Nuclear Medicine in Oncology
Practice
2011

Radiopharmaceuticals

<table>
<thead>
<tr>
<th>Pharmaceutical</th>
<th>Radionuclide</th>
<th>Function</th>
<th>Tumor type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diphasphonates</td>
<td>Tc-99m, Ga-67</td>
<td>Osteoblast</td>
<td>Bone tumor &amp; metast.</td>
</tr>
<tr>
<td>Ga-citrate</td>
<td>Tc-99m, In-111</td>
<td>Osteosarcoma, melanoma, lymphoma, primary hepatoma</td>
<td></td>
</tr>
<tr>
<td>Labeled antibodies</td>
<td>Tc-99m, In-111</td>
<td>Cholangiocarcinoma, prostate, lymphoma, melanoma</td>
<td></td>
</tr>
<tr>
<td>Nal</td>
<td>I-131</td>
<td>Differentiated thyroid cc.</td>
<td></td>
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<tr>
<td>MIBG</td>
<td>Tc-99m, Ga-67</td>
<td>Neuroblastoma, pheochromocytoma</td>
<td></td>
</tr>
<tr>
<td>Pertechnetate</td>
<td>Tc-99m</td>
<td>Thyroid</td>
<td></td>
</tr>
<tr>
<td>Collide</td>
<td>Tc-99m</td>
<td>Liver</td>
<td></td>
</tr>
<tr>
<td>Ochrctide</td>
<td>In-111</td>
<td>Somatostatin analogues</td>
<td></td>
</tr>
<tr>
<td>DMSA(V)</td>
<td>Tc-99m</td>
<td>Medullary thyroid cc.</td>
<td></td>
</tr>
<tr>
<td>MIBI</td>
<td>Tc-99m</td>
<td>Mitochondrial Parathyroid, breast, etc.</td>
<td></td>
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<tr>
<td>FDG</td>
<td>F-18</td>
<td>glucose</td>
<td></td>
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<tr>
<td>Methylation</td>
<td>Se-75</td>
<td>Adrenal cortex</td>
<td></td>
</tr>
</tbody>
</table>

Neuroendocrine tumors

- I-123 (or I-131) MIBG:
  - in catecholamine storage granules (like norepinephrine)
  - adrenal medulla, sympathetic nervous tissue
- Indications:
  - suspected neuroendocrine tumors
  - Pheochromocytoma
  - Carcinoid tu.
  - Neuroblastoma in children
- Not while antihypertensive/antidepressant therapy
- In-111 Pentetreotide (Somatostatin analog)
  - metastases from neuroendocrine tumors
  - Pheochromocytoma (when antihypertensive/antidepressant therapy cannot be discontinued)
- Prognosis of possible Sandostatin therapy
- FDG (more expensive)

By tumor types

- Lymphoma: FDG (Ga-citrate: less sensitive)
- Lung: FDG (exclude cancer; staging)
- Melanoma: Lymphoscintigraphy: staging
  FDG: metastases
- Breast: MIBI: inconclusive X-ray; US
  FDG: staging, re-staging, response
- Colorectal, Ovarian: FDG: identify tu / met.
- Prostate: Prostascint (mAb): prognosis of planned therapy
- Bone scan: met.
- Thyroid cc: Nal
- Ti, MIBI, Ochrctide, FDG
  DMSA(V): medullary
cardiology

The changing focus of PET

PET applications worldwide
mid 80’s 2000

- neurology
- cardiology
- oncology

Indications: FDG PET

- Initial (preoperative) staging of cancer
- Differentiation between scar and residual tumor
- Demonstration of suspected recurrences
- Monitoring response to therapy
- Prognosis
- Radiotherapy treatment planning

Medicare Covered Indications

- Breast Cancer: Staging, restaging, and monitoring response to therapy
- Colorectal Cancer: Diagnosis, staging, and restaging
- Neuroendocrine Cancer: Diagnosis, staging, and restaging
- Head & Neck Cancers (excluding NO and HNS): Diagnosis, staging, and restaging
- Lung Cancer (Non-Small Cell): Diagnosis, staging, and restaging
- Thyroid: Diagnosis, staging, and restaging
- Malignant glioma (surgical margin evaluation of resected tumor): Diagnosis, staging, and restaging
- Myocardial viability: Diagnosis, staging, and restaging
- Bladder, Prostate, Rectal, & Gynecologic: Diagnosis, staging, and restaging
- Pericardial effusion: Diagnosis, staging, and restaging

What is PET good for?

- Traditional imaging:
  - Shows only major structural changes
  - Relatively not sensitive to identify neoplasms
  - Only delayed visualization of response to therapy

FDG PET:

- “Enlights” cancer
- Shows metabolic response to therapy
Role of PET in diagnosing tumors

Review of literature on FDG PET (26 000 studies, all kinds of tumor)

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
<th>Impact on therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>86 %</td>
<td>90 %</td>
<td>89 %</td>
<td>30 %</td>
</tr>
</tbody>
</table>

SENSEITIVITY AND SPECIFICITY OF PET AND CT IN CANCERS

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity [Detects cancer?]</th>
<th>Specificity [Detects only cancer?]</th>
<th>Change in Patient Management Due to PET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>PET CT</td>
<td>PET CT</td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>98% 67%</td>
<td>73% 76%</td>
<td>37%</td>
</tr>
<tr>
<td>Staging</td>
<td>92% 61%</td>
<td>91% 95%</td>
<td>31%</td>
</tr>
<tr>
<td>Rectal</td>
<td>98% 72%</td>
<td>92% 95%</td>
<td>16%</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>93% 77%</td>
<td>85% 68%</td>
<td>31%</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>89% 80%</td>
<td>93% 73%</td>
<td>21%</td>
</tr>
<tr>
<td>Staging</td>
<td>83% 63%</td>
<td>95% 73%</td>
<td>16%</td>
</tr>
<tr>
<td>Melanoma</td>
<td>84% 88%</td>
<td>91% 75%</td>
<td>26%</td>
</tr>
</tbody>
</table>

Why PET/CT?

Limitations of PET:
- Limited anatomical details
- Low spatial resolution
- Time consuming (related to CT and X-ray)
- Not generally acknowledged among docs

PET/CT advantages:
- Adds anatomic details to PET
  - less false positive
- Shorter imaging time (decay correction)
- Better known by docs

CT, or PET + CT?


<table>
<thead>
<tr>
<th></th>
<th>PET+CT</th>
<th>CT alone</th>
</tr>
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<tbody>
<tr>
<td>Diagnostic accuracy</td>
<td>87 %</td>
<td>59 %</td>
</tr>
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<thead>
<tr>
<th></th>
<th>PET+CT</th>
<th>Only CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>93 %</td>
<td>75 %</td>
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<td>95 %</td>
<td>63 %</td>
</tr>
<tr>
<td>Accuracy</td>
<td>94 %</td>
<td>68 %</td>
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</tbody>
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Questions:
- Which function?
- Organ or tissue?
- Planar or tomographic?
- View / slicing
- Abnormality
- Opinion

Tu #1
Dg.: Papillary carcinoma of thyroid gland. Met?
99mTc MIBI

Better Localisation Equals Better Treatment Planning

- Newly diagnosed NSCLC
- PET/CT used to guide radiation treatment volume
- Discrpezancy between PET and CT volumes related to respiratory excursion

Better delination of physiological uptake

- Appreciation of normal or variant FDG uptake
- Better understanding and interpretation of FDG PET scans

Questions:

Tu #1
Dg.: Papillary carcinoma of thyroid gland. Met?
99mTc MIBI

Anterior
Posterior

Univ. Debrecen, Dep. of Nucl. Med.
Tu. #2 Medullary thyroid carcinoma. Met?

18F-FDG PET

Tu. #3. Parathyroid adenoma?

Univ. Debrecen, Dep. of Nucl. Med.

Tu #4. FDG PET

Right middle lobe NSCLC. Met?
Liver CT: suspicious lesion  CT-guided biopsy: non diagnostic
Bone scan: suspicious accumulation in a thoracal vertebra

images courtesy of F. Benard, M.D., HUP Philadelphia

Tu #5 FDG PET

Tu. #6 Solitary melanoma. Met?

FDG PET

Tu #7

Breast scintigraphy: 99mTc-MIBI

Ant

RPO 30

Univ. Debrecen, Dep. of Nucl. Med.

Tu #8

Breast scintigraphy: 99mTc MIBI

Tu #9

Breast tu?

FDG-PET

images courtesy of F. Benard, M.D., HUP Philadelphia

DEOEC PET Centrum

NM in Oncology

2011

2011

2011

2011

2011

2011

2011

2011

2011
Tu #10. Sentinel node
Preoperative imaging

Tu #11
Tu mammæ. Met?
Methionine PET

Tu #12. FDG PET
St. p. op. Colorectal carcinoma
Recurrence?

Tu #13
Pancreas carcinoma?
FDG PET

Tu #14 Octreotide scintigraphy

Tu #15: $^{111}$In Octreotide
SPECT slices

Tu #16
Hodgkin’s lymphoma
$^{67}$Ga-citrate whole body scintigram

Tu #17 Hodgkin’s lymphoma
FDG-PET
Tu #18. Malignant melanoma?
FDG PET
97-12-12
98-6-10
DEOEC PET Centre

Tu #19. Prostata cc. Met?
Tc-99m HEDP bone scintigram

Tu #20. Mamma cc. Met?
Tc-99m HEDP bone scintigram

Tu #21. Anti-granulocyte MoAb scintigram Met.