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Interest of SPECT/CT in Detection of Sentinel Lymph Node in Breast Cancer

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Abstract

Aim: Assess the role of hybrid modality SPECT/CT versus planar scintigraphy in sentinel lymph node (SLN) identification in patients with breast cancer. **Methods:** Planar scintigraphy and hybrid modality SPECT/CT were performed in 23 women with breast cancer (mean age 59.5 years with range 25 - 82 years) with invasive breast cancer (T0, T1 and T2), without clinical evidence of axillary lymph node metastases (N0) and no remote metastases (M0), radiocolloid was injected in four subareolar sites. Planar and SPECT/CT images were separately interpreted. **Results:** SLNs were detected on lymphoscintigraphy in all patients (100%), taking into consideration both techniques (planar and SPECT-CT images). Planar images identified 45 SLNs in 23 women, with a mean of 1.95 per patient, whereas 56 SLNs were detected on SPECT/CT, increasing this mean to 2.43 per patient. Drainage to internal mammary lymph nodes was seen in 4 patients (17.39%). However, two foci of uptake were identified on planar image as hot SLN in two patients (8.69%); while they have been found as a false positive non-nodal site of uptake on SPECT/CT. **Conclusion:** SPECT/CT is more focused than planar scintigraphy in the detection of SLN in patients with breast cancer. It detects some lymph nodes not visible on planar images, excludes false positive uptake and exactly locates axillary and non-axillary SLNs.

Keywords

Sentinel Lymph Node, Breast Cancer, Planar Scintigraphy, SPECT/CT

1. Introduction

The sentinel lymph node (SLN) is defined as the first node in the lymphatic drainage of the primary tumor. The detection and biopsy of the SLN already has

been implemented in the surgical treatment of breast cancer insofar as it is the most accurate and the only reliable method for nodal staging which can diagnose microscopic tumor spread to the regional lymph nodes [1]. Minimal invasive SLN biopsy successfully has replaced lymphadenectomy for nodal staging, thus avoiding side effects of lymphadenectomy including lymphedema, pain, and stiffness [2] [3]. Planar lymphoscintigraphic imaging is an important element in lymphatic mapping, identifying sentinel lymph nodes (SLNs) in more than 95% of breast cancer patients [4]. However, conventional planar imaging sometimes failed to preoperatively identify the exact number and localization of the detected lymph nodes [5]. Since 2000, hybrid cameras combining a dual head gamma camera with a low-dose radiograph tube mounted on the same gantry were developed, and image fusion has been successfully introduced in clinical practice [6]. We report our experience of this hybrid imaging method in lymphology and oncology, particularly for the SLN detection in patients with breast cancer.

2. Materials and Methods

Planar lymphoscintigraphy followed by low-dose SPECT/CT mode was performed in 23 women (mean age 53.5 yrs with range 39 - 73 years). All patients had infiltrating ductal carcinoma and were classified as Stage I, meeting the following criteria:

Inclusion Criteria:

- Patients with invasive breast cancer confirmed histologically after cytopuncture or preoperative microbiopsia.
- Stages T0, T1, T2 < 20 mm (unifocal tumor).
- Without lymph node involvement (N0).
- Without remote metastases (M0).
- No history of breast or axillary surgery.

Exclusion criteria:

- Tumor size > 20 mm
- Multifocal involvement.
- Palpable lymphadenopathy.
- Remote metastases.
- History of breast or axillary surgery.
- Neoadjuvant therapies (chemo or radiotherapy).

Our examination protocol was spread over two days in all our patients. On the day prior to surgery, an activity of 74 MBq of ^{99m}Tc labelled colloid (Nanocis) divided in four equal aliquots of 0.25 ml was injected by nuclear medicine physician. Our patients were injected in four subareolar sites, and a light massage was done 5 minutes after the injection. We did not have any complication from the injection of ^{99m}Tc labelled colloid or the imaging procedure.

Planar scintigraphy was performed using a dual-head gamma camera (Hawkeye, GE Healthcare) equipped with low energy high resolution (LEHR) collimators, from the twentieth minute after injection. The patients were positioned

supine with the arms above the head. Images were obtained in anterior and lateral projections, during ten minutes per projection. SPECT/CT images were acquired immediately after planar images, covering the chest. SPECT was performed over one field of view (128 × 128 matrix, 60 frames at 25 s per view) using steps of 6 degrees.

The CT data were used for attenuation correction and image fusion. The iterative reconstruction (OSEM 3D) was used for generating both SPECT and CT slices. The SPECT/CT images were viewed using two dimensional orthogonal re-slicing in axial, sagittal and coronal orientation. The location of the SLN was marked on the skin with indelible ink.

3. Results

SLNs were detected on lymphoscintigraphy in all patients (100%), taking into consideration both techniques (planar and SPECT-CT images). SPECT/CT compared with planar images SPECT/CT showed more accurate information in 17 patients (73.91%). The localization and number of SLNs were exactly the same in only 6 patients (23.52%). Planar images identified 45 SLNs in 23 women, with a mean of 1.95 SLN per patient, whereas 56 SLNs were detected on SPECT/CT, increasing this mean to 2.43 SLNs per patient. Further, SPECT/CT showed the accurate anatomical location of whole detected SLNs (Table 1). In 7 patients (30.43%), the exact anatomical localization was equivocal on planar images, whereas SPECT/CT showed the exact anatomical information needed to assign the SLN Levels particularly for the internal mammary lymph chain and the level II of axillary lymph nodes. In 5 patients (21.73%), SLNs close to the injection site were detected with SPECT/CT that was not visible on planar images due to scatter radiation (Figure 1). Drainage to internal mammary lymph chain (IMC) was seen in 4 patients (17.39%). In one of these four patients, SPECT/CT revealed, in addition to the internal mammary node, an axillary SLN not detected in planar imaging (Figure 2). However, two foci of uptake were identified on planar image as hot SLN in two patients (8.69%), while it has been found as a false positive non-nodal site of uptake on SPECT/CT.

Table 1. Location of SLN according to tumor site detected by SPECT/CT.

Tumor site	Patients	Location of SLN		
		Axillary region	Internal mammary chain	Other
Upper outer quadrant	12	31 (96.87%)	1 (3.13%)	0
Upper inner quadrant	5	12 (85.71%)	2 (4.29%)	0
Central portion	2	3 (100%)	0	0
Lower outer quadrant	3	4 (100%)	0	0
Lower inner quadrant	1	2 (66.66%)	1 (33.34%)	0

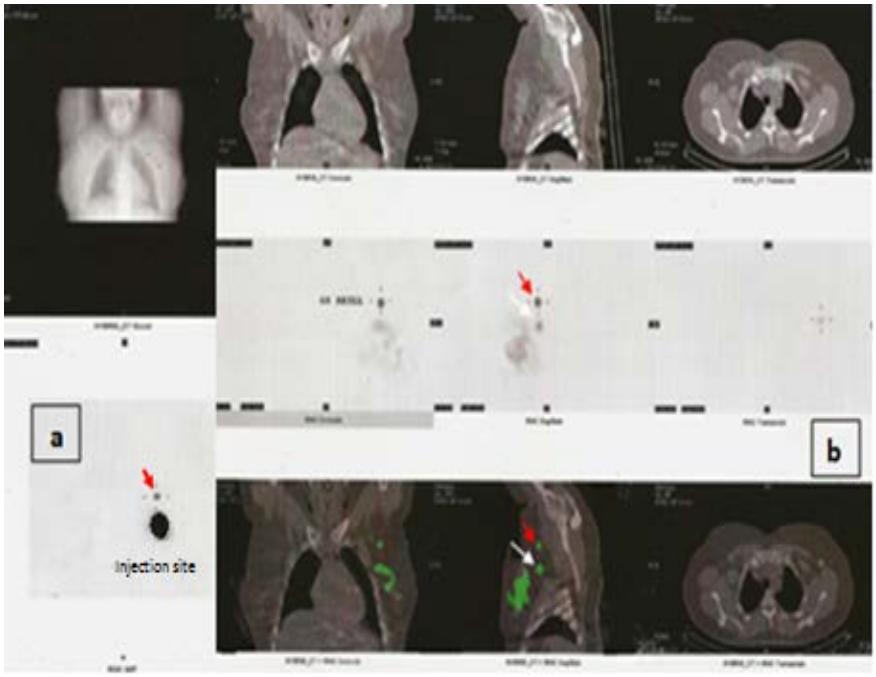

Figure 1. SLN detection in a left breast cancer (T1N0M0). Anterior planar image in (a) demonstrates an axillary SLN (red *arrow*). The localization of this SLN is not precise. SPECT-CT image in (b) confirms the exact localization of the axillary SLN and also shows, in sagittal view, a second axillary SLN hidden by tumor activity (white *arrow*).

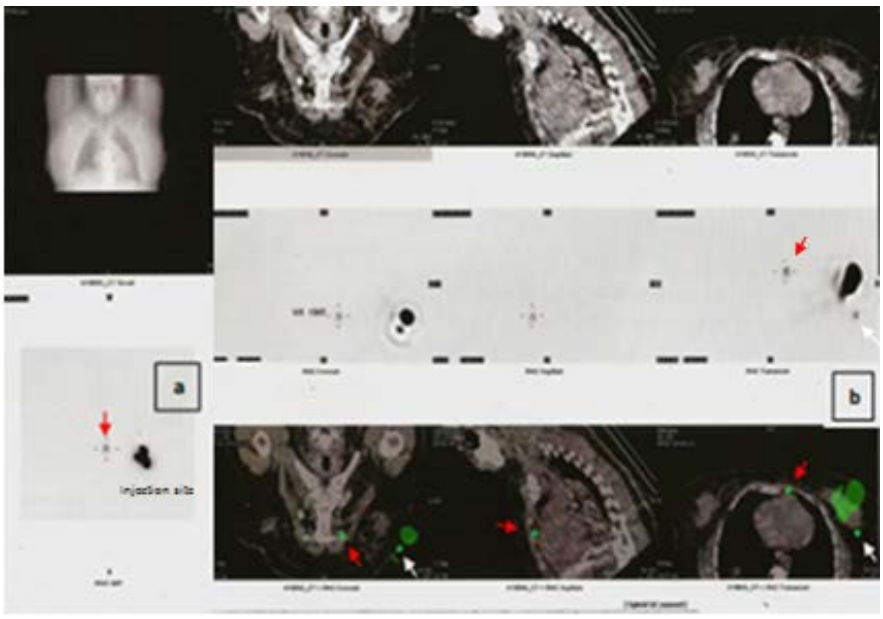

Figure 2. Lymphoscintigraphy SLN detection in a left breast cancer (T1N0M0). Anterior planar image in (a) demonstrates a parasternal SLN (red arrow). SPECT-CT fusion image in (b) confirms the exact localization of the internal mammary lymph node and also shows a second axillary SLN (white *arrow*) not detected in planar image.

4. Discussion

Hybrid SPECT/CT modality merges functional information provided by tomos-

cintigraphy with anatomical data from computed tomography (CT) [7] [8]. Compared to conventional single-modality imaging approaches, dual-modality systems allow precise anatomical localization of the SLN, facilitating the detection of SLN during minimally invasive surgery [6] [9]. In our study, integrated SPECT/CT was significantly superior to planar images, especially with regard to the exact anatomical location of the SLN.

Contamination, nodes close to the injection site, and overweight patients are three noted instances in which SLN identification and localization are better with SPECT than with standard planar methods [10] [11]. Lerman *et al.* [12] stated that the rate of false-negative planar imaging results for 122 overweight and obese patients was 28%, higher than that for the general study population.

After the ipsilateral axilla, the second most frequent drainage basin from breast tumor sites is the internal mammary chain (IMC) with wide variability in the rate of detection of this drainage [13]. In our study, SLN in IMC was detected in 4 of the 23 patients (17.39%). These SLNs were clearly identified on SPECT/CT. Moreover, SPECT/CT provides an anatomical overview in two and three-dimensional perspectives creating a surgical road-map that cannot be provided by planar images or intraoperative lymphatic mapping techniques. The present study confirms the additional value of SPECT/CT in the anatomical localization of more SLNs and underlines its relevance for the surgical approach. SPECT/CT, therefore, facilitates surgical exploration in difficult cases and may improve staging [14]. In fact, SLNs outside the axilla and nodes close to the injection site were easier to identify using SPECT/CT [15] [16]. This latter also allows precise characterization of the size, depth and anatomical location of the sentinel lymph node [17].

Pitfalls of planar lymphoscintigraphy interpretation may be avoided by adding SPECT/CT to the acquisition protocol. Two close SLNs can be clearly separated on SPECT images. SLNs showing only faint activity on planar images, if deeply located, may be better identified on SPECT. SPECT/CT may reduce the false-positive rate by differentiating between nodal and extranodal foci such as skin folds or radioactive contamination, which can be misinterpreted as hot lymph nodes on planar images as it was found in two patients in our study [18] [19].

5. Conclusion

The introduction of SPECT/CT in the exploration of SLN contributes to the localization of lymph nodes in patients with breast cancer. It can detect SLNs not visualized by planar imaging, exclude false positif and accurately locates axillary and extra-axillary nodes. This hybrid mode of exploration then allows a better orientation of the diagnosis and much less invasive therapeutic strategy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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