SPECT/CT IMAGE GENERATION AND CRITERIA FOR COMPREHENSIVE SENTINEL NODE INTERPRETATION

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MODERN SENTINEL NODE CONCEPT
1989-1992


DONALD MORTON
SENTINEL NODES AS THE LYMPH NODES DIRECTLY DRAINING FROM THE TUMOUR SITE

OMGO NIEWEG

2001
Ann Surg Oncol 8:538-41

2013

“THE BLUE NOTE”

vital dies PATENT BLUE
DAVID Krag

Surgical resection and radiolocalization of the sentinel lymph node in breast cancer using a gamma probe

Surg Oncol 1993;2:335-9

“OPEN & LISTEN”
FUNCTIONAL TRACERS $^{99m}$Tc-colloid

PHAGOCYTOSIS IN MACROPHAGES

1993
INTRODUCTION
PREOPERATIVE
LYMPHOSCINTIGRAPHY
$^{99m}$Tc-colloid particles

"OPEN & SEE"
PREOPERATIVE LYMPHOSCINTIGRAPHY

FIRST ROADMAP FOR SURGEONS

2D ROADMAP
SPECT / CT
3D ROADMAP
LYMPHOSCINTIGRAPHY & SPECT / CT

A COMPREHENSIVE INTERPRETATION

Consultants’ Meeting on GOSTT
IAEA - VIENNA 2011
Guided intraOperative Scintigraphic Tumour Targeting

ENGLOBING ALL NUCLEAR MEDICINE ASPECTS REQUIRED TO GUIDE SURGICAL PROCEDURES TAKING THE SENTINEL NODE AS A WORKING MODEL

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Editors

Atlas of Lymphoscintigraphy and Sentinel Node Mapping
A Pictorial Case-Based Approach

SPECT/CT Image Generation and Criteria for Sentinel Node Mapping

Renato A. Valdes Olmos and Sergi Vidal-Sicart

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8.1 Introduction

SPECT/CT is based on the hypothesis of the existence of an ideally and perfectly positioned lymph node draining a regional lymphatic basin. This hypothesis states that the lymphatic drainage of the lymph node is a direct route from the primary tumor to the sentinel lymph node (SN) (i.e., lymphatic duct or vessel). This SN is surrounded by a lymphoid tissue, although it is not necessarily the most distant lymph node. The SN is the sentinel lymph node drained by the sentinel lymphatic vessels from the primary tumor. The SN can be visualized and localized with radioactive tracer (99mTc) or contrast material. The SN is detected by imaging with SPECT/CT, which combines the advantages of SPECT and CT. SPECT/CT is a non-invasive imaging technique that utilizes the combination of a gamma camera and a CT scanner.

8.2 The Clinical Problem

The SPECT/CT procedure is based on the hypothesis that the SN is the sentinel lymph node that drains a regional lymphatic basin. This hypothesis states that the lymphatic drainage of the lymph node is a direct route from the primary tumor to the sentinel lymph node (i.e., lymphatic duct or vessel). This SN is surrounded by a lymphoid tissue, although it is not necessarily the most distant lymph node. The SN is the sentinel lymph node drained by the sentinel lymphatic vessels from the primary tumor. The SN can be visualized and localized with radioactive tracer (99mTc) or contrast material. The SN is detected by imaging with SPECT/CT, which combines the advantages of SPECT and CT. SPECT/CT is a non-invasive imaging technique that utilizes the combination of a gamma camera and a CT scanner.
FIRST CHALLENGE

TO DEMONSTRATE THE ABILITY OF LYMPHOSCINTIGRAPHY TO IDENTIFY THE LYMPH NODES DIRECTLY DRAINING FROM THE SITE OF THE PRIMARY TUMOUR

FUNCTIONAL TRACERS

$99m^\text{Tc}$-nanocolloid

PHAGOCYTOSIS IN MACROPHAGES

PROLONGED DETECTION WINDOW

PREOPERATIVE LYMPHOSCINTIGRAPHY

SURGERY POSSIBLE THE SAME DAY OR THE DAY AFTER TRACER ADMINISTRATION
PREOPERATIVE LYMPHOSCINTIGRAPHY

- MELANOMA
- ORAL CAVITY
- PENILE CANCER
- VULVA
- TESTICLE

0-10 min DYNAMIC STUDY
15 min + 2 hours STATIC IMAGES
FOLLOWED BY SPECT/CT at 2 hours

PREOPERATIVE LYMPHOSCINTIGRAPHY

- BREAST
- PROSTATE
- CERVIX

15 min + 2-3 hours STATIC IMAGES
FOLLOWED BY SPECT/CT at 2-3 hours
PREOPERATIVE LYMPHOSCINTIGRAPHY

SEQUENTIAL IMAGING

EARLY IMAGES

TO DEPICT LYMPHATIC DUCTS AND EARLY DRAINING NODES

DELAYED IMAGES

TO DIFFERENTIATE EARLY DRAINING NODES FROM SECONDARY NODES
&
TO DEPICT OTHER SN IN DIFFERENT BASINS

OVERESTIMATION NUMBER SN
PREOPERATIVE LYMPHOSCINTIGRAPHY

SEQUENTIAL IMAGING

EARLY IMAGES TO DEPICT LYMPHATIC DUCTS AND EARLY DRAINING NODES

UNDERESTIMATION NUMBER SN

TO DIFFERENTIATE EARLY DRAINING NODES FROM SECONDARY NODES & TO DEPICT OTHER SN IN DIFFERENT BASINS

DELAYED IMAGES
PREOPERATIVE LYMPHOSCINTIGRAPHY

IDENTIFICATION SENTINEL NODES

INTERPRETATION CRITERIA

VISUALIZATION OF LYMPHATIC DUCTS
MOMENT OF APPEARANCE
LYMPH NODE BASIN
INTENSITY LYMPH NODE UPTAKE
CRITERIA

- **DEFINITIVELY SN**
  - Own lymphatic duct
  - Single draining lymph node

- **HIGHLY PROBABLE SN**
  - Node appearing between injection site and early draining node
  - Lymph node with increasing uptake

- **LOW PROBABLE SN**
  - Nodes with less uptake appearing distal from early draining node in a basin
SPECT-CT

MATRIX 128
30 sec/frame (40 frames)
ITERATIVE RECONSTRUCTION
(FLASH, 4 SUBSETS, 8 ITERATIONS)

LOW DOSE - 40 mAs
130 kV, Kernel B30s medium
SLICES ±2 mm (head/neck, pelvis)
5mm (axilla, groin)

CORRECTION
ATTENUATION/SCATTER
SPECT-CT FUSION

SPECT/CT
ORTHOGONAL MULTIPLANAR RECONSTRUCTION (MPR)
SPECT-CT
MAXIMUM INTENSITY PROJECTION (MIP)
FUSED IMAGES MPR

SPECT-CT
VOLUME RENDERING
3D

ADJUSTMENT COLOUR SCALE VALUES 16-BIT CLUT (color look up table)
GRAPHICAL 3D > MUSCLE=RED  SKIN/FAT=BLUE  BONE=YELLOW
SENTINEL NODE=OCHRE-YELLOW
59% (29/49) VISUALIZATION IN OBESE PATIENTS WITHOUT SN VISUALIZATION ON PLANAR IMAGES

ADDITIONAL VALUE SPECT-CT

BREAST CANCER 42% (48/134)

INCISION ADJUSTMENT and/or (19) ADDITIONAL SNs (AXILLARY, INTERPECTORAL, INTRAMAMMARY) 4 TUMOR (+) SN

BREAST CANCER RECURRENCE

A

B

C

D

E

F
Melanoma

SPECT-CT improves anatomical SN recognition does not replace lymphoscintigraphy