The Concept of GOSTT

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Changing paradigms in radioguided surgery and intraoperative imaging: the GOSTT concept

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GOSTT

(radio)Guided
intraoperative
scintigraphic
tumor
Targeting
Radioguided Surgery

- Surgical procedures involving preoperative “labeling” of the target tissue with adequate radiopharmaceutical.
- Intraoperative guidance with a radioactivity-detecting probe facilitates identification of the target tissue to be removed.
- Intrinsic features include minimal surgical access and probe-aided assessment of the completeness of excision.
- The radiopharmaceutical is either a lymphotropic, non-tumor-specific agent injected interstitially (for sentinel lymph node biopsy) and/or an agent with preferential accumulation in a tumor lesion following interstitial or systemic administration.
Radioguided Surgery

A new concept in Nuclear Medicine?
THE USES OF NUCLEAR DISINTEGRATION IN THE DIAGNOSIS AND TREATMENT OF BRAIN TUMOR*

WILLIAM H. SWEET, M.D.†

BOSTON
Figure 1. Robinson-Type Probe Counter.
Only the tiny cylindrical shaft (2 mm. in diameter) enters the brain; the radiation-sensitive portion of this shaft begins 5 mm. from the tip and extends toward the hub for 13 mm.
**TABLE 2. Brain Tumors Localized with Probe Counter Using P^{32}.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct localization (60 demarcated)</td>
<td>105</td>
</tr>
<tr>
<td>Uncertain localization</td>
<td>1</td>
</tr>
<tr>
<td>False negative (1 avoidable)</td>
<td>4</td>
</tr>
<tr>
<td>False positive</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>114</strong></td>
</tr>
</tbody>
</table>
Non-imaging, intrinsically “digital” Nuclear Medicine
Contributions of Nuclear Medicine to Radioguided Surgery

• Late 1940s: pioneering experience with intraoperative $\beta^-$ counting probes (digital display only).

• Early 1980s: adding a new intraoperative sense to the surgeon for radioimmunoguided surgery (sound pitch proportional to activity level).

• Early 2000s: intraoperative imaging probes and hybrid imaging (preoperative SPECT/CT).

• Early 2010s: growing integration of all modalities, including intraoperative optical imaging.
Changing Times in Medicine

The New England Journal of Medicine

Volume 245  December 6, 1951  Number 23

The Uses of Nuclear Disintegration in the Diagnosis and Treatment of Brain Tumor  875
William H. Snell

Unusual Arteriographic Findings of the Lower Limb  888
Floyd C. Leonard and George A. Vassos

Bisected Lobotomy  888
Julius Levene, Milton Steinhardt and Harry C. Solomon

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Remember this term?

Back in 1876 when Eli Lilly and Company had just begun—nearly everything was less complex than now. An exception was the practice of writing elaborate prescriptions, often with twenty or more ingredients. Because this allowed considerable chance for error, physicians were accustomed to mark any unusual dose with the abbreviation Q.R., for quoniam rectum meaning "correct amount." The physician thus gave assurance that the amount stated was what he had intended.

In recent years, with the advent of more specific medicines and less involved prescriptions, the use of this term has nearly vanished. However, the Red Lilly label on a pharmaceutical container continues to be as assurance that the contents are exactly as stated; the Red Lilly—like the abbreviation Q.R.—is a verification of accuracy.

Lilly  E I LILLY AND COMPANY  INDIANAPOLIS 6, INDIANA, U.S.A.
Fundamental Forces Driving the Growth of Radioguided Surgery

- Oncologic surgery becoming as less invasive/mutilating as possible.
- The emerging concept of the sentinel lymph node in oncologic surgery for staging parameter “N”.
- Growing applications of non-sentinel lymph node radioguided surgery with different approaches to tumor targeting (interstitial or systemic routes).
- Growing applications of robotic surgery.
- Growing collaboration of surgeons with other specialists (crucial).
radioguided surgery

radioimmunoguided surgery

Medline-based Search
Modalities for Localizing Anatomically the Sentinel Node on Lymphoscintigraphy

- Planar imaging without reference landmarks.
- Planar imaging with contour of the body by moving a radioactive point source.
- Planar imaging with transmission scan from a flood source beneath the patient’s body.
- SPECT.
- SPECT/CT.
- [Intraoperative imaging devices].
Breast Cancer
Breast Cancer
Breast Cancer
Breast Cancer
Melanoma
Melanoma
Melanoma
Melanoma
Melanoma in head and neck
Head and neck cancer
Head and neck cancer
Penile cancer
Penile cancer
Penile cancer
Cervical cancer
Endometrial cancer
Vulvar cancer
Prostate cancer
Prostate cancer
Testicular cancer
Testicular cancer
General Indications for SPECT/CT in Sentinel Lymph Node Biopsy

• In cases without visualization or with poor visualization of radiocolloid drainage at planar imaging. Due to the correction for tissue attenuation, SPECT/CT is more sensitive than planar imaging, and is in general particularly useful in obese patients.

• Identification of number, size, depth, and exact topographic localization of SLNs in areas with complex anatomy, such as the head and neck, or with unexpected lymphatic drainage patterns.

• Topographic localization and detection of additional SLNs in areas of deep lymphatic drainage such as the pelvis, abdomen, or mediastinum.
Added Values of SPECT/CT for Radioguided Sentinel Lymph Node Biopsy

Breast cancer

• faster intraoperative search and overall improved accuracy in 42% and 82% of patients, respectively;

• additional SLNs in 13%, unexpected drainage patterns in 21%, and false-positive sites in 9% of patients, respectively.

Cutaneous melanoma

• additional SLNs in 20%, better intraoperative search in 29%, and adjustment in surgical approach in 29%, respectively, with overall added value in 46% of patients (unselected group);

• adjustment in surgical approach in 36% of patients in a group with unclear/unexpected patterns of lymph drainage.
Intraoperative Imaging in Radioguided Surgery

• Dedicated small-field-of-view gamma cameras.

• High-resolution imaging based on advanced detection technologies compared to conventional gamma cameras.

• No role for actual intraoperative guide in the surgical bed (too bulky for surgical access).

• Important role for assessing completeness of removal, especially in locations close to the injection site.
Freehand SPECT imaging technology
used in CSS300 during surgery

Data with tracked non-imaging probe
- Non-uniform / non-symmetric set
- <180° covered
- Center depends on scan
- < 40 thousand events
$^{99m}$Tc-Sestamibi
$^{99m}$Tc-Sestamibi
$^{99m}$Tc-Sestamibi
Added Value of SPECT/CT versus SPECT for Parathyroid Surgery

- Large body of evidence indicating improved pre-operative localization of parathyroid adenomas.
- Sensitivity of SPECT/CT versus SPECT for localizing hyperfunctioning adenomas reported to be from moderately to markedly increased (in up to 40% of patients).
- Better specificity of SPECT/CT versus SPECT, even in patients with concomitant multinodular goiter and/or distorted anatomy because of prior surgery.
Growing Integration of Radioguidance with Other Intraoperative Imaging

• Bimodal radioactive and fluorescent agents.
• Promising perspectives especially in case of (robot-assisted) endoscopic surgery.