
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<td>Radiotherapy</td>
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<tr>
<td>Surgery: yes/no</td>
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<tr>
<td>with/without axillary disectomy</td>
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<tr>
<td>Chemotherapy: yes/no</td>
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<tr>
<td>Any family History of Any Cancer?</td>
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</tr>
<tr>
<td>BRCA1/BRCA2 positive</td>
<td>yes/no</td>
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**Figure 1:** A sample of questionnaire/history form which should be asked from patients undergoing MRI breast.

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T2-weighted sequences are useful for detecting the presence of a fatty component within a lesion, which is also a major aspect predicting its benign nature. T1 sequences are therefore performed without fat suppression. They also allow metal markers to be detected which may have been positioned at the end of biopsy. When the biopsy took place using stereotactic mammography, arthrotomography, the marker provides confirmation that the position of the biopsied lesion and of contrast uptake in the MRI is the same. This detection of the biopsy marker is based on detecting the magnetic susceptibility artefact on T1 gradient-echo sequences, created by the metallic nature of the marker. The longer the TE of the sequence the more the artefact is visible. Dynamic sequences must satisfy the two major classic requirements of perfusion imaging: good temporal resolution (< 2 minutes) and good spatial resolution (mm isotropic pixel).

The overall sensitivity for detection of breast MRI of 90%. The overall specificity was 72%.

In a retrospective study, El Khouli et al.36 selected 93 cases and both CE-MRI and DWI were performed. The association of DWI with ADC significantly improved the diagnostic performance and lesion characterization when compared with conventional T1-weighted and CE-MRI. Partridge et al.37 reported that ADC values of DCIS were lower when compared to benign lesions and invasive ductal carcinoma. Rohrer et al.38 found 96% of pure DCIS lesions to be hypointense in DWI.

**TECHNOLOGICAL DEVELOPMENTS**

Another method which can improve specificity of breast MRI is spectroscopy and DWI.

**DIFFUSION WEIGHTED MRI (DWI):**

DWI is a non-invasive MRI technique which measures the mobility of water molecules in tissue, providing information such as cellular density, viscosity, membrane integrity, and tissue microstructure, without the need of contrast injection.9,10 DWI is able to differentiate between tissue types based on the use of the apparent diffusion coefficient (ADC). Malignant breast tumors usually have a higher ADC value when generally present with restricted water diffusion and lower ADC values when compared to benign lesions.9,10

In a retrospective study, El Khoury et al.36 selected 93 women with 101 lesions (68 malignant tumors and 33 benign tumors) who underwent MRI using a 3.0 T magnetic field, and both CE-MRI and DWI were performed. The association of DWI with ADC significantly improved the diagnostic performance and lesion characterization when compared with conventional T1-weighted and CE-MRI. Partridge et al.37 reported that ADC values of DCIS were lower when compared to benign lesions and invasive ductal carcinoma. Rohrer et al.38 found 96% of pure DCIS lesions to be hypointense in DWI.

**SCREENING HIGH RISKS PATIENT:**

MRI has an important role in screening high-risk patients. The American Cancer Society Guidelines for the Early Detection of Cancer advice annual breast MRI beginning at the age of 23-30 years in patients carrying particular cases. The European Society of Breast Imaging also recommends annual MRI screening.18

Additionally MRI can be beneficial in patients with dense breast parenchyma. Mammography has a high false negative rate in patients with dense breast tissue.14,15 In a large multicenter study, Schnall et al.16 proved that MRI has superior capability to detect additional occult cancer foci when compared to mammography, particularly in women with radiographically dense breasts and larger index cancers.17(85% vs 7.7%). Many other studies confirm that MRI has the highest diagnostic value when used in heterogeneous or extremely dense breast parenchyma.18,19,20

The European Breast Imaging Society also advises the use of pre operative MRI in staging malignant lesions in patients with dense breast tissue. 18 Several guidelines recommend annual supplemental screening with MRI for women who are at high risk for breast cancer (Lifetime risk 20%–25% or more). This includes women who carry mutations of the BRCA genes, their first-degree untested relatives, and women who received radiation to the chest between the ages of 10 and 30 years (e.g., treatment for Hodgkin lymphoma). Expert consensus does not currently support supplemental screening for women with a lifetime risk of breast cancer that is less than 15%. There is considerable uncertainty about the use of MRI screening for women with intermediate risk (15%-20%), including those with dense breasts or a previous diagnosis of atypia (e.g., lobular carcinoma in situ, atypical ductal hyperplasia, or aphtyxial ductal hyperplasia) on breast biopsy.28,29

**CONCLUSION**

In addition to mammography, MRI imaging is now becoming part of routine clinical practice for certain patient populations at high risk for breast cancer. Optimizing breast MRI imaging technique is the first step toward maximizing diagnostic accuracy. Knowledge of the imaging appearances of invasive cancers and DCIS along with an awareness of the benefits and limitations of the various modalities, particularly mammography and US, in identification of MRI detected breast cancer is essential. DWI and spectroscopy used in conjunction with DCE-MRI increases the specificity for cancer detection and used alone holds promise of being useful for widespread cancer screening.

**REFERENCES**


