Molecular breast imaging (MBI) represents the current state-of-the-art nuclear breast cancer imaging (see Figure 1), allowing superior imaging at significantly lower radiation doses than prior-generation breast-specific gamma imaging (see Figure 2). MBI involves intravenous injection of Technetium-99m-Sestamibi. Technetium-99m (Tc99m) is a radioisotope with a six-hour half-life and emits 140 keV gamma energy, ideal for clinical imaging.

Technetium-99m-Sestamibi is an isonitrile compound approved in 1997 by the Food and Drug Administration (FDA) as a radiopharmaceutical to detect breast cancer (also known as Miraluma). Tc99m Sestamibi accumulates and is trapped within cellular mitochondria in an energy-dependent manner. Since mitochondria play an essential role in cancer metabolism, it is known that Tc99m-Sestamibi will accumulate to a greater extent in cancerous cells than in normal cells.

MBI is based on an improved imaging system developed specifically for breast imaging. During the imaging exam, the breast is placed between two gamma camera heads engineered with cadmium zinc telluride (CZT) solid-state pixilated detectors. The pixilated CZT detectors result in better energy and spatial resolution than the BSGI pixilated sodium iodide (NaI) based detectors. Therefore, the MBI system is superior to BSGI in detecting small (less than 1 cm) breast cancers and allows imaging to be performed with lower injected doses of Tc99m-Sestamibi.

The MBI system has two heads and applies only mild compression to immobilize the breast. Similar to mammography, MBI provides craniocaudal and mediolateral oblique views of each breast, which facilitates comparison between MBI images and mammographic images.
Figure 1: Right breast invasive ductal cancer is not detected by mammography (A); however is clearly seen on MBI (B) as well as with breast MRI (C,D).
A - Right screening mammogram (CC and MLO) images showed dense fibroglandular breast tissue and was interpreted as a negative mammogram.
B - MBI showed a 3 cm mass with marked uptake of the radiotracer in the right breast (arrows) and normal distribution of the radiotracer in the left breast.
C, D - Breast MRI (sagittal and axial views) after administration of intravenous contrast showed abnormal enhancing 3 cm mass in the right breast (arrows), corresponding to the mass seen with MBI.
*Image contributed by Gaiane M. Rauch, MD, PhD, UT MDACC.*

Figure 2: Effect of breast density on cancer detection using mammography and breast-specific gamma imaging (BSGI). Left panel images (A, B) demonstrates detection of invasive ductal carcinoma in a mammographically dense breast by BSGI that is obscured on mammography. Right panel images (C, D) demonstrates detection of invasive ductal carcinoma in a mammographically nondense breast by both mammography and BSGI. *Reprinted with permission from Rechtman LR et al 2014 AJR 202:293-298.*

**MBI Advantages and Disadvantages**

**Advantages**

- Identify some breast cancers not detected by mammography
- Identify more breast cancers in women with dense breast tissue than mammography, tomosynthesis (“3D mammography”), and ultrasound
• Provides information for preoperative local staging and for assessing response to neoadjuvant therapy
• Can be used directly for biopsy of suspicious findings identified on MBI

Disadvantages

• Not widely available in medical centers around the USA. **Visit this link for a listing of U.S. MBI Centers**
• Exam takes 30-45 min (about 8 minutes per view per breast)
• Radiation exposure higher than mammography, but less than other imaging exams (see Figure 3)

**Figure 3:** Chart showing the radiation (effective) dose from many of the more common diagnostic imaging procedures. Worldwide, background radiation doses range from 2.5 to 10 mSv per year. MBI = molecular breast imaging; mCi = millicuries. Reference: Hruska CB, O’Connor MK. *J Am Coll Radiol.* 2015 Oct;12(10):1103-5. doi: 10.1016/j.jacr.2015.07.001.
In what clinical settings can MBI be considered for my patients?

Nearly half of all women have dense breast tissue. The sensitivity of mammography is known to be reduced in women with dense breast tissue. As an adjunct to mammography, MBI can improve cancer detection in women with dense breast tissue because dense breast tissue does not reduce the ability of MBI to detect breast cancer. MBI has demonstrated significantly higher diagnostic performance than that of mammography in detecting breast cancers in dense breasts. The overall cancer detection rate increased from 3.2 per 1000 with mammography alone to 12.0 per 1000 with mammography and MBI using low doses (8 mCi) of Tc99m Sestamibi (p < 0.001) (supplemental yield of 8.8 per 1000). MBI also had significantly higher sensitivity in women with dense breasts. The reported sensitivity of MBI alone compared to mammography alone was 81.0% versus 23.8% (p<0.001), with specificities of 93.5% vs. 89.1% (p<0.0001), respectively [Reference: Rhodes DJ, Hruska CB, Conners AL, et al. Journal club: molecular breast imaging at reduced radiation dose for supplemental screening in mammographically dense breasts. AJR Am J Roentgenol. 2015;204(2):241-251. doi:10.2214/AJR.14.13357].

MBI may be used to further evaluate indeterminate findings on mammogram and ultrasound or as a substitute for contrast-enhanced breast MRI in women who are unable to undergo MRI imaging due to claustrophobia or other contraindications. MBI can also be used for breast cancer staging or to evaluate tumor response to neoadjuvant therapy prior to surgery.

MBI may be useful for women:

- with dense breast tissue
- with newly diagnosed breast cancer to evaluate amount of disease in the breast
- with breast cancer receiving chemotherapy, to check for response to the treatment
- with inconclusive or unclear findings on mammogram or ultrasound
- who cannot tolerate breast MRI
- with breast implants when mammograms are limited
How does MBI compare with other modalities?

<table>
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<tr>
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<th>Cancer detection rate in women with dense breast tissue</th>
<th>Relative radiation exposure</th>
<th>Imaging time</th>
<th>Cost</th>
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</table>

Have clinical practice guidelines been published for MBI?

The SNMMI published a Practice Guideline for Breast Scintigraphy with Breast Specific Gamma Cameras in 2010 (Goldsmith et al). This document is currently (in 2021) undergoing updated revision by a joint working group between SNMMI and EANM.

The American College of Radiology published a Practice Parameter for the Performance of MBI Using a Dedicated Gamma Camera in 2017.

Where can my patients obtain MBI?

At present, MBI is the preferred modality over BSGI among the available breast specific cameras. MBI is available at select medical centers in the United States.

MBI is FDA approved; however individual insurance coverage may vary. Further details regarding coding and insurance considerations are discussed by Shermis et al (2017).

References


RELATED CONTENT

- Cancer-Specific Information
- Fact Sheet: Molecular Imaging and Breast Cancer
- Neurology-Specific Information
- Fact Sheet: What is PET?
- Fact Sheets

About SNMMI

The Society of Nuclear Medicine (SNMMI) is an international scientific and medical organization dedicated to raising public awareness about nuclear and molecular imaging and therapy and how they can help provide patients with the best health care possible. With more than 18,000 members, SNMMI has been a leader in unifying, advancing and optimizing nuclear medicine and molecular imaging since 1954.

The material presented in this pamphlet is for informational purposes only and is not intended as a substitute for discussions between you and your physician. Be sure to consult with your physician or the nuclear medicine department where the treatment will be performed if you want more information about this or other nuclear medicine procedures.