2004 Workshop on the Nuclear Radiology
of Breast Cancer
Rome (Italy) October 22-23

Physica Medica · Vol. XXI, Supplement 1, 2005

Detecting Infiltrating Lobular Carcinoma Using Scintimammographic Breast Specific Gamma Imaging

Douglas Kieper, Rachel F. Brem, R. Hoeffer, C. Keppel, D. Wymer

Abstract

This study evaluated the effectiveness of scinimammography performed with gamma cameras optimized for breast imaging in the detection of infiltrating lobular carcinoma. This new procedure, Breast Specific Gamma Imaging (BSGI), was conducted on 105 patients presenting with 113 breast lesions. Studies were conducted at two medical centers using three prototype cameras [14, 16]. Biopsy and pathology reports were obtained for all cases and, of the 34 detected carcinomas, 6 were determined to be infiltrating lobular type without mixed component other than lobular carcinoma in situ. Of the 6 lesions, 4 were smaller than 1 cm, the smallest measuring 3mm at biopsy. BSGI detected all 6 of the lobular carcinomas and correctly identified the secondary lesion in the only multifocal case. The BSGI foci sizes matched the lesion size at biopsy to within +/−5.5mm, with about an equal number of cases over and under estimated. CONCLUSION: BSGI provides an effective tool for the detection of lobular carcinoma and in the determination of lesion size and multifocality.

Background

Infiltrating lobular carcinoma (ILC) is the second most common breast malignancy representing around 10% of breast cancer diagnoses [1]. Although it is normally considered to be less aggressive than infiltrating ductal carcinoma (IDC), a recent study demonstrated that the long term clinical outcomes for ILC are not more favorable than that of IDC [1]. Additionally, one study indicated that at 5 year follow-up, reoccurrence rates were the same as ductal carcinomas [2]. Since ILC is much less likely to produce microcalcifications, the probability of early detection is lower than that of IDC. Therefore, ILC is normally detected at a later stage, increasing the likelihood of large primary lesions and positive node status at biopsy [3]. Detection with ultrasonic evaluation is also limited, particularly for smaller lesions [4]. Lastly, ILC is more likely to be multifocal than IDC with many of the secondary lesions being mammographically occult [4]. These factors indicate a relatively high risk to the patient and lack of effective diagnostic tools for ILC. MRI of the breast has proven to be effective in the detection of ILC and has demonstrated good agreement with biopsy in lesion size and disease multifocality [3]. However, MRI suffers from a high false positive rate resulting in a lack of specificity limiting its value in clinical evaluation [5, 6].

Scintimammography performed with standard full field-of-view nuclear medicine systems has been studied and has been found to lack sensitivity for lesions under one centimeter and medially located lesions [7, 8, 9]. These shortcomings arise from the poor effective study resolution and limited maneuverability of the detector head. More specifically, the prone pendant breast positioning used in this technique does not allow the breast to be imaged directly against the collimator and since spatial resolution decreases with an increase of target-to-collimator distance, poor study resolution is achieved with this configuration. In addition, since the only practical detector position for these large systems is the lateral view, medially located lesions suffer from even poorer spatial resolution. Lastly, as lesion depth in tissue is increased, attenuation of the lesion signal in the breast increases. This explains why standard cameras, positioned at the lateral aspect of the breast have poor sensitivity for medially located lesions. In many regards, scintimammography with the standard gamma camera resembles the early days of x-ray mammography when general-purpose x-ray systems were used with noticeably poor results as compared to dedicated mammography systems such as those used today. To address this issue, dedicated breast specific gamma cameras have been introduced which allow the breast to be imaged with compression and in geometries comparable to mammography [10]. Dedicated detector systems allow imaging of the breast from various angles, including the medial aspect, thereby minimizing the lesion-to-detector distance and the impact of attenuation and resolution losses. Preliminary studies with these dedicated cameras have shown an increase in overall sensitivity when compared to standard systems with notable enhancement of sensitivity for lesions smaller than 1 cm [15, 16].

Materials and Methods

Several dedicated gamma camera prototypes have been constructed and tested by several institutions [11]. Among these designs were two general purpose BSGI systems, a 5" x 5" field-of-view (FOV) system and

Address for correspondence:

a 6" x 8" FOV system. In addition a 2" x 2" FOV stereotactic biopsy system was constructed to evaluate the potential of gamma guided biopsy [12]. Clinical results from the stereotactic system have been published in other forums, but these publications have not specifically evaluated lobular carcinoma detection in this patient sample [13, 14]. The 5" x 5" and 6" x 8" systems were used in a separate clinical study and the published results demonstrated an improvement in sensitivity over the standard gamma camera system, but again the pathological data was not analyzed as part of that publication [15]. To evaluate the detection of lobular carcinomas with this technique, we conducted a post hoc evaluation of patient data from the two institutional studies introduced above. In addition to the initial study images, pathology reports from biopsy and surgery were reviewed. In the first study, conducted with the general purpose BSGI systems, patients were referred to the study based on suspicious mammographic or clinical findings including: palpable masses with no mammographic correlate, possible multicentricity demonstrated in mammography or sonography, asymmetric breast tissue in mammogram with no sonographic or clinical correlate. In the second study, conducted with the stereotactic gamma imaging system, patients who were routinely scheduled for x-ray stereotactic biopsy were recruited to participate. For our evaluation, complete biopsy and surgical pathology reports were obtained along with the BSGI diagnostic report from the original authors.

Results

The first institutional study contained 50 patients with 58 breast lesions. There were 28 malignant biopsy findings with a total of 5 lobular carcinoma lesions in 4 patients. The second study contained 55 patients with clinically significant mammographic findings; 29 radiodense breast masses and 26 clusters of microcalcifications. From this study, there were 13 malignancies with one ILC reported. From the combined data, the BSGI systems detected all 6 of the ILC including the secondary lesion in the multifocal case. Our results are confirmed by other authors who note the detection of lobular carcinoma with this technique [16,17] and in detection of the multifocal and multicentric disease [15, 18, 19]. Four lesions in this study were smaller than 1 cm at biopsy and the smallest lesion detected was 3mm. Additionally, the BSGI foci size matched the lesion size at biopsy to within +/– 5.5mm, with about an equal number of cases over and under estimated.

Discussion

BSGI demonstrated 100% sensitivity (6/6 lesions) for infiltrating lobular carcinoma. These results demonstrate its utility in the detection of ILC and the potential as a tool for the presurgical determination of the extent of disease. Of considerable interest is that other authors directly comparing scintimammography to MRI, the currently accepted tool for evaluating the extent of disease for ILC, have reported the specificity for SMM to better than that of MRI, but MRI possessing a higher sensitivity [20, 21, 22]. The demonstrated improvement in sensitivity with the BSGI technique to scintimammography promises to provide a cost effective adjunctive diagnostic tool to mammography for the detection of lobular carcinoma.

Bibliography

[1] Arpino G, Bardou V J, Clark G M, Elledge R M. Infiltrating lobular carcinoma of the breast: tumor characteristics and clinical outcome. Breast Cancer Res. 2004; 6(3):r149-56. Epub 2004 Feb 17.

[2] Korhonen T, Huhtala K, Holli K. A comparison of the biological and clinical features of invasive lobular and ductal carcinomas of the breast. Breast Cancer Res Treat. 2004 May; 85(1): 23-9.

[3] Helvie M A, Paramagul C, Oberman H A, Adler D D. Invasive lobular carcinoma. Imaging features and clinical detection. Invest Radiology. 1993 Mar; 28(3): 202-7.

[4] Diekmann F, Diekmann S, Beljavskaja M, et al. Preoperative MRT of the breast in invasive lobular carcinoma in comparison with invasive ductal carcinoma. Rofo Fortschr Geb Neuen Bildgeb Verfar. 2004.

[5] Gilles R. MRI of the breast. Techniques and current values. Cancer Radiother. 2003 Nov; 7 Suppl 1:115s-119s.

[6] Schelfout K, Van Goethem M, Kersschot E, et al. Contrast-enhanced MR imaging of breast lesions and effect on treatment. Eur J surg Oncol. 2004 Jun; 30(5)501-7.

[7] J. Villanueva-Mayer, M. H. Leonard Jr., E. Briscoe, F. Cesani, S. A. Ali, S. Rhoden, M. Hove, D. Cowan, Mammoscintigraphy with Technetium-99m-Sestamibi in Suspected Breast Cancer. J. Nucl. Med. 1996; 37 (6): 926-930.

[8] I. Khalkhali, I. Mena, L Diggles, Review of imaging techniques for the diagnosis of breast cancer: a new role of prone scintimammography using technetium-99m sestamibi. Eur. J. Nucl. Med. 1994; 21 (4): 357-62.

[9] J. Tolmos, J. A. Cutrone, B. Wang, H. I. Vargas, M. Stuntz, F. S. Mishkin, L. E. Diggles, R. J. Venegas, S. R. Klein, and I. Khalkhali, Scintimammographic analysis of nonpalpable breast lesions previously identified by conventional mammography. *J. Nat. Can Inst*. 1998; 90: 846-49.

[10] Schillaci O, Buscombe J. Breast scintigraphy today: indications and limitations. Eur J Nucl Med and Mol Img. 2004;

[11] Majewski S, Kieper D, Curran E, Keppel C, Kross B, Palumbo A, Popov V, Weisenberger A G, Welch B, Wojcik R, Williams M, Goode A R, Moore M, Zang G. Optimization of dedicated scintimammography procedure using detector prototypes and compressible phantoms. IEEE Trans Nucl Sci. 2001 Jun; 41.

[12] Weisenberger A G, Barbosa F, Green T D, Hoefer R, Keppel C, Kross B, Majewski S, Popov V, Wojcik R, Wymer D. Small field of view scintimammography gamma camera integrated to a stereotactic core biopsy digital x-ray system. IEEE Trans Nucl Sci. 2002.

[13] Wymer D C, Green T, Keppel C, Kieper D, Weisenberger A, Majewski S. Evaluation of clinically occult mammographic abnormalities using scintimammography with enhanced gamma camera imaging. Society of Nuclear Medicine Annual Meeting. 2003; New Orleans LA.

[14] Kieper D, Green T D, Hoefer R, Keppel C, Wymer D C, Weisenberger AG and 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 Jan; 497(1): 168-73.

[15] Brem R, Schoonjans J, Kieper D, Majewski S, Goodman S and Civelek C. High-Resolution Scintimammography: A Pilot Study. J Nucl Med. 2002 July; 43(7): 909-15.

[16] Coover L, Caravaglia G, Kuhn P. Scintimammography with dedicated breast camera detects and localizes occult carcinoma. J Nucl Med. 2004; 45: 553-58.

[17] Polan R, Klein B, Richman R. Educational Exhibit RSNA Annual Meeting; Chicago; 2001.

[18] Cwikla J B, Buscombe J R, Holloway B. Can scintimammography with Tc-99m-sestamibi identify multifocal and multicentric primary breast cancer? Nucl Med Commun 2001; 22: 1287-1293.

[19] Prats E, Aisa F, Abos D, et al. Mammography and 99mTc-MIBI scintimammography in suspected breast cancer. J Nucl Med. 1999; 40(2): 296-301.

[20] Fenlon H M, Phelan N C, O'Sullivan P, Tierney S, Gorey T, Ennis J T. Benign versus malignant breast disease: comparison of contrast-enhanced MR imaging and Tc-99m tetrofosmin scintimammography. Radiology 1997 Oct; 205(1): 214-220.

[21] Palmedo H, Grunwald F, Bender H, Schomburg A, Mallmann P, Krebs D, Biersack H J. Scintimammography with technetium-99m methoxyisobutylisonitrile: comparison with mammography and magnetic resonance imaging. Eur J Nucl Med 1996 Aug; 23(8): 940-946.

[22] Tiling R, Sommer H, Pechmann M, Moser R, Kress K, Pfluger T, Tatsch K, Hahn K. Comparison of technetium-99m-sestamibi scintimammography with contrast-enhanced MRI for diagnosis of breast lesions. J Nucl Med 1997 Jan; 38(1): 58-62.