Comparison of Breast MR Imaging with Molecular Breast Imaging in Breast Cancer Screening, Diagnosis, Staging, and Treatment Response Evaluation

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KEYWORDS

• Breast imaging • Breast cancer • MBI • BSGI • Functional imaging • Breast cancer screening • Breast cancer staging • Neoadjuvant chemotherapy response

KEY POINTS

- Breast MR imaging and molecular breast imaging (MBI) are accurate and useful supplements to screening mammography in patients at high risk for breast cancer and patients with dense breasts.
- Breast MR imaging and MBI have similar sensitivity in breast cancer diagnosis and staging. MBI has been reported to have higher specificity resulting in lower cost.
- Breast MR imaging is the most sensitive and most widely used imaging modality for evaluation of breast cancer response to neoadjuvant chemotherapy (NAC). The limited evidence available regarding use of MBI for evaluation of response to NAC shows that this technique has promise, but development of quantitative algorithms and validation with prospective studies are required.
- The advantages of breast MR imaging over MBI include absence of radiation exposure and widespread availability. The advantages of MBI over breast MR imaging include lower cost, claustrophobia-free design, absence of nephrotoxicity, and absence of limitations related to patient body weight.

INTRODUCTION

Functional imaging modalities, including MR imaging and nuclear imaging with technetium (Tc-99m) sestamibi, are gaining acceptance as adjunct modalities for breast cancer evaluation. The unique advantage of functional breast imaging over standard anatomic imaging, such as mammography and ultrasonography, is that functional imaging can reveal vascular, metabolic, and molecular changes associated with cancer before morphologic changes can be detected.

The functional imaging modality most widely used in patients with breast cancer, dynamic contrast-enhanced MR imaging, can detect angiogenesis associated with tumor growth and can also detect changes in tumor microcirculation and contrast agent uptake associated with the increased permeability of tumor blood vessels.[1] Diffusion-weighted MR imaging and its quantitative derivative, the apparent diffusion coefficient, act as a breast cancer biomarker based on the diffusivity of water, tumor cellularity, and tumor cell membrane integrity.[2]

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Tc-99m sestamibi scanning is gaining acceptance as an adjunct modality for evaluation of breast cancer. Tc-99m sestamibi is a gamma-emitting radiotracer originally developed for cardiac perfusion imaging and later found to show uptake in breast tumors. The accumulation of Tc-99m sestamibi in breast tumors is due to increased angiogenesis in tumors and an increased concentration of mitochondria in cancer cells.[3] Tc-99m sestamibi is also a transport substrate for a multidrug-resistance–associated glycoprotein, P-glycoprotein, which is overexpressed in the cell membranes of chemoresistant cancers. Thus, Tc-99m sestamibi scanning is useful in predicting sensitivity to chemotherapy.[4] Initial breast imaging with Tc-99m sestamibi, referred to as scintimammography, was performed with whole-body gamma cameras that had poor spatial resolution and were unable to reliably detect lesions smaller than 1 cm, limiting its widespread clinical use. Recent development of dedicated breast nuclear imaging devices with significantly improved resolution and sensitivity has led to increased interest in functional nuclear breast imaging with Tc-99m sestamibi.[5] These dedicated devices are usually referred to as molecular breast imaging (MBI) systems.

Breast MR imaging and MBI are used as adjunct imaging for breast cancer screening in women at high risk for breast cancer and women with dense breasts, for detecting mammographically occult breast lesions, for detecting additional ipsilateral and contralateral sites of disease during presurgical evaluation, and for predicting response to neoadjuvant therapy.

> Breast MR imaging and MBI are functional adjunct imaging modalities useful for
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> - Detecting mammographically occult breast lesions
> - Screening of high-risk women and women with dense breast tissue
> - Detecting additional ipsilateral and contralateral sites of disease during presurgical evaluation
> - Predicting response to neoadjuvant chemotherapy.

This article reviews clinical applications of breast MR imaging and MBI in breast cancer screening, diagnosis, staging, and treatment response evaluation; discusses the differences and similarities between breast MR imaging and MBI; and discusses the advantages and disadvantages of these 2 functional imaging techniques.

MOLECULAR BREAST IMAGING SYSTEMS

Currently, 2 major types of dedicated breast gamma imaging systems are available: single-headed scintillation detector (Sodium Iodide or Cesium Iodide) systems, commonly referred to as breast-specific gamma imaging (BSGI) (Dilon 6800, Dilon Technologies); and dual-headed direct-conversion semiconductor detector (cadmium zinc telluride) systems, commonly referred to as MBI (Discovery NM750b, GE Healthcare; LumaGem 3200s, Gamma Medica). In recent years, use of the collective term MBI to describe all dedicated breast gamma imaging systems has gained acceptance, and they are referred to as such in this article.[5] Both types of systems use standard mammographic views (craniocaudal and mediolateral oblique). The breast is positioned between a paddle and the detector for BSGI and between 2 detectors for MBI. Usually, imaging is started within 5 minutes after intravenous injection of Tc-99m sestamibi with a 10-minute acquisition per view (craniocaudal and mediolateral oblique) for each breast, for a total imaging time for both breasts of approximately 40 minutes.

BREAST MR IMAGING AND MOLECULAR BREAST IMAGING IN BREAST CANCER SCREENING

Mammography is currently the gold standard for breast cancer screening. However, mammography has limited sensitivity in screening patients with dense breast tissue and young women at high risk for breast cancer. Functional imaging modalities have been shown to overcome limitations of mammography screening, and breast MR imaging has become an accepted supplemental screening modality for high-risk women.[6]

The reported sensitivity of breast MR imaging for breast cancer detection in high-risk women ranges from 64% to 94%, and the reported specificity ranges are from 54% to 98%.[7] The reported incremental cancer detection rate for MR imaging varies from 8 to 31 cases per 1000 women screened.[8]

The performance of MBI as a supplement to mammography for breast cancer screening is similar to that of MR imaging. Meta-analysis of MBI as an adjunct to mammography for breast cancer detection showed a pooled sensitivity of 95% and specificity of 80%.[9] A retrospective study of supplemental MBI in 849 subjects at increased risk for breast cancer reported an incremental cancer detection rate of 16.5 cases per 1000 women screened, which was similar to rates with MR imaging.[10]

Because dense breasts are associated with reduced sensitivity of mammography in the