Procedural Guideline for Breast Scintigraphy with Breast-Specific Gamma Cameras

Version 3.9

Authors: Ward Parsons, MD (The Rose Medical Center, Houston, TX); Milton J. Guiberteau, MD (St Joseph Medical Center, Houston, Texas); Stanley J. Goldsmith, MD (New York Presbyterian Hospital and Cornell University); Lillian H. Stern, MD (Methodist Division of Thomas Jefferson University); Leora Lanzkowsky, MD (Eisenhower Schnitzer/Novack Breast Center Rancho Mirage, California); Jean Weigert MD (Mandell and Blau M.D.'s PC New Britain, CT); Thomas F. Heston, MD (Family Care Network, Bellingham, Washington)

I. Purpose

The purpose of this guideline is to assist breast imaging practitioners in patient selection for, performance, interpretation, and reporting of ^{99m}Tc-sestamibi breast-specific gamma imaging (BSGI). BSGI is not indicated for breast cancer screening of the general population. It is not an alternative to tissue sampling that would be indicated by clinical findings or other imaging studies.

II. Background

Breast-specific gamma imaging (BSGI) is performed with a high-resolution, small field-of-view, breast optimized gamma camera after intravenous administration of 99mTc-sestamibi. This procedure is conducted to detect breast malignancies and is therefore classified under the CPT codes 78800 – 78804 Radiopharmaceutical Localization of Tumor or Distribution of Radiopharmaceutical Agent(s).

III. Clinical Indications

A. Patients with probable breast malignancy

1. Evaluating the extent of disease
2. Detecting multicentric, multi-focal, or bilateral disease

B. Patients with personal history of breast malignancy

1. Suspected recurrence
2. Adjunct to monitoring response to chemotherapy

C. Patients with indeterminate breast abnormalities

1. Nipple discharge with abnormal mammogram and/or sonographic abnormality with or without contrast ductography.
2. For lesions considered to have low probability of malignancy (BIRADS 3), when patient reassurance is warranted
3. Evaluation of lesions identified by breast imaging, palpable or non-palpable
4. Evaluation of palpable abnormalities not demonstrated by mammography or ultrasound
5. Evaluation of multiple masses demonstrated on breast imaging
6. To aid in biopsy targeting
7. Evaluation of diffuse or multiple clusters of microcalcifications
8. Evaluate the breasts for occult disease in cases of axillary node metastases with unknown primary
9. Unexplained architectural distortion

D. Patients with technically difficult breast imaging

1. Radiodense breast tissue
2. Implants, free silicone, or paraffin injections compromising the mammogram

E. Patients for whom Breast MRI would be indicated

1. MRI is diagnostically indicated, but not possible
   a. implanted pacemakers or pumps
   b. ferromagnetic surgical implants
   c. risk of nephrogenic systemic fibrosis response to gadolinium.
   d. body habitus exceeding the inside of the MRI bore
   e. patients with breasts too large to be evaluated with in the breast coil
   f. patients with acute claustrophobia
   g. other factors limiting compliance with a prescribed MRI study.

2. As an alternative for patients who meet MRI screening criteria: BRCA1, BRCA2 mutations; parent, sibling, or child BRCA+**;** Lifetime risk of 20-25% established**;** chest radiation between ages 10 and 30

IV. Procedure

A. Patient Preparation:

1. No special preparation for the test is needed. A thorough explanation of the test should be provided by the technologist or physician.
2. The patient should remove all clothing and jewelry above the waist and should wear a mammography cape or gown.

B. Information pertinent to performing the procedure

1. Relevant imaging studies should be available for correlation.
2. The interpreting physician should be aware of physical findings, symptoms and clinical history.
3. The date of last menses or pregnancy and lactation status of the patient should be determined.
   a. BSGI should be performed between day 2 and day 12 of the patient's cycle if possible.
   b. If pregnancy is possible, study should be delayed until onset of menses.
   c. Lactating patients should be postponed for three months after cessation of lactation.
4. Ideally, BSGI should be performed prior to interventional procedures. Breast scintigraphy (BSGI) is commonly used in pre-surgical planning and can effectively evaluate the remainder of the breast tissue in such cases. If performed within 2 weeks after a cyst aspiration/fine needle aspiration, or 3 to 4 weeks after a core or excisional biopsy it can produce false positive results at the interventional site. This effect is less likely if imaging is conducted within the first 72 hours after needle procedures.

C. Precautions

1. Known hypersensitivity to 99m Tc-sesta-mibi is a contraindication
2. Pregnancy is a contraindication

D. Radiopharmaceutical

1. Intravenous administration of 25 mCi 99mTc-sestamibi via upper extremity vein opposite the breast with the suspected abnormality.
2. The radiopharmaceutical should be administered using an indwelling venous catheter or butterfly needle followed by 10 cc of saline to flush the vein.

Radiation Dosimetry: Adults*

Radiopharmaceutical	Administered activity MBq (mCi)	Organ receiving the largest radiation dose mGy/MBq (rad/mCi)	Effective dose mSv/MBq (rem/mCi))
^{99m}Tc-sestamibi	740–1,110 iv (20–30)	0.039 Gallbladder (0.14)	0.0085 (0.031)

[1]International Commission on Radiological Protection. *Radiation Protection in Biomedical Research.* ICRP Publication 62. New York, NY: Pergamon Press; 1993:23.

E. Image Acquisition

1. Instrumentation
   a. high-resolution small field-of-view gamma camera
   b. A symmetric energy window should be centered over the 140-keV photo-peak of 99mTc.
2. Patient Position
   a. The patient is seated for the entire scan. Image positions should duplicate standard mammographic views according to the most recent mammogram.
3. Imaging
   a. Imaging begins 5–10 minutes after administration of the radiopharma-ceutical.
   b. Planar images are acquired for 10 minutes each or 175K, (5 minutes minimum)
   c. Planar images should be acquired for each breast:
      - Right Craniocaudal
      - Left Craniocaudal
      - Right Mediolateral Oblique
      - Left Mediolateral Oblique

* If needed, additional images may be acquired according to the interpreting physician: 90 degree lateral (LM or ML), axillary tail (AT), cleavage view (CV), exaggerated craniocaudal (XCC), implant displacement (ID), Right Antero-posterior View (axilla), Left Antero-posterior View (axilla).

- For lesions close to the chest wall, an extra craniocaudal image with minimum immobilization can help to ensure inclusion of posterior tissues, especially in women with breast tissue that resists compression.

F. Interventions

Both a needle localization technique and an intra-operative lumpectomy technique using a gamma probe for guidance have been described in the medical literature to conduct biopsy (23, 24).

G. Processing

1. Interpretation of the image should be done on a computer workstation as adjustment of the image contrast by the interpreting physician may be necessary.
2. Various display parameters, including grayscale linear as well as color and logarithmic displays may be considered to optimize interpretation.
3. If color scales are used, linear monochromatic (hot metal) are preferable to multi-color (rainbow).

H. Interpretation

1. Homogeneous uptake of the radiopharmaceutical in the breast or axilla is consistent with a normal study.
2. Patchy or diffusely increased radiopharmaceutical uptake in the breasts is usually a normal variant, especially when the distribution correlates with mammographic anatomy.
3. Features suggestive of benign disease of the breast are diffuse or patchy uptake of mild to moderate intensity, often bilateral, with ill-defined boundaries.
4. Focal increased uptake of the radiopharmaceutical in the breast or axilla (in the absence of radiopharmaceutical infiltration) can be suspicious for malignancy, inflammation, atypia and some benign processes.
5. The intensity of focal uptake in lesions is highly variable. The image features suspicious for breast malignancy are moderate-to-intense focal uptake with well-delineated contours.
6. Focal increased uptake (1 or more foci) in the ipsilateral axilla, in the presence of a primary lesion is strongly suggestive of axillary lymph node metastatic involvement (in the absence of radiopharmaceutical infiltration).
7. Masking of high-activity lesions in the breast can improve visualization of adjacent breast tissues. This masking can be performed using round pieces of lead placed between the lesion and the detector. Both the masked and original images should be included in the final display.

I. Reporting

The report to the referring physician should indicate the most likely diagnosis and should recommend appropriate follow-up.

J. Quality Control

1. Routine scintillation camera quality control should be performed as described in the Society of Nuclear Medicine Procedure Guideline for General Imaging.

   *** Note –Some of the devices developed for this procedure are based on a pixilated design (both digital and scintillator element types) and not a single crystal design. The QC and QA of these devices may require additional or modified testing procedures to maintain proper operation. The manufacturer's manuals should be reviewed in addition to these guidelines.

2. Quality control measures and radiation safety precautions should be followed as described in the Society of Nuclear Medicine Procedure Guidelines for Use of Radiopharmaceuticals.

K. Sources of Error

1. Infiltration of the radiopharmaceutical administered in an arm vein may cause false-positive uptake in the ipsilateral axillary lymph nodes. Imaging of an injection site is helpful in evaluating the presence and extent of dose infiltration. This is particularly important if an unsuspected breast lesion is discovered on the same side as the infiltration.
2. Patient motion and/or motion of the breast relative to the detector will decrease the accuracy of the test.
3. The sensitivity, specificity, and accuracy of this test depends upon several factors, including the size of the breast neoplasm being imaged. While the sensitivity of this test for subcentimeter tumors is high, around 90%, as with all radiologic examinations sensitivity decreases with lesion size.

VI. Concise Bibliography:

1. Schillaci O, Buscombe JR. Breast scintigraphy today: indications and limitations. Eur J Nucl Med Mol Imaging. 2004 Jun;31 Suppl 1:S35-45. Epub 2004 Apr 23.

2. Rhodes DJ, O'Connor MK, Phillips SW, Smith RL, Collins DA. Molecular Breast Imaging: A New Technique Using Technetium Tc99m scintimammography to detect small Tumors of the Breast. Mayo Clin Proc. 2005;80:24-30.
3. Brem R, Fishman M, Rapelyea J. Detection of Ductal Carcinoma in situ with Mammography, Breast Specific Gamma Imaging, and Magnetic Resonance Imaging: A Comparative Study Acad Radiol 2007; 14: 945-950.
4. Brem R, Petrovice I, Rapelyea J, et al. Breast-Specific Gamma Immaging with 99m TC-Sestamibi and Magnetic Resonance Imaging in the Diagnosis of Breast Cancer- A Comparative Study The Breast Journal, 2007 13:465-469.
5. Palmedo H, Grunwald F, Bender H, Schomburg A, Mallmann P, Krebs D, Biersack HJ. Scintimammography with Technetium-99m methoxyisobutylisonitrile: comparison with mammography and magnetic resonance imaging. Eur J Nucl Med 1996 Aug;23(8):940-6.
6. Tiling R, Khalkhali I, Sommer H, Moser R, Meyer G, Willemsen F, Pfluger T, Tatsch K, Hahn K. Role of technetium-99m sestamibi scintimammography and contrast-enhanced magnetic resonance imaging for the evaluation of indeterminate mammograms. Eur J Nucl Med 1997 Oct;24(10):1221-9.
7. Kolb TM, Lichy J,Newhouse JH. Comparison of the performance of screening mammography, physical examination and breast US and evaluation of factors that influence them: an analysis of 27,825 patient evaluations. Radiology. 2002;225:165-175.
8. Coover LR, Caravaglia G, Kuhn P. Scintimammography with dedicated breast camera detects and localizes occult carcinoma. J Nucl Med. 2004 Apr;45(4):553-8.
9. Brem R, Rapelyea J, Zisman G, et al. Occult breast cancer: scintimammograpy with high-resolution breast-specific gamma camera in Women at High Risk for Breast Cancer. Radiology. 2005;237:274-280.
10. Wilczek B, Asplen P, Bone B, Pegerfalk A, Frisell J, Danielsson. Complimentary use of Scintimammography with Tc99-MIBI to triple diagnostic procedure in palpable and non-palpable breast lesions. Acta Radiologica 44 (2003) 288–293.
11. Kieper D, Green TD, Hoefer R, Keppel C, Wymer DC, Weisenberger AG, Welch B. Data analysis methods for a small field-of-view combined scintimammography/digital X-ray system in breast lesion management. Nucl Instr and Meth A. 2003; 497: 135-140.
12. Simpson-Herren L, Sanford AH, Holmquist JP, Effects of surgery on the cell kinetics of residual tumor. Cancer Treat Rep 1976; 60:1749-60.
13. Taillefer R, Robidoux A, Turpin S, Lambert R, Cantin J, Leveille J. Metastatic axillary lymph node technetium-99m-MIBI imaging in primary breast cancer. Nucl Med. 1998 Mar;39(3):459-64.
14. Chen J, Wu H, Zhou J, Hu J.Using Tc-99m MIBI scintimammography to differentiate nodular lesions in breast and detect axillary lymph node metastases from breast cancer. Chin Med J (Engl). 2003 Apr;116(4):620-4.
15. Van de Wiele C, Rottey S, Goethals I, et al. 99mTc sestamibi and 99mTc tetrofosmin scintigraphy for predicting resistance to chemotherapy: a critical review of clinical data. Nucl Med Commun 2003; 24:945–950.
16. Pwnica-Worms D, Chiu ML, Budding M, et al. Functional imaging of multidrug-resistant P-glycoprotein with an organotechnetium complex. Cancer Res 1993; 53:977–984.
17. Mezi S, Primi F, Capoccetti F, Scopinaro F, Modesti M, Schillaci O. In vivo detection of resistance to anthracycline based neoadjuvant chemotherapy in locally advanced and inflammatory breast cancer with technetium-99m sestamibi scintimammography. Int J Oncol. 2003 Jun;22(6):1233-40.
18. Salvatore M, Del Vecchio S. Dynamic imaging: scintimammography. Eur J Radiol. 1998 May;27 Suppl 2:S259-64.
19. Claudio JA, Emerman JT. The effects of cyclosporin A, tamoxifen, and medroxyprogesterone acetate on the enhancement of adriamycin cytotoxicity in primary cultures of human breast epithelial cells. Breast Cancer Res Treat. 1996;41(2):111-22.
20. Alonso O, Delgado L, Nunez M, Vargas C, Lopera J, Andruskevicius P, Sabini G, Gaudiano J, Muse IM, Roca R.. Predictive value of (99m)Tc sestamibi scintigraphy in the evaluation of doxorubicin based chemotherapy response in patients with advanced breast cancer. Nucl Med Commun. 2002 Aug;23(8):765-71.
21. Dunnwald LK, Gralow JR, Ellis GK, Livingston RB, Linden HM, Lawton TJ, Barlow WE, Schubert EK, Mankoff DA. Residual tumor uptake of [(99m)Tc]-sestamibi after neoadjuvant chemotherapy for locally advanced breast carcinoma predicts survival. Cancer. 2005 Jan 6 .

22. Kieper D, Green TD, Hoefer H, Keppel C, Wymer DC, Weisenberger AD, Welch B. Analysis Methods for a Small Field-of-View Combined Scintimammography/Digital X-ray System in Breast Lesion Management. Nucl Instr and Meth. 2003 January; 497(1):168–73.
23. Cox C. Et al. Localization of an Occult Primary Breast Cancer with Technetium-99m Sestamibi Scan and an Intraoperative Gamma Probe. Cancer Control Journal: Imaging in Oncology. 2006 February ; available on – line: http://www.moffitt.usf.edu/pubs/ccj/v3n5/dept3.html.
24. Coover LR, Caravaglia G, Kuhn P. Scintimammography with dedicated breast camera detects and localizes occult carcin-oma. J Nucl Med. 2004 Apr;45(4):553-8.