Dedicated Breast Gamma Camera Imaging and Breast PET: Current Status and Future Directions

Deepa Narayanan, MS[a,*], Wendie A. Berg, MD, PhD[b]

KEYWORDS

• Molecular breast imaging • Positron emission mammography • Breast PET • Breast cancer
• Breast PET tracers

KEY POINTS

- Dedicated breast imaging using gamma and PET scanners provide high sensitivity and specificity, and can be used as an adjunct to mammography in women with breast cancer.
- Dedicated breast PET and dedicated gamma camera images must be interpreted together with mammography and other prior breast imaging, biopsy history, and patient risk factors.
- Dose reduction strategies are critical to allowing greater use of nuclear medicine modalities, especially in the screening setting.
- Newer technologies and tracers are under development to improve the performance of nuclear breast imaging.

Anatomic imaging such as mammography and ultrasound imaging are the mainstay of conventional breast imaging. Contrast-enhanced MR imaging, which is both anatomic and shows areas of increased vascularity and vascular permeability, is widely used for high-risk screening and assessing disease extent and response. Functional breast imaging techniques using dedicated gamma cameras or PET scanners can complement conventional imaging by providing specific cellular information to aid in the diagnosis, staging, and treatment of breast cancer. The 2 most common radiotracers used for breast imaging are the gamma-emitting ^{99m}Tc-sestamibi (140 keV, half-life of 6 hours) that measures mitochondrial activity and the positron emitting glucose analog $_{18}$F-fluorodeoxyglucose (FDG; 511 keV, half-life of 110 minutes) that measures metabolic activity. Conventional whole-body gamma cameras and whole-body PET systems with a large field of view have limited spatial resolution and low sensitivity for smaller tumors.[1,2] The development of high-resolution dedicated breast scanners has resulted in improved lesion detectability, particularly for subcentimeter lesions, owing to technical improvements in detector performance, the ability to position these compact cameras closer to the breast, and the availability of projections similar to those of mammography.[3] The goal of this article is to discuss existing clinical data for nuclear medicine imaging in breast cancer and review technologies in development.

DEDICATED SINGLE PHOTON GAMMA IMAGING

Dedicated breast gamma imaging uses semiconductor-based gamma cameras in a mammographic configuration to visualize the uptake of ^{99m}Tc-sestamibi. Sestamibi, originally

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[a] National Cancer Institute, 9609 Medical Center Drive, Rockville, MD 20850, USA; [b] Department of Radiology, University of Pittsburgh School of Medicine, Magee-Womens Hospital of UPMC, 300 Halket Street, Pittsburgh, PA 15213
* Corresponding author.
E-mail address: mndeepa@gmail.com

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developed as a cardiac tracer, is approved by the US Food and Drug Administration for breast cancer imaging, accumulating selectively in breast tumors rather than the surrounding normal breast tissue.[4] There are 3 different commercially available dedicated gamma camera systems. The breast-specific gamma imaging (BSGI) detector system from Dilon Technologies (Newport News, VA) was the first dedicated breast gamma imaging system on the market. The original BSGI scanner consists of a single panel detector with NaI crystals and a field of view of 20 × 20 cm; a recent version uses cesium iodide crystals with a larger field of view of 25 × 20 cm. Lumagem (previously Gamma Medica Inc., Salem, NH; recently acquired by CMR Navis-can, Carlsbad, CA) and the Discovery NM750b (GE Healthcare, Milwaukee, WI) systems are dual panel systems that use 2 cadmium zinc telluride (CZT) detector panels with a field of view of 20 × 16 cm and 24 × 16 cm, respectively **Table 1**. Single panel detector systems are called BSGI systems and dual-panel systems are referred to as molecular breast imaging (MBI) systems in much of the literature on this topic and are so named in this paper. Dual-panel MBI systems show improved lesion detection sensitivity compared with single-panel systems, owing to reduced lesion-to-detector distance, especially in women with large breasts and smaller lesions.[5,6] Stereotactic biopsy capability is available for the Dilon and GE systems.

In all dedicated breast gamma camera imaging systems, patients are positioned similar to mammography to obtain craniocaudal (CC) and mediolateral oblique (MLO) views with only gentle compression applied to stabilize the breast. Screening Patients are scheduled for imaging

Table 1
Gamma camera breast imaging

	Dilon Diagnostics (Newport News, VA)	Gamma Medica Inc. (Salem, NH)	GE Healthcare (Milwaukee, WI)
			
SYSTEM	Dilon Diagnostics 6800	Gamma Medica LumaGEM 3200S	GE Healthcare Discovery NM750b
Detector	NaI	CZT	CZT
Detector Geometry	Single panel detector	Dual panel detectors	Dual panel detectors
FOV (cm)	20 × 20	20 × 16	24 × 16
Biopsy	Available	In Development	Available
Spatial Resolution	4–4.2 mm	4.8–5.6 mm	4.4–4.6 mm
Injected dose	10–12 mCi	4–8 mCi	4-8 mCi
Pixel size	3 mm	1.6 mm	2.5 mm

Abbreviations: CZT, cadmium zinc telluride; FOV, field of view.
Adapted from Hsu DF, Freese DL, Levin CS. Breast-dedicated radionuclide imaging systems. J Nucl Med 2016;57 Suppl 1:40S–5S.