# Breast-Specific Gamma Imaging (High-Resolution Molecular Imaging of the Breast) : A Useful Adjunct to Breast Imaging

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## INTRODUCTION

- Mammography is considered the best method to screen patients for breast cancer with a high sensitivity but with a low specificity. In women with dense breasts the false negative rate may increase significantly.
- Breast-Specific Gamma Imaging (High-Resolution Molecular Imaging of the Breast) is a novel physiologic approach to breast imaging in which radio-isotope is taken up by cells with a high metabolic activity such as the rapidly dividing cells in breast cancers.
- The purpose of this study is to evaluate Breast-Specific Gamma Imaging (BSGI) as an adjunct imaging modality to mammography and breast ultrasound and to evaluate its sensitivity, specificity, positive and negative predictive values.

## MATERIALS AND METHODS

- 512 women who were High Risk for the development of Breast Cancer, newly diagnosed with breast cancer or had inconclusive mammography and ultrasound imaging underwent imaging with a dedicated high-resolution, breast-specific gamma camera (Dilon 6800, Dilon Technologies, Inc., Newport News, VA) following injection in an ante-cubital vein with 25.0-30.0 mCi 99m-Tc Sestamibi (Miraluma; DuPont Pharma, Billerica, Ma).
- They ranged in age from 22-90 with a mean of 53.6 years of age.
- Patients were imaged within 10 minutes of injection in the CC and MLO views bilaterally with additional views as deemed necessary by the radiologist.
- Images were determined to be normal, indeterminate or abnormal by two imagers.
- Additional mammography work-up, second-look ultrasound or MRI was used as needed to further evaluate foci of increased radiotracer uptake on BSGI.
- Patients with suspicious areas on mammography, ultrasound or BSGI imaging underwent biopsy or were followed for 6 to 24 months with mammography and/or ultrasound as deemed appropriate by the radiologist.

## POPULATION

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|---|---|
| Personal History of Breast Cancer | 62 (12%) |
| New Diagnosis of Breast Cancer | 20( 4%) |
| Palpable Mass-Neg Mamm and Usg | 52(10%) |
| New Indeterminate Calcifications | 46 ( 9%) |
| Family History Dense Breasts | 66 (13%) |
| New area of Asymmetry of Nodule not Palpable | 266 (52%) |

## RESULTS

- Of the 512 patients, 415 have had 6 to 24 month follow-up with no new findings.
- 97 biopsies were performed, of which 46 were positive and 51 were negative; 5 in patients with negative studies
- Sensitivity of 89%, specificity of 90%, positive predictive value 47%, negative predictive value 98%.
- In patients with newly diagnosed cancer, BSGI findings resulted in a change in surgical management in 7 patients, 4 occult contra lateral cancers and 6 patients underwent mastectomy due to identification of more extensive disease.
- The smallest cancers identified were 5 mm, 7 mm and 8 mm.
- All ILC's were visualized by BSGI .
- There were 5 false negatives-grade one IDC 1 mm w/i DCIS and
- a 4mm grade 1 tubular cancer (in one patient), a grade one IDC less than 5 mm, an LCIS, ADH, and a pappiloma (one biopsy), and a grade III IDC 1.0 cm

| | |
|---|---|
| SENSITIVITY | 89% |
| SPECIFICITY | 90% |
| POSITIVE PREDICTIVE VALUE | 47% |
| NEGATIVE PREDICTIVE VALUE | 98% |
| TRUE POSITIVE | 41 |
| TRUE NEGATIVE | 421 |
| FALSE NEGATIVE | 5 |
| FALSE POSITIVE | 45 |

FALSE POSITIVES
Fibrocystic Tissue of Varying types-30; Fibroadenoma-9
Inflammatory Rxn and Fat Necrosis-3; PASH-1; Fibrosis-1

TRUE POSITIVES
IDC-16 *; ILC-14 *; LCIS-4; DCIS-3
Tubular CA-1; Pappiloma-3
ADH-1
*GRADE I-III

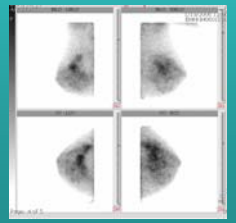
FALSE NEGATIVES
IDC 1 mm grade I; TUBULAR CA 4 mm grade I; <5 mm IDC grade I LCIS; ADH AND PAPPLIOMA (one Bx); 10 mm grade II IDC (probable positioning error)

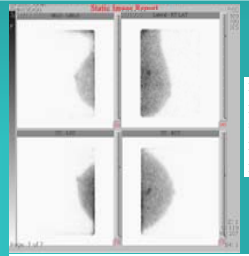
## EXAMPLE CASES

### Unsuspected Bilateral Breast Cancer

**History** – 52 year-old patient with two palpable masses in the left breast.
**Mammogram** – Diffuse bilateral density with no asymmetric density present in the area of the palpable mass. BIRADS 0.
**Ultrasound** – two hypoechoic lesions are noted in the areas of the palpable masses. BIRADS 4.
**MRI** - left breast - 2 abnormally enhancing masses consistent with malignancy. Right breast– diffuse enhancement but no focal abnormality.

**BSGI** – Left breast – two areas of high focal uptake are noted corresponding to the palpable masses, highly suspicious for malignancy. Right breast –intense diffuse uptake, the intensity of this area and the asymmetric nature make it suspicious for malignancy.
**Pathology** – Left Breast – multifocal ductal carcinoma
Right breast - mastectomy showed diffuse lobular carcinoma in-situ.





### 7mm Lobular Carcinoma

**History:** 65 year-old with past Hx of left breast cancer 7 years ago.

**Mammogram**: Few nonspecific CA++ adjacent Vague area of Asymmetry rt UOQ not significantly different from Mamm of 2003.

**BSGI** Triangular area of uptake at vague asymmetry rt breast.

**Pathology**: Invasive Lobular Carcinoma with Positive Axillary Nodes.

### Grade 3 Ductal Carcinoma

**History**: 55 year-old patient in for screening mammogram.

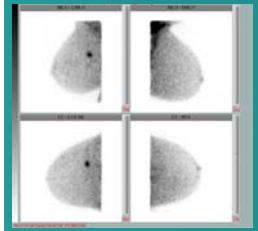
**Mammogram**: Moderately dense breast tissue. There is a new area of asymmetry in the left breast not present in previous mammograms. Recommend additional views and ultrasound. BIRADS 0.

**Additional Views**: Persistent density is observed, slightly irregular in shape however no abnormal calcifications are observed.

**US**: Markedly inhomogeneous echotexture. No definite solid lesion is seen.

**BSGI**: Focal area of increased uptake is noted in the left breast corresponding to the area of asymmetry in the mammographic views. Positive. Suggest tissue sampling.

**Pathology**: Needle biopsy: invasive ductal carcinoma nuclear grade 3, histologic grade 3. Mixed Lobular carcinoma and DCIS.



## CONCLUSIONS

- We evaluated 512 patients in the two years of having BSGI in our institution. The majority of patients were referred for an indeterminate mammogram and/or ultrasound. A history of breast cancer or new diagnosis of breast cancer as well as family history also warranted study.
- Sensitivity of 89%, Specificity of 90%, PPV of 47% and NPV of 98%. The outcome was altered in 7 patients who had mastectomy due to more extensive or bilateral cancer not diagnosed prior to BSGI imaging. No Infiltrating Lobular cancers were missed, an interesting finding that needs further investigation.
- Breast-Specific Gamma Imaging (high-resolution molecular imaging of the breast) is a valuable technology that can help as an adjunct to mammography and breast ultrasound to diagnose unsuspected cancers with a high sensitivity, specificity, PPV and NPV.
- Further study is warranted to compare BSGI with MRI as well as larger multi-center studies of more long-term results. Specific tumor types should also be evaluated including DCIS, LCIS, ILC and IDC of different grades.

*This project was funded by a grant from Dilon Technologies, Inc. Thanks to Ms. Alissa Lipnick, University of Connecticut and Ms. Jill Gagen for their help with data collection.*