Review Article

Open Access

Archives Of Breast Cancer

DOI: 10.19187/abc.20185398-105

Diagnostic Efficacy of Technetium-99m-Sestamibi Scintimammography in Comparison with Mammography to Detect Breast Lesions: A Systematic Review

Sahel Heydarheydari[a], Seyed Masoud Rezaeijo[b], Mohsen Cheki[c], Ehsan Khodamoradi[d], Karim Khoshgard*[a]

[a] *Department of Medical Physics, Faculty of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran*
[b] *Department of Medical Physics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran*
[c] *Department of Radiologic Technology, Faculty of Paramedicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[d] *Department of Radiology and Nuclear Medicine, Paramedical School, Kermanshah University of Medical Sciences, Kermanshah, Iran*

ARTICLE INFO

Received:
27 February 2018
Revised:
03 June 2018
Accepted:
28 June 2018

key words:
Technetium-99m-sestamibi, scintimammography, mammography, breast Lesions

ABSTRACT

Background: To systematically review the performance of scintimammography compared with mammography in detecting breast lesions.

Methods: A literature search was performed in PubMed and ScienceDirect databases with "scintimammography AND breast lesions," "mammography AND breast lesions," "diagnostic value," and "accuracy" as keywords to identify all related studies published in English from January 1, 2000, to August 1, 2017. Twenty-five studies, with a total of 4094 patients with clinically suspicious breast lesions, were included in the final analysis to assess the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of scintimammography vs. mammography in detecting breast lesions.

Results: The sensitivity and specificity of mammography were 75.82 ± 10.53 (95% confidence interval [CI], 50-84) and 59.58 ± 22.79 (95% CI, 20-91.4), respectively. The PPV and NPV of mammography were 75.60 ± 2.21 (95% CI, 42-93) and 61.62 ± 1.67 (95% CI, 39.1-86), respectively. The sensitivity of scintimammography was 86.64 ± 8.84 (95% CI, 58.3-100), and the specificity was 83.42 ± 10.74 (95% CI, 60-100). The PPV and NPV of scintimammography were 82.10 ± 11.65 (95% CI, 58-98.30) and 81.02 ± 17.00 (95% CI, 45-100), respectively.

Conclusions: Although mammography has a high sensitivity in the examination of older patients with fatty breast tissue, it is less reliable in detecting breast lesions in young and premenopausal patients with dense breasts. Diagnostic accuracy of scintimammography, as a functional imaging modality, is not affected by breast density, contrary to mammography. Therefore, scintimammography can improve the specificity of mammography.

Introduction

Breast cancer is the most frequent malignancy in women, affecting 1 in 13 women in their lifetime.[1-4] Patients with breast cancer who have it detected at an early stage will have a better survival rate.[5] The most widely used tool for detection of breast cancer, besides the physical examination, is mammography, which has a high accuracy in detecting breast lesions.[6] The sensitivity of mammography in patients with dense breasts may be low;[7] and, in patients with fibrocystic changes of the breast, mammographic detection of breast carcinoma may be difficult. Mammography has low specificity in distinguishing

Address for correspondence:
Karim Khoshgard, Ph.D.
Address: Department of Medical Physics, Kermanshah University of Medical Sciences, Sorkheh Lizheh, Kermanshah, Iran,
P.O. Box: 6714869914
Tel: +98-83-34274618
Fax: +98-83-34276477
E-mail: khoshgardk@gmail.com

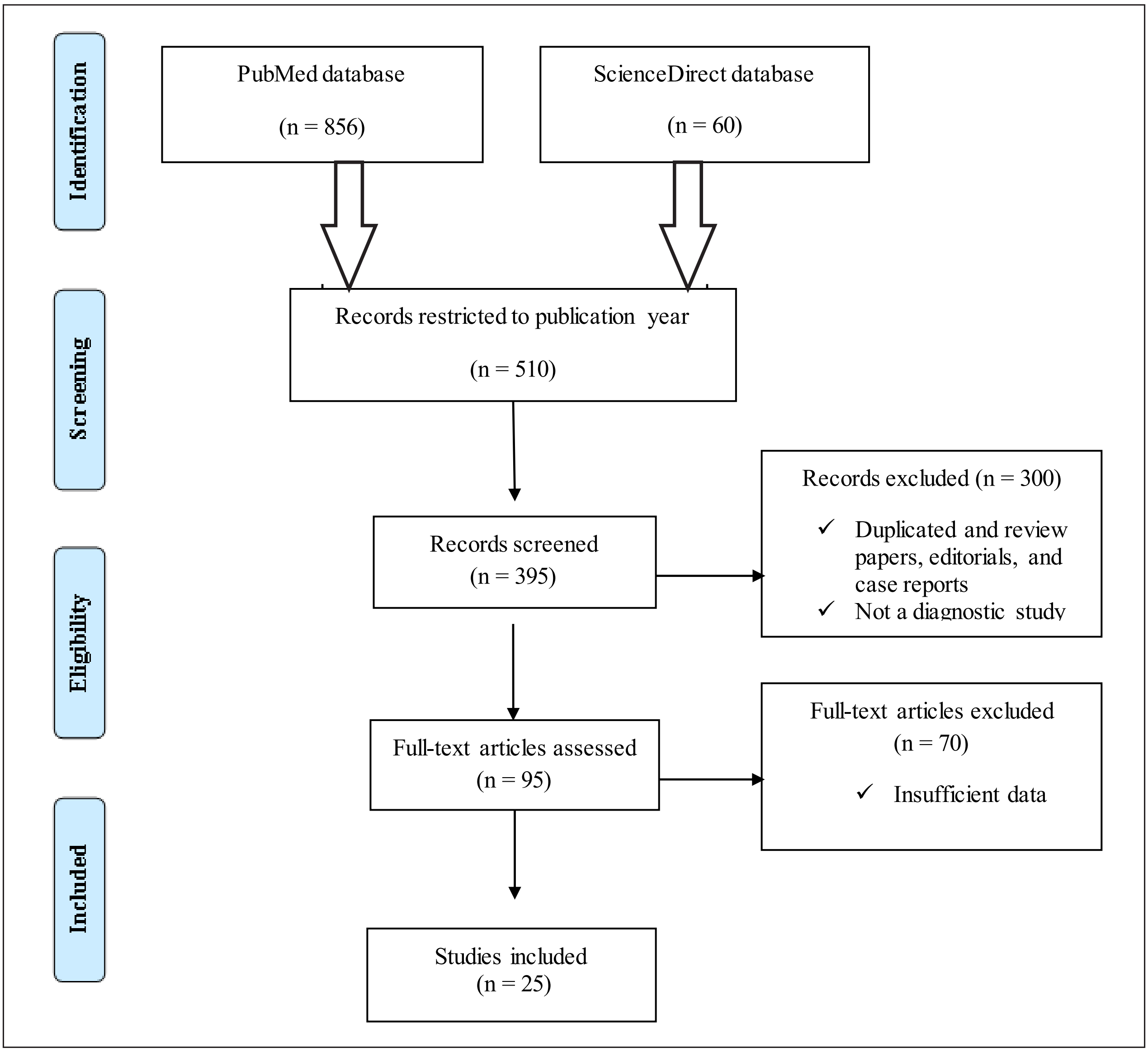

Figure 1. Flowchart Summarizing Search Strategy and Study Selection

between malignant and benign processes. Therefore, it is impossible to detect breast lesions using mammography alone in some cases.[8,9]

The high rate of breast biopsies in patients with benign lesions has encouraged the use of non-invasive imaging modalities with greater accuracy such as magnetic resonance imaging (MRI), ultrasound (US), positron emission tomography (PET), and scintigraphy.[10] Recently, it was demonstrated that technetium-^{99m}-sestamibi (^{99m}Tc-MIBI) accumulates in different types of tumors. For suspected breast lesions, some studies demonstrated that scintigraphy with ^{99m}Tc-MIBI differentiated benign from malignant lesions.[11] ^{99m}Tc-MIBI scintigraphy is a noninvasive diagnostic modality in evaluating breast carcinoma in the field of nuclear medicine.

The aim of the present systematic review was to compare the performance of scintimammography with mammography in the detection of breast lesions.

Methods

Search strategy

A literature search was performed in PubMed and ScienceDirect databases using the following keywords: "scintimammography (mammoscintigraphy) AND breast lesions," "mammography AND breast lesions," "diagnostic value," and "accuracy." Articles that cited related studies were also searched to find any related publication (using PubMed, Europe PubMed Central, and Google Scholar citation tracking tools). An updated search strategy was developed in order to identify all related papers published in English from January 1, 2000, to August 1, 2017. The full search strategy is presented in Figure 1.

Selection of studies

Titles and abstracts obtained from the literature search were examined for eligibility. Information given in the titles and abstracts had to suggest that the study (1) included patients with suspected breast lesions, (2) conducted scintimammography or mammography in those patients, and (3) evaluated diagnostic values of the tests (sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]). Full-text articles were retrieved for further assessment.

Inclusion/exclusion criteria

Studies were included if they assessed sensitivity, specificity, PPV, or NPV of scintimammography or mammography in the diagnosis of breast lesions. We included studies with or without comparator groups. Editorials, case reports, and review articles were excluded. All eligible papers were compared independently assessed by two authors for predefined inclusion criteria.

Data extraction

Two authors independently extracted the following data from each included study: the first author's name, publication year, journal, country, details of study design, number of patients and their characteristics, index test or tests, reference standard, sensitivity, specificity, PPV, and NPV. The diagnostic performance of scintimammography and mammography in the detection of breast lesions was assessed by comparing index test results with the reference standards. Any discrepancies between the two researchers were resolved through consensus.

The patients were classified as true positive (TP) when both the index test (i.e., scintimammography or mammography) and the reference standard (pathological assessment) detected breast lesion, true negative (TN) when neither test detected breast lesion, false negative (FN) when the index test failed to detect a breast lesion identified by the reference standard, and false positive (FP) when the index test incorrectly suggested a breast lesion not detected by the reference standard. Sensitivity was defined as TP/(TP+FN) and specificity as TN/(TN+FP).

Quality assessment

We used the revised Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) to evaluate the quality of the included studies. Assessment of the risk of bias and applicability concerns were performed in 4 domains including patient selection, index test, reference standard, and flow and timing. Applicability concern and risk of bias were judged as low, high, or unclear for the various QUADAS domains.[12]

Statistical analysis

SPSS 16 was used for data analysis using descriptive statistics. Sensitivity, specificity, PPV, and NPV, along with 95% confidence intervals (CIs), were calculated for each study.

Table 1. Main Characteristics of the Studies Evaluating the Diagnostic Value of Scintimammography

First author (Year)	Number of patients	Mean age (Year)	Index test	Sensitivity (%)	Specificity (%)	PPV* (%)	NPV** (%)
Chen (2000)[13]	35	—	Scintimammography (Planar)	77.8	88.2	—	—
Prats (2001)[14]	253	53.5	Scintimammography (Planar)	91	71	81	85
			Palpable lesions	97	57	82	86
			Nonpalpable lesions	77	83	78	82
Yildizi (2001)[15]	63	55	Scintimammography (Planar)	100	96	88	100
Koukouraki (2001)[16]	116	—	Scintimammography (Planar)	95	80	92	86
Aguilar (2001)[17]	36	57	Scintimammography (Planar)	78.9	72.2	75	76.5
Horne (2001)[18]	35	53.5	Scintimammography (Planar)	89.4	80	85	85.7
Bagni (2003)[19]	45	51	Scintimammography (Planar)	84	71	94	45
Sampalis (2003)[20]	1243	56	Scintimammography (Planar)	93	87	58	98
Myslivecek (2004)[21]	303	—	Scintimammography (Planar)	82	91	—	—
			Scintimammography (SPECT)	92	91		
Fondrinier (2004)[22]	41	—	Scintimammography (Planar)	58.3	81	78	63
Cicco (2004)[23]	40	52	Scintimammography (Planar)	87.5	60.0	72.4	80
Kim (2005)[24]	520	≤45	Scintimammography (Planar)	79.6	78.6	—	—
		>45		85.7	77.5		
Prats (2007)[25]	308	54	Scintimammography (Planar)	85	95	80	96
			Palpable lesions	97	94	91	98
			Nonpalpable lesions	68	96	68	96
Usmani (2008)[26]	36	47.13	Scintimammography (Planar)	86	88	96	64
Habib (2009)[27]	28	—	Scintimammography (Planar)	93.3	71.4	87.5	83.3
Cesare (2011)[28]	172	—	Scintimammography (SPECT)	100	93.5	92.5	100

**PPV: Positive predictive value; **NPV: Negative predictive value*

Results

Twenty-five studies assessing the sensitivity, specificity and/or PPV and NPV of scintimammography or mammography in the detection of breast lesions were included in the analysis. The studies included a total of 4094 patients (age: 51.68 ± 4.07 y) with clinically suspicious breast lesions. Table 1 shows the main characteristics of the 16 studies evaluating the diagnostic value of scintimammography, and Table 2 shows the main characteristics of the 3 studies assessing the diagnostic value of mammography. Six studies compared the diagnostic value of scintimammography with mammography (Table 3).

Sensitivity and specificity of mammography were 75.82 ± 10.53 (95% CI, 50-84) and 59.58 ± 22.79 (95% CI, 20-91.4), respectively. Also, mammography had a PPV of 75.60 ± 2.21 (95% CI, 42-93) and an NPV of 61.62 ± 1.67 (95% CI, 39.1-86).

The sensitivity of scintimammography was 86.64 ± 8.84 (95% CI, 58.3-100), and its specificity was 83.42 ± 10.74 (95% CI, 60-100). PPV and NPV of scintimammography were 82.10 ± 11.65 (95% CI, 58-98.30) and 81.02 ± 17.00 (95% CI, 45-100), respectively.

Table 2. Main Characteristics of the Studies Evaluating the Diagnostic Value of Mammography

First author (Year)	Number of patients	Mean age (Year)	Index test	Sensitivity (%)	Specificity (%)	PPV* (%)	NPV** (%)
Hoi (2000)[29]	60	60	Mammography	84	80	93	63
Chen (2002)[30]	60	60	Mammography	84	80	93	63
Kotsianos-Hermle (2009)[31]	97	97	Mammography	76.5	91.4	—	—

*PPV: Positive predictive value; **NPV: Negative predictive value*

Table 3. Main Characteristics of the Studies Evaluating the Diagnostic Value of Mammography

First author (Year)	Number of patients	Mean age (Year)	Index test	Sensitivity (%)	Specificity (%)	PPV* (%)	NPV** (%)
Mulero (2000)[32]	109	—	MG (dense breasts)	81	28	—	—
	8	under 30	MG (young females)	50	20	—	—
	24	—	MG (previous surgery)	80	42	—	—
			SM (dense breasts)	88	90	—	—
			SM (young females)	100	100	—	—
			SM (previous surgery)	80	100	—	—
Sun (2000)[33]	81	55	MG	83	47	—	—
			SM (Planar)	88	87	—	—
Lumachi (2001)[34]	87	47	MG	80.6	60.0	90.6	39.1
			SM (Planar)	80.6	93.3	98.3	50.0
Cwikła (2003)[35]	154	—	MG	69	72	81	57
			SM (Planar)	87	65	81	75
Krishnaiah (2003)[36]	94	44	MG	65	72	42	86
			SM (Planar)	83	83	59	94
Ozulker (2010)[37]	46	46	MG	81	63	54	86
			SM (Planar)	93	86	78	96

MG: Mammography; SM: Scintimammography; *PPV: Positive predictive value; **NPV: Negative predictive value

Discussion

Although mammography has high sensitivity in the examination of older patients with fatty breast tissue, it is less reliable in detecting breast lesions in patients with dense breasts, breast implants, and architectural distortion after radiation therapy or surgery.[7] In a mammography unit with both a rhodium (Rh) anode and a molybdenum (Mo) anode, filtered with rhodium and molybdenum, respectively, the mammograms obtained by using the Mo/Mo combination were preferred. However, the mammograms obtained with the Rh/Rh combination were better than the Mo/Mo mammograms for young patients with dense breasts.[38]

^{99m}Tc-MIBI scintigraphy plays an important role in localizing the breast tumors when ultrasound or mammography is not contributory. Diagnostic accuracy of scintimammography, as a functional imaging modality, is not affected by breast density, contrary to mammography, because of the advantages of labeling with ^{99m}Tc sestamibi radiopharmaceutical. Its uptake in the lesion involves several causes, including mitochondrial activity, angiogenesis, and presence of malformed vessels, but does not depend on the presence of architectural distortion and localized variation in breast density.[39-45]

The intensity of ^{99m}Tc-MIBI uptake varies from mild to high depending on factors such as the type, size, location, and hormonal factors. The size of the lesion affects sensitivity. The sensitivity for palpable lesions is significantly higher than that for nonpalpable ones.[46,47] Another clinical application of ^{99m}Tc-MIBI scintigraphy is the detection of patients with microcalcifications. Scintimammography seems to be helpful in differentiating malignant from benign calcifications and leads to a decrease in the frequency of breast biopsies.[48] Some studies had separated the statistics for palpable and nonpalpable lesions because of the difference in management strategy.[14, 25, 49] Palmedo reported that the total specificity and sensitivity of 99mTc-MIBI scintimammography were 69% and 71%, respectively; for palpable lesions, however, the specificity and sensitivity of scintimammography increased to 91% and 83%, respectively.[49] Palmedo reported similar results in another research and showed that the total sensitivity of scintimammography was 88%, increasing to 100% for palpable lesions.[50] Another study reported that the sensitivity of scintimammography in detecting nonpalpable lesions was 78.3% compared with 89.1% for mammography; but, in palpable lesions, the sensitivity of scintimammography (91.3%) was higher than the sensitivity of mammography (78.2%).[51] Based on the clinical studies, ^{99m}Tc-MIBI scintimammography is more accurate than mammography in differentiating palpable breast lesions. Therefore, the utility of the technique has been emphasized to decrease the frequency of breast biopsies.[1] As mentioned, the sensitivity of scintimammography can be affected by tumor size, and the specificity and sensitivity of ^{99m}Tc-MIBI scintimammography increase for palpable breast lesions.[49, 50] Therefore, attempts have been made to enhance the sensitivity of scintimammography for the detection of cancer, especially for nonpalpable and ≤1-cm lesions.[52, 53] Myslivecek compared the specificity and sensitivity of scintimammography in detecting primary breast lesions with both single-photon emission computed tomography (SPECT) and planar images (Table 1). The results showed that SPECT scintimammography was slightly (10%) more sensitive than planar scintigraphy.[21] Taillefer and Khalkhali reported PPV values of 97.7% and 76.9%, respectively, and NPV values were 81% and 97%, respectively.[54, 55] Palmedo reported that in 60% of false-negative (FN) mammograms, scintimammography was able to detect malignant lesions true-positive (TP).[49] It is worth mentioning that scintimammography with ^{99m}Tc-MIBI or ^{99m}Tc-sestamibi scintimammography is a noninvasive imaging modality and highly sensitive test in detecting primary breast lesions.[49,54,55]

The present systematic review demonstrates the high diagnostic value of scintimammography with ^{99m}Tc-MIBI as a complementary method that improves the specificity of mammography and is potentially able to reduce the frequency of breast biopsies. Scintimammography is a noninvasive, low–radiation dose diagnostic method and an easy-to-perform procedure which may offer additional information above that provided by conventional radiology, especially in young, premenopausal patients with dense breasts and in patients who are on hormone replacement therapy, where the sensitivity of mammography is limited by the characteristics of the breast tissue. Technetium-99m-sestamibi scintimammography has the potential to determine the metabolic state of microcalcification, primary breast lesion, axillary lymph node detected by other imaging modalities. Scintimammography may discriminate between benign and malignant breast lesions in patients with a palpable mass or when the lesion size is more than 10 mm.

However, mammography has a high sensitivity in the examination of older patients with fatty breast and is associated with a small amount of radiation exposure. Mammography has a better spatial resolution compared with scintimammography. Nevertheless, the development and general availability of high-resolution cameras dedicated to breast imaging will probably allow scintimammography to become of routine use.

Conflict of Interest

The authors have no potential conflict of interest concerning the content of the present article.

References

1. Pan L, Han Y, Sun X, Liu J, Gang H. FDG-PET and other imaging modalities for the evaluation of breast cancer recurrence and metastases: a meta-analysis. J Cancer Res Clin Oncol. 2010;136(7):1007-22.
2. Pennant M, Takwoingi Y, Pennant L, Davenport C, Fry-Smith A, Eisinga A, *et al.* A systematic review of positron emission tomography (PET) and positron emission tomography/computed tomography (PET/CT) for the diagnosis of breast cancer recurrence. Health Technol Assess. 2010;14(50):1-103.
3. Warning K, Hildebrandt MG, Kristensen B, Ewertz M. Utility of 18FDG-PET/CT in breast cancer diagnostics--a systematic review. Dan Med Bull. 2011;58(7):A4289.
4. Heydarheydari S, Haghparast A. Diagnostic Value of PET/CT in Comparison with Other Conventional Imaging Modalities for the Evaluation of Breast Cancer Recurrence: A Systematic Review of the Literature. Archives of Breast Cancer. 2016;3(3):77-82.
5. Helvie MA, Chang JT, Hendrick RE, Banerjee M. Reduction in late-stage breast cancer incidence in the mammography era: Implications

for overdiagnosis of invasive cancer. Cancer. 2014;120(17):2649-56.
6. Hall FM. Screening mammography—potential problems on the horizon. Mass Medical Soc; 1986.
7. Brem RF, Tabár L, Duffy SW, Inciardi MF, Guingrich JA, Hashimoto BE, *et al.* Assessing improvement in detection of breast cancer with three-dimensional automated breast US in women with dense breast tissue: the SomoInsight Study. Radiology. 2014;274(3): 663-73.
8. PRESSMAN PI. Delayed diagnosis of breast cancer as a result of normal mammograms. Archives of Surgery. 1983;118(8):992-.
9. Sickles EA. Mammographic features of 300 consecutive nonpalpable breast cancers. AJR Am J Roentgenol. 1986;146(4):661-3.
10. Moriguchi SM, LA DEL, Griva BL, Koga KH, ET DAS, H DELV, *et al.* Accuracy of (99m)Tc-sestamibi scintimammography for breast cancer diagnosis. Exp Ther Med. 2010;1(1):205-9.
11. Campeau RJ, Kronemer KA, Sutherland CM. Concordant uptake of Tc-99m sestamibi and Tl-201 in unsuspected breast tumor. Clin Nucl Med. 1992;17(12):936-7.
12. Whiting PF, Rutjes AW, Westwood ME, Mallett S, Deeks JJ, Reitsma JB, *et al.* QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Annals of internal medicine. 2011;155(8):529-36.
13. Chen S, Liu W, Mao Y, Zhu W, Yao Z, Sun X, *et al.* 99mTc-MIBI and 99mTc-MDP scintimammography for detecting breast carcinoma. Chin Med J (Engl). 2000;113(5):4003.
14. Prats E, Banzo J, Merono E, Herranz R, Carril J. 99mTc-MIBI scintimammography as a complement of the mammography in patients with suspected breast cancer. A multicentre experience. The Breast. 2001;10(2):109-16.
15. Yildiz A, Colak T, Gungor F, Ozugur S, Boz A, Tuncdemir F, *et al.* Diagnostic value of 99mTc MIBI scintimammography in patients with breast lesions. Rev Esp Med Nucl. 2001;20(4):276-81.
16. Koukouraki S, Koukourakis M, Vagios E, Velidaki A, Tsiftsis D, Karkavitsas N. The role of 99mTc-sestamibi scintimammography and colour Doppler ultrasonography in the evaluation of breast lesions. Nuclear medicine communications. 2001;22(11):1243-8.
17. AguilarJ, Andrés B, Nicolás F, Muelas M, Pérez-Flores D, Aguayo JL. Value of 99mTc-MIBI scintimammography in women with impalpable breast lesions seen on mammography. The European journal of surgery. 2001;167(5):344-6.
18. Horne T, Pappo I, Cohen-Pour M, Baumer M, Orda R. 99Tcm-tetrofosmin scintimammography for detecting breast cancer: a comparative study with 99Tcm-MIBI. Nuclear medicine communications. 2001;22(7):807-11.
19. Bagni B, Franceschetto A, Casolo A, De Santis M, Bagni I, Pansini F, *et al.* Scintimammography with 99mTc-MIBI and magnetic resonance imaging in the evaluation of breast cancer. Eur J Nucl Med Mol Imaging. 2003;30(10):1383-8.
20. Sampalis FS, Denis R, Picard D, Fleiszer D, Martin G, Nassif E, *et al.* International prospective evaluation of scintimammography with 99mTechnetium sestamibi. The American journal of surgery. 2003;185(6):544-9.
21. Myslivecek M, Koranda P, Kaminek M, Husak V, Hartlova M, Duskova M, *et al.* Technetium-99m-MIBI scintimammography by planar and SPECT imaging in the diagnosis of breast carcinoma and axillary lymph node involvement. Nucl Med Rev Cent East Eur. 2004;7(2):151-5.
22. Fondrinier E, Muratet JP, Anglade E, Fauvet R, Berger V, Lorimier G, *et al.* Clinical experience with 99mTc-MIBI scintimammography in patients with breast microcalcifications. Breast. 2004;13(4):316-20.
23. De Cicco C, Trifiro G, Baio S, Sierra ML, Pizzamiglio M, Cassano E, *et al.* Clinical utility of 99mTc-Sestamibi scintimammography in the management of equivocal breast lesions. Cancer Biother Radiopharm. 2004;19(5):621-6.
24. Kim SJ, Kim IJ, Bae YT, Kim YK, Kim DS. Comparison of quantitative and visual analysis of Tc-99m MIBI scintimammography for detection of primary breast cancer. Eur J Radiol. 2005;53(2):192-8.
25. Prats E, Razola P, Sainz J, Tardín L, Andrés A, Abós M, *et al.* Scintimammography with 99mTc-MIBI in clinical practice. Repercussion on the clinical management of the patient. Revista española de medicina nuclear (English Edition). 2007;26(3):153-9.
26. Usmani S, Khan HA, Javed A, Al Mohannadi S, Al Huda FA, Al Shammary I. Functional breast imaging with Tc 99m Mibi for detection of primary breast lesion and axillary lymph node metastases. Gulf J Oncolog. 2008(4):52-7.
27. Habib S, Maseeh uz Z, Hameed A, Niaz K, Hashmi H, Kamal S. Diagnostic accuracy of Tc-99m-MIBI for breast carcinoma in correlation with mammography and sonography. J Coll Physicians Surg Pak. 2009;19(10):622-6.
28. DeCesare A, De Vincentis G, Gervasi S, Crescentini G, Fiori E, Bonomi M, *et al.* Single-photon-emission computed tomography (SPECT) with technetium-99m sestamibi in the diagnosis of small breast cancer and axillary lymph node involvement. World J Surg. 2011; 35(12):2668-72.
29. Hoi Y, Hsieh J, Tsai S, Sun S, Kao C. Usefulness of technetium-99m tetrofosmin mammoscintigraphy as compared to mammography for detecting and differentiating palpable breast masses of young Taiwanese women. Anticancer

research. 2000;20(3B):2061-4.
30. Chen D, Jeng L, Kao A, Lin C, Lee C. Usefulness of mammoscintigraphy with thallium-201 single photon emission computed tomography to differentiate palpable breast masses of young Taiwanese women when comparing with mammography. Neoplasma. 2002;49(5):334-7.
31. Kotsianos-Hermle D, Hiltawsky KM, Wirth S, Fischer T, Friese K, Reiser M. Analysis of 107 breast lesions with automated 3D ultrasound and comparison with mammography and manual ultrasound. Eur J Radiol. 2009;71(1):109-15.
32. Mulero F, Nicolas F, Castellon MI, Fuentes T, de la Cruz P, Roca V, *et al.* [99m Tc-MIBI scintigraphy compared to mammography in the diagnosis of breast cancer in dense, operated and young women breasts]. Rev Esp Med Nucl. 2000;19(5):344-9.
33. Sun S, Hsieh J, Tsai S, Ho Y, Lee J, Kao C. The role of Tc-99m methoxyisobutylisonitrile scintima-mmography as compared to mammography in evaluating palpable breast masses of Taiwanese women. Anticancer research. 2000;20(3B):21336.
34. Lumachi F, Ferretti G, Povolato M, Marzola MC, Zucchetta P, Geatti O, *et al.* Accuracy of technetium-99m sestamibi scintimammography and X-ray mammography in premenopausal women with suspected breast cancer. Eur J Nucl Med. 2001;28(12):1776-80.
35. Cwikła J, Buscombe J, Kolasińska A, Holloway B, Hilson A. Evaluation of scintimammography as an additional test to conventional mammography in detection of breast cancer. Ginekologia polska. 2003;74(5):362-70.
36. Krishnaiah G, Sher-Ahmed A, Ugwu-Dike M, Regan P, Singer J, Totoonchie A, *et al.* Technetium-99m sestamibi scintimammography complements mammography in the detection of breast cancer. Breast J. 2003;9(4):288-94.
37. Ozülker T, Ozülker F, Ozpaçaci T, Bender O, Değirmenci H. The efficacy of (99m) Tc-MIBI scintimammography in the evaluation of breast lesions and axillary involvement: a comparison with X-rays mammography, ultrasonography and magnetic resonance imaging. Hellenic journal of nuclear medicine. 2010;13(2):144-9.
38. Kimme-Smith C, Wang J, DeBruhl N, Basic M, Bassett LW. Mammograms obtained with rhodium vs molybdenum anodes: contrast and dose differences. AJR Am J Roentgenol. 1994;162(6):1313-7.
39. Omar WS, Eissa S, Moustafa H, Farag H, Ezzat I, Abdel-Dayem HM. Role of thallium-201 chloride and Tc-99m methoxy-isobutyl-isonitrite (sestaMIBI) in evaluation of breast masses: correlation with the immunohistochemical characteristic parameters (Ki-67, PCNA, Bcl, and angiogenesis) in malignant lesions. Anticancer Res. 1997;17(3B):1639-44.
40. Tierney S, Fenlon H, Phelan N, O'sullivan P, Ennis J, Gorey T. Scintimammography in the assessment of local recurrence following conservative breast surgery. The British Journal of Surgery-Supplement. 1998;85:51.
41. Cutrone JA, Khalkhali I, Yospur LS, Diggles L, Weinberg I, Pong EM, *et al.* Tc-99m Sestamibi Scintimammography for the Evaluation of Breast Masses in Patients with Radiographically Dense Breasts. Breast J. 1999;5(6):383-8.
42. Zegel H, Heller L, Edell S, Squires F, Rubin J. Tc-99m sestamibi scintimammography in the mammographically dense breast. Clin Nucl Med. 1999;24(12):968-74.
43. Kolasinska A, Cwikla J, Buscombe J, Parbhoo S, Davidson T, Holloway B, *et al.* 63. Scintimammography in recurrent breast cancer: A primary or secondary role? Nuclear Medicine Communications. 2000;21(4):389.
44. Kuhn JC, Siegel A, Poplack S, Arrick B. Chest wall recurrence of breast cancer detected by scintimammography. Clin Nucl Med. 2000; 25(2):104-6.
45. Usmani S, Khan HA, Niaz K, Uz-Zaman M, Niyaz K, Javed A, *et al.* Tc-99m-methoxy isobutyl isonitrile scintimammography: imaging postexcision biopsy for residual and multifocal breast tumor. Nuclear medicine communications. 2008;29(9):826-9.
46. Fliquete MP, Giménez JC, Vázquez CF, Más CA, Vázquez CA. Role of 99mTc-Sestamibi in the diagnosis of breast cancer. Report on 100 cases. Revista espanola de medicina nuclear. 1999;18(6):436-41.
47. Tofani A, Sciuto R, Semprebene A, Festa A, Pasqualoni R, Giunta S, *et al.* 99Tcm-MIBI scintimammography in 300 consecutive patients: factors that may affect accuracy. Nuclear medicine communications. 1999; 20(12):111321.
48. Bekis R, Derebek E, Balci P, Kocdor MA, Degirmenci B, Canda T, *et al.* 99mTc sestamibi scintimammography. Screening mammographic non-palpable suspicious breast lesions: preliminary results. Nuklearmedizin. 2004;43(1):16-20.
49. Palmedo H, Biersack H, Lastoria S, Maublant J, Prats E, Stegner H, *et al.* Scintimammography with technetium-99m methoxyisobutylisonitrile: results of a prospective European multicentre trial. European journal of nuclear medicine. 1998;25(4):375-85.
50. Palmedo H, Schomburg A, Grunwald F, Mallmann P, Krebs D, Biersack H-J. Technetium-99m-MIBI scintimammography for suspicious breast lesions. Journal of Nuclear Medicine. 1996;37(4):626-30.
51. Wilczek B, Aspelin P, Bone B, Pegerfalk A, Frisell J, Danielsson R. Complementary use of scintimammography with 99m-Tc-MIBI to

triple diagnostic procedure in palpable and non-palpable breast lesions. Acta Radiol. 2003;44(3):288-93.
52. Brem RF, Schoonjans JM, Kieper DA, Majewski S, Goodman S, Civelek C. High-resolution scintimammography: a pilot study. J Nucl Med. 2002;43(7):909-15.
53. Kim BS, Moon BI, Cha ES. A comparative study of breast-specific gamma imaging with the conventional imaging modality in breast cancer patients with dense breasts. Ann Nucl Med. 2012;26(10):823-9.
54. Khalkhali I, Cutrone J, Mena I, Diggles L, Venegas R, Vargas H, *et al.* Technetium-99m-sestamibi scintimammography of breast lesions: clinical and pathological follow-up. J Nucl Med. 1995;36(10):1784-9.
55. Taillefer R, Robidoux A, Lambert R, Turpin S, Laperrière J. Technetium-99m-sestamibi prone scintimammography to detect primary breast cancer and axillary lymph node involvement. Journal of Nuclear Medicine. 1995;36(10): 1758-65.