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The hidden sentinel node in breast cancer: Reevaluating the role of SPECT/CT and tracer reinjection

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Abstract

Introduction: Lymphoscintigraphy with planar imaging is considered a helpful tool to depict lymph node drainage in patients with invasive breast cancer. Single Photon Emission Computed Tomography with integrated CT (SPECT/CT) is usually performed to detect sentinel nodes (SN)s in breast cancer patients showing non-visualisation on lymphoscintigraphy. Incorporation of new SN indications (recurrent surgery, previous radiotherapy, or neo-adjuvant chemotherapy) has led to an increase of non-visualisation rates. The present study evaluates the contribution of SPECT/CT and tracer reinjection for SN-visualisation in breast cancer patients without drainage on lymphoscintigraphy.

Methods: Between 1st of July 2008 and 6th of November 2014 in total 1968 patients underwent a SN breast procedure, using intra-tumoural tracer administration. SPECT/CT was performed in 284 breast cancer patients with non-visualisation of SNs on lymphoscintigraphy. If SN non-visualisation persisted, a second radiotracer injection with repeated imaging was performed when logistics allowed this. Univariate analysis was applied to evaluate SPECT/CT visualisation rates in specific subgroups.

Results: The SPECT/CT visualisation rate was 23.2% (66/284). Univariate analysis revealed no significant subgroups influencing SPECT/CT visualisation. In patients receiving reinjection after persistent SPECT/CT non-visualisation the SN-visualisation rate reached 62.1% (36/58). Intraoperatively, the SN-identification rate using a gamma probe and blue dye was 87.9% (175/199) and 32.9% (28/85) for, respectively, primary and recurrent surgery after non-visualisation on lymphoscintigraphy.

Conclusion: In this evaluation including new breast cancer SN indications, SPECT/CT scored lower than reinjection to visualise SNs in patients with non-visualisation on lymphoscintigraphy. Consequently, our institutional protocol has been readjusted.

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Keywords: SPECT/CT; Breast cancer; Sentinel node; SLNB; Non-visualisation

Introduction

Single Photon Emission Computed Tomography with integrated CT (SPECT/CT) is currently used for various sentinel node (SN) indications.[1,2] This hybrid modality provides information about the anatomical location of radioactive SNs and the option for attenuation correction. Based on the guidelines of the Society of Nuclear Medicine and Molecular Imaging and the European Association of Nuclear Medicine, current indications for SPECT/CT in breast cancer include the localisation of extra-axillary SNs, non-visualisation on planar images, or otherwise difficult to interpret drainage on conventional planar imaging.[3] However, there is still no consensus about the subsequent strategy after a non-visualisation on planar imaging to improve visualisation: either SPECT/CT or reinjection. Both the application of SPECT/CT and a reinjection into daily practice are associated with additional costs, extra

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time, and/or radiation exposure for the patient. The controversy on this subject is reflected by the fact that some centers do not use SPECT/CT at all, some use it for every patient, and others use it for specific indications.[4,5]

In a first study in our hospital,[6] the role of SPECT/CT was evaluated in addition to planar imaging in breast cancer patients with primary tumours smaller than 3 cm revealing an unusual lymphatic drainage, a lymphatic drainage pattern that is difficult to interpret, or in cases of non-visualisation on the planar lymphoscintigrams. This protocol with additional SPECT/CT imaging was systematically applied leading to a large dataset of SPECT/CT scans. However, concurrently to the incorporation of SPECT/CT, indications for the SN procedure were extended to patients with more locally advanced breast cancer receiving neo-adjuvant chemotherapy, multicentric/multifocal breast cancer, and patients with local breast cancer recurrence after surgery and/or radiotherapy. Until now, the largest studies evaluating SPECT/CT scans for breast cancer surgery are from Uren et al. with 741 patients and Ibusuki et al. with 223 patients including T1-T2 tumour lesions.[7,8] A small proportion of these patients had non-visualisation on planar imaging. Recently, a review was published combining all studies about SPECT/CT for breast cancer SN indications, in this study only a small proportion of patients presented with non-visualisation.[9] The purpose of this study is to reevaluate the additional value of SPECT/CT in patients with non-visualisation on planar lymphoscintigraphy in terms of the preoperative visualisation, also in the light of the new subset of patients in whom the SN procedure was performed in the last years.

Materials and methods

Patients

All consecutive patients with a SPECT/CT scan for the indication of non-visualisation on planar imaging in the period from the 1st of July 2008 to the 6th of November 2014 were identified for data analysis. In this period 1968 patients received lymphoscintigraphy for invasive breast cancer, ductal carcinoma in situ (at preoperative diagnosis), after neo adjuvant systemic treatment, or for recurrent breast cancer sentinel node procedures. In total, 284 (14.4%) patients had non-visualisation on planar lymphoscintigraphy and were included for further analysis.

Imaging method

Technetium-99m albumin nanocolloid (99mTc-nanocolloid) (Nanocoll; GE-Healthcare, Eindhoven, The Netherlands) (100–140 MBq in a volume of 0.2 ml) was injected intratumourally for mainly two-day protocols. Planar imaging, lymphoscintigraphy, was performed at early (15 min) and late (3–4 h) intervals after injection of the radiotracer. A cobalt-57 flood source was placed behind the patient to outline the body contour. A gamma camera equipped with Mullecom collimator (Symbia T; Siemens, Erlangen, Germany) was used. Anterior, oblique, and lateral images were obtained position and, if needed, additional images were acquired. SNs were defined as lymph nodes upon which the primary tumour drains directly. This is determined by lymph nodes visualised at the 15-min images, lymph nodes with increasing radiotracer uptake on the 3-h images, and lymph nodes in other anatomical levels.

In case of non-visualisation, SPECT/CT images were acquired immediately after the late planar images. The SPECT/CT system (Symbia T; Siemens, Erlangen, Germany) consisted of a dual-head variable-angle gamma camera equipped with Mullecom collimators and a multislice spiral CT scanner optimised for rapid rotation. SPECT acquisition (matrix 128 × 128, 60 frames at 30s per view) was performed using steps of 6°. After reconstruction, the SPECT images were corrected for attenuation and scatter. Three kinds of SPECT images were created for evaluation; attenuation and scatter corrected, attenuation corrected without scatter correction, without both attenuation and scatter correction. Both SPECT and CT axial 5-mm slices were generated using an Esoft 2000 application package (Siemens, Erlangen, Germany). Images were fused using an Osirix Dicom viewer (version 2.7–4.1). The SPECT/CT images were also viewed using two-dimensional orthogonal reslicing in axial, sagittal and coronal orientations. Maximum intensity projections with a three-dimensional display as well as volume rendering reconstruction were generated to indicate the sentinel nodes in relation to anatomical structures.

When logistics allowed in patients with persistent non-visualisation on SPECT/CT, a second, more superficial radiopharmaceutical (100–140 MBq) injection was given in the peripheral zone of the tumour after which delayed planar lymphoscintigraphy was repeated.

Surgical protocol

Patent blue dye (Laboratoire Guerbet, Aulnay-Sous-Bois, France) was administered immediately before the operation. The marked SN regions were explored looking for a blue lymphatic duct and the gamma probe (Neoprobe, Johnson & Johnson Medical, Hamburg, Germany) was used to search for radioactive SNs. The axilla was carefully palpated and suspicious palpable nodes were routinely removed.

Histopathological examination

All harvested nodes were fixed in formalin, bisected, embedded in paraffin. Pathological evaluation included haematoxylin-eosin for all harvested nodes and additional immunohistochemical staining (CAM 5.2; Becton Dickinson, San Jose, CA) for SNs.

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