New surgical approaches in melanoma, breast and gynaecological cancers by using nuclear medicine devices

Dr. Sergi Vidal-Sicart
19 July 2010
CURRENT RADIOGUIDED SURGERY

Sentinel node biopsy
Melanoma
Breast cancer
Gynecologic cancers

ROLL (SNOLL)
CURRENT RADIOGUIDED SURGERY

Sentinel node in breast cancer procedural guidelines

EANM-EORTC general recommendations for sentinel node diagnostics in melanoma
Eur J Nucl Med Mol Imaging 2009; 36: (on line)

EANM-SENT Joint practice guidelines for radionuclide lymphoscintigraphy for sentinel node localization in oral/oropharyngeal squamous cell carcinoma
(will be available soon)
Implementation of sentinel node biopsy in breast cancer patients in the Netherlands
Once upon a time...
LYMPHOSCINTIGRAPHY EVOLUTION
LYMPHOSCINTIGRAPHY EVOLUTION
SENTINEL NODE EVOLUTION

More than 90% SNL localization


IAEA
SENTINEL NODE IDENTIFICATION

Melanoma >99%

Breast cancer >90%

Head & Neck cancer >85%
(oral, tongue, pharynx, larynx, thyroid)

Gynecological cancer >90%
(vulva, cervix, endometrium)

Urological cancer >90%
(prostate, bladder, penis, testicular)

LYMPHOSCINTIGRAPHY LIMITATIONS

Planar images
Lymphatic basins (localization, number)
Nodes (localization, number, activity)
Lymphatic channels
Sentinel node and second echelon nodes
Skin marking

¿SLN depth?
¿Anatomical relationships?
¿How many nodes?
¿Surgical approach?
¿Lymphatic drainage absence?
No drainage (or faint uptake)

Anatomic references
What is the anatomical localization?
LYMPHOSCINTIGRAPHY LIMITATIONS

Patient positioning
LYMPHOSCINTIGRAPHY LIMITATIONS

Patient positioning
The dark side of the node
Identification and harvesting of 100% cases SLN in “difficult” locations
NEW APPROACHES IN RADIOGUIDED SURGERY

HYBRID IMAGE

REAL-TIME IMAGE
## Pros
- Surgical planning
- More SLN
- Reduction of surgical time
- Lesser SLN non-visualization
- Nodes closer to injection site
- Lesser false (+) and (-) cases
- Deep nodes

## Cons
- Cost and added time
- Additional radiation
- Non suitable for dynamic studies
- More difficult skin location
- More SLNs harvested

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Gallowitsch HJ et al. Nuklearmedizin 2007; 46: 252-256
SPECT-CT documented benefits over conventional images

Better SLN localization in obese patients
Reduction in SLN nonvisualization percentage
Better anatomical depiction (interpectoral, extraaxillary nodes)
Better SLN depiction in upper outer quadrant tumours

OTHER SPECT-CT ADVANTAGES

- Pectoral Major
- Pectoral Minor

23.8 mm

45.5 mm

40.4 mm

38.9 mm
Additional lymph node visualization up to 43% cases
Accuracy in node location and better surgical approach
Better “in transit” and masked (“shine-through“) nodes depiction

NO “extra value” in limbs melanoma drainage

van der Ploeg IMC et al. Ann Surg Oncol 2009; 16; 1537-1542
SPECT-CT in other malignancies

Haerle SK. Ann Surg Oncol 2009 (on line)


Pandit N et al. Gynecol Oncol 2010 (in press)

SPECT-CT reviews

A review on the clinical uses of SPECT/CT

Giuliano Mariani · Laura Bruselli · Torsten Kuwert · Edmund E. Kim · Albert Flotats · Ora Israel · Maurizio Dondi · Naoyuki Watanabe

REVIEW

SPECT/CT for Preoperative Sentinel Node Localization

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WILLEM MEINHARDT, MD, PhD,° W. MARTIN C. KLOP, MD, PhD,°°° BERN B R. KROON, MD, PhD,°°°
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3Department of Urology, The Netherlands Cancer Institute, Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands
4Department of Head and Neck Surgery, The Netherlands Cancer Institute, Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands
SPECT/CT EXPERIENCE IN SLN

Period June 2007-September 2009  200 SPECT-CT

ORAL CAVITY  2  
VULVA  8  
CERVIX  21  
ENDOMETRUM  32  
BREAST  78  
MELANOMA  59  

Head & Neck  22  
Thorax  20  
Abdomen  11  
Limbs  6  

IAEA
**SPECT/CT EXPERIENCE IN SLN**

**PROCESSING ASPECTS**

- **[SPECT Options]**
  - Online customization for
    - Iterative Reconstruction (OSEM/MLEM)
    - FBP
  - Filter gallery

- **Options -> Save Customization**
  - Filters are saved for future use with the selected study type and dataset type

**Note:**
must be adjusted for each:
- Study type
- Dataset type
SPECT/CT EXPERIENCE IN SLN

TECHNICAL ASPECTS

<table>
<thead>
<tr>
<th></th>
<th>SPECT</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition lasting</td>
<td>19 min</td>
<td>5 min</td>
</tr>
<tr>
<td>Workstation processing</td>
<td>10-20 min</td>
<td></td>
</tr>
</tbody>
</table>
PROCESSING ASPECTS

For a better lymph node depiction a very filtered process is not necessary

Our results are better with ITERATIVE RECONSTRUCTION method (by increasing the iterations number).

What is our scheme?

OSEM reconstruction
No pre and post filter
Scatter correction is not always necessary (Gynecologic cancers)
Iterations 5
Subsets 20
## RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Visualization</th>
<th>Regions</th>
<th>SLN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Planar</td>
<td>SPECT-CT</td>
<td>Planar</td>
</tr>
<tr>
<td>VULVA</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>CERVIX</td>
<td>11</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>ENDOMETRUM</td>
<td>10</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>BREAST</td>
<td>47</td>
<td>46</td>
<td>63</td>
</tr>
<tr>
<td>MM Head &amp; Neck</td>
<td>13</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>MM Thorax</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>MM Abdomen</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>MM Limbs</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

N = 103
# SPECT/CT EXPERIENCE IN SLN

## RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Planar</th>
<th>SPECT-CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Visualization</td>
<td>99/103 (96%)</td>
<td>102/103 (99%)</td>
</tr>
<tr>
<td>Drainage areas</td>
<td>133</td>
<td>139</td>
</tr>
</tbody>
</table>

- Same drainage: 90 patients
- Higher SLN number: 12 patients
- Subjective surgeon's evaluation: SPECT-CT better - 75%
- Surgical approaching change: - 21% cases
SPECT/CT EXPERIENCE IN SLN

Posterior view. Dynamic study

Delayed images (3 h)

Left Scapular MM
SPECT/CT EXPERIENCE IN SLN

Inner lower Breast cancer
SPECT/CT EXPERIENCE IN SLN

Vulva

Cervix
SPECT/CT EXPERIENCE IN SLN

Endometrium

30 min

2 h
SPECT-CT

Pros

Surgical planification
More SLN
Surgical time reduction
Lesser SLN nonvisualization
SLNs closer to tracer injection
Lesser false (+) images
Deep nodes

Cons

Additional cost and time
Additional radiation
Non suitable for dynamic studies
Skin marking difficult
More SLN excised

INDICATIONS

Unusual drainage patterns (extraaxillar, several lymphatic basins...)

Planar lymphoscintigraphic images difficult to interpret (low activity, injection closer to nodes, depth...)

SLN nonvisualization during conventional lymphoscintigraphy

When it can be done (huge workload)

Gynecologic tumours

SPECT-CT
Radioguided surgery can evolve with image devices application during the surgical procedure.
• Can be used for quick and precisely tracking the relative activity of very small organs like lymph nodes.
• This equipment is very portable, even someone is cordless.
• This equipment permit an easy access to any part of the body.
• Probes don’t provide image information, and can’t easy assure that no other hot node remain undetected.
• Using probes in surgical room has the requirement of pre-surgical exploration made by a gamma camera.
PORTABLE GAMMA CAMERAS

Small field of view, high-resolution, portable γ-camera for axillary sentinel node detection


Nucl Instrum Meth Phys Res 2006; 569: 273-276

Precise Localization of Sentinel Lymph Nodes and Estimation of Their Depth Using a Prototype Intraoperative Mini γ-Camera in Patients with Breast Cancer

Carole Mathelin, Samuel Salvador, Daniel Huss, and Jean-Louis Guyonnet

1Service de Gynécologie-Obstétrique, Hôpital Civil, CHRU, Strasbourg, France; and 2Institut Pluridisciplinaire Hubert Curien, UMR 7179-CNRS/INSERM et ULP, Strasbourg, France

Validation Project of a Portable Gamma camera

Device optimization for a clinical use
Validation Project of a Portable Gamma camera

Device optimization for a clinical use
Validation Project of a Portable Gamma camera

Device optimization for a clinical use

Software modifications
Validation Project of a Portable Gamma camera

Comparison with a hand-held gamma probe
Comparison with a hand-held gamma probe

This portable Gamma camera is, approximately, 75% more sensitive than gamma probe when 4 mm pin-hole collimator is used but is 30% lesser sensitive than gamma probe when 2.5 mm collimator is used.

In phantom study, SLN detection was quite similar between gamma camera and gamma probe when the “node” activity was high. When the “node” activity was poor, portable gamma camera located it quicker than gamma probe (in vitro test).

<table>
<thead>
<tr>
<th>Activity (µCi)</th>
<th>t median (s) camera</th>
<th>t median (s) probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>46</td>
<td>72</td>
</tr>
<tr>
<td>2.4</td>
<td>71</td>
<td>96</td>
</tr>
</tbody>
</table>
Left malar (Breslow 2.2mm Clark V) malignant melanoma
Right upper limb malignant melanoma

Conventional Gamma camera

Pre-surgical

Surgery
Right heel melanoma
Right heel melanoma
Portable Gamma camera in melanoma

Real time SLN identification
Useful in surgical room
SLN harvesting assessment
Head & neck MM and special cases
Complementary to the hand-held gamma probe
CLINICAL APPLICATION

ANT IMC

ANT axilar

OBLIQUE axilar

LATERAL Axilar
Positioning and acquisition

High count nodes: OK
Thin patients: OK

Ant AX pos | Ant AX Acq | IMC pos | Lat pos | Lat adq | Oblique pos | Oblique adq
Closely active nodes
Satisfactory visualization
Elderly patients (> 70 year old)
Huge volume breasts
Fatty axillas

SLN with poor activity
Intraoperative evaluation of Intercostal space
CLINICAL APPLICATION

Intrammammary nodes
CLINICAL APPLICATION

ROLL
Centered lesion

Involved margins
<table>
<thead>
<tr>
<th></th>
<th>Free margins</th>
<th>Involved margins</th>
<th>Concordant results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centered</strong></td>
<td>15</td>
<td>8</td>
<td>15/23 65%</td>
</tr>
<tr>
<td><strong>Non centered</strong></td>
<td>7</td>
<td>8</td>
<td>8/15 53%</td>
</tr>
<tr>
<td><strong>In contact</strong></td>
<td>1</td>
<td>3</td>
<td>3/4 75%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>26/42 62%</strong></td>
</tr>
</tbody>
</table>

Portable Gamma camera in breast cancer

Real time SLN identification (active)
Useful in surgical room
SLN excision assessment
Useful in IMC and concrete cases
Complementary to hand held gamma probe
CLINICAL APPLICATION
CLINICAL APPLICATION
306 explorations with portable GC

Breast: 180
Melanoma: 89
Cervix: 11
Endometrium: 12
Vulvar: 13
Tongue: 1

**BREAST CANCER**

Pre-surgical assessment 165
Surgical Assessment 85
Correct portable GC SN Visualization 72 (85%) (learning curve)
Correct probe localization 83 (98%)
Portable GC better results 8 (IMC/IM)

**MELANOMA**

Pre-surgical assessment 89
Surgical Assessment 20
Correct portable GC SN Visualization 20 (100%)
Correct probe localization 19 (95%)
Portable GC better results 4 (In transit SN, submandibular)
<table>
<thead>
<tr>
<th>Surgical experience</th>
<th>Visualization</th>
<th>pGC/Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>VULVA</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>CERVIX</td>
<td>12/11</td>
<td>11/11</td>
</tr>
<tr>
<td>ENDOMETRIUM</td>
<td>8/7</td>
<td>7/8</td>
</tr>
</tbody>
</table>
Factors Affecting the Successful Mapping on Lymphoscintigraphy

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>n</th>
<th>Radiotracer</th>
<th>Rate*</th>
<th>Factor**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marchal F (2005)</td>
<td>201</td>
<td>$^{99}$mTc-sulfur colloid, 37MBq</td>
<td>72.2%</td>
<td>Age, injection site of radiotracer, localization of the tumor</td>
</tr>
<tr>
<td>Chakera AH (2005)</td>
<td>442</td>
<td>$^{99}$mTc-nanocolloidal albumin, 10–168MBq</td>
<td>87%</td>
<td>Age, body weight, injection site of radiotracer</td>
</tr>
<tr>
<td>Goyal A (2005)</td>
<td>823</td>
<td>$^{99}$mTc-nanocolloidal albumin, 40MBq</td>
<td>72%</td>
<td>Age, BMI, tumor size, localization of the tumor, SLN identification rate, No. of removed SLNs</td>
</tr>
<tr>
<td>Lo YF (2008)</td>
<td>232</td>
<td>$^{99}$mTc-sulfur colloid, 37MBq</td>
<td>88.4%</td>
<td>Tumor size, lymph node metastasis</td>
</tr>
<tr>
<td>Rousseau C (2004)</td>
<td>280</td>
<td>$^{99}$mTc-sulfur colloid, 30–40MBq</td>
<td>78.6%</td>
<td>Age, SLN identification rate, No. of removed SLNs, radioactivity content in SLN</td>
</tr>
</tbody>
</table>

BMI = body-mass index is the height/weight ratio, calculated by body weight (kg) divided by the square of the height (m).
* Rate of nonvisualized cases on lymphoscintigraphy.
** Factor associated with a failed axillary mapping on lymphoscintigraphy.
Symbiotic approachment to refining the radioguided surgery (case selection)

Pre-surgical lymphoscintigraphy
Hand-held gamma probe
Blue dye

Pre-surgical SPECT-CT
Intraoperative assessment with portable gammacamera

THANK YOU
FOR YOUR KIND ATTENTION