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Original article

## Surgical guidance by freehand SPECT for sentinel lymph node biopsy in early stage breast cancer: A preliminary study



*Chirurgie guidée par SPECT portable : intérêt dans la technique du ganglion sentinelle dans les cancers du sein de stade précoce. Étude préliminaire*

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### ABSTRACT

**Objective.** – Sentinel lymph node biopsy (SLNB) is a standard for patients with early breast cancer. Using a gamma-detecting probe connected to an infrared camera, the Declipse freehand SPECT (FhSPECT) system (Surgiceye<sup>®</sup>) is able to detect and locate any radioactive source in 3D. The objective of this study was to evaluate the potential interest of FhSPECT imaging for real-time guidance SLNB in breast cancer. **Methods.** – A prospective single-center clinical study assessed sensitivity and usability of FhSPECT for SLN detection and surgical guidance in breast cancer patients. SLN detection rate with FhSPECT was compared with lymphoscintigraphy (LS) and colorimetric method. Durations of FhSPECT acquisitions and of the SLNB procedure were measured in order to evaluate the practicability of the device. **Results.** – Between May and September 2014, 20 patients with early stage invasive breast cancer (cT<sub>0-2</sub>N<sub>0</sub>) underwent SLNB using FhSPECT and blue dye detection. Preoperative LS revealed 41 radioactive axillary SLNs (median = 2 SLN per patient; range 0–4) in 20 patients. Preoperative FhSPECT detected 40 axillary SLNs (median = 2; range: 1–4) in 20 patients. The corresponding sensitivity of FhSPECT was 97.5%. For 4 patients (20%), FhSPECT detected more axillary SLNs than LS. The colorimetric method identified only 24 axillary SLNs (2 patients had no blue dye injection on account of a history of allergy), leading to a sensitivity of 67% (24 blue SLNs/36 resected SLNs after blue dye injection). Median duration of FhSPECT acquisitions was 5 minutes (range: 1–26 min). Median duration of SLNB procedure was 11.5 minutes (range: 3–55 min). Duration of acquisitions analysis based on the number of use of the device showed decreasing values suggesting the existence of a short learning curve. **Conclusion.** – This study demonstrated that FhSPECT is feasible and facilitates SLN identification.

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### R É S U M É

**Objectif.** – Grâce à une sonde de détection gamma reliée à une caméra infrarouge, le système Declipse FhSPECT (Surgiceye<sup>®</sup>) détecte et localise toute source radioactive dans l'espace, et reconstruit, en 3D et en temps réel, sa localisation. L'objectif était d'évaluer l'intérêt de ce nouvel outil dans le guidage du geste chirurgical lors de la procédure du ganglion sentinelle axillaire (GS) dans les cancers invasifs du sein (cT<sub>0-2</sub>N<sub>0</sub>). **Méthodes.** – Étude monocentrique prospective évaluant la sensibilité de détection et l'utilité du FhSPECT pour le guidage chirurgical de la procédure du GS. Le taux de détection des GS du FhSPECT a été comparé à celui de la lymphoscintigraphie préopératoire (LS) et celui de la méthode colorimétrique. La durée des acquisitions SPECT et des procédures du GS ont été mesurées.

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**Résultats.** – Entre mai et septembre 2014, 20 patientes présentant un cancer invasif du sein ( $cT_{0-2}N_0$ ) ont bénéficié d'une lymphadénectomie sélective sentinelle guidée par FhSPECT et méthode colorimétrique. La LS a révélé 41 GS (médiane par patiente = 2 [0–4]) chez 20 patientes. Le FhSPECT a détecté 40 GS (médiane par patiente = 2 [1–4]), correspondant à une sensibilité du FhSPECT de 97,5 %. Pour 4 patientes (20 %), le FhSPECT a détecté plus de GS que la LS. La méthode colorimétrique a permis l'identification de 24 GS chez 18 patientes (2 patientes n'ayant pu bénéficier de cette technique du fait d'antécédent allergique), correspondant à une sensibilité de 67 % seulement (24 GS bleus/36 GS prélevés après injection de bleu/18 patientes). La durée médiane des acquisitions SPECT était de 5 minutes [1–26] minutes et de la procédure du GS était de 11,5 [3–55] minutes. L'analyse des durées d'acquisitions en fonction du nombre d'utilisation du FhSPECT a montré une diminution des valeurs, suggérant l'existence d'une courbe de apprentissage de cette technique.

**Conclusion.** – Cette étude a montré que le GS guidé par FhSPECT est faisable, fiable et facilite l'identification et la résection des GS.

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## 1. Introduction

Sentinel lymph node biopsy (SLNB) is an integral feature of invasive breast cancer management [1]. Preoperative SLN marking uses two complementary techniques: a radio-isotopic technique with 99m Technetium ( $^{99m}\text{Tc}$ ) and a colorimetric technique using blue dye. Preoperative identification of SLN is based on a lymphoscintigraphy (LS) performed several hours before surgery, allowing the surgeon to determine the number and location of the SLN(s). In most cases, a combined method is sufficient to identify and locate SLN intraoperatively. However, in a few cases (5%), no SLN can be identified. It has also been reported that the accuracy of SLNB depends on the surgeon's experience: in particular, less experienced surgeons have problems identifying the SLNs [2].

Freehand SPECT (FhSPECT) (Declipse system, SurgicEye® GmbH, Munich, Germany) is a new system connecting a gamma detection probe with a 3D tracking tool using an infrared camera. This system can locate in space any radioactive source and reconstruct a three-dimensional image showing its location. This highly mobile freehand device is easy to use in the operating room, both preoperatively before section and in real-time during surgery. Its use in SLN detection has been described in other pathologies [3–5], and recently in breast cancer [6–8]. This device has been suggested to increase the success rate of SLN identification, especially in overweight patients and in cases of failed LS.

The aim of this study was to evaluate the potential interest of FhSPECT imaging for guidance SLNB in breast cancer.

## 2. Methods

This prospective single-center clinical study was designed to assess the sensitivity and usefulness of FhSPECT for SLN detection and SLNB surgical guidance in breast cancer patients. All patient with invasive breast cancer confirmed by core needle biopsy with indicated axillary SLNB ( $cT_{0-2}N_0$ ) were included in this study between May and September 2014.

FhSPECT comprises a conventional gamma probe as a detector (30° collimated crystal probe), CdTe probe connected to a gamma detection device (Europrobe3, Eurorad SA, Eckbolsheim, France), an infrared (IR) optical tracking system (Polaris Vicra, Northern Digital Inc., Waterloo, Ontario, Canada), a data processing unit implementing the algorithms for 3D image reconstruction and an appropriate graphical user interface (Fig. 1).

Using a patient reference target (reference geometry includes IR optical markers) and a probe reference target for the gamma probe, the IR optical tracking system captures the relative position and orientation of the patient in relation to the gamma probe. The information regarding position and orientation is then

synchronized with the gamma probe readings in order to reconstruct the 3D image in the data processing unit (Figs. 2 and 3). This 3D real-time reconstruction guides the surgeon in navigated resection of the SLNs.



Fig. 1. FhSPECT Declipse system, SurgicEye GmbH, Munich, Germany.

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