IAEA RTC
PET/CT imaging of head & neck cancer

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Glucose metabolism and FDG uptake

Glucogen

Pentoses-P

Glicolisis

18FDG
18FDG-6P
18FDG-1P
Lack of group OH in C2
PGmutase
Isomerase
TRAPPED
TRACER
18FDPGL
G6PDH
HK
G6Pase
18FDG

6LUT-1
FDG uptake

SUVmax=4.8  SUVmax=5.6

FDG PET/CT imaging of head & neck cancer

False positive

- Surgical Procedures
  - Biopsy, dental care
- Infection
  - Sinusitis, abscess, TB, sarcoidosis, parodontitis.
- Radiation-induced injury
- Tiroiditis
- FDG uptake in muscles
  - Stress
  - Crying, speech
  - Chewing
- Brown fat

PET/CT facilitates the interpretation
FDG PET/CT imaging of head & neck cancer
Indications FDG

- Staging
  - Carcinoma of unknown primary
  - Detection of lymph node metastases
  - Detection of distant metastases
  - Detection of second primary tumours
- Treatment Planning
  - Treatment monitoring
  - Detection of disease recurrence

Hustinx R, et al. EJNM Mol Imaging 2010;37:645-651

FDG PET/CT. Carcinoma of unknown primary:
Lymph node metastases from squamous cell carcinoma

- FDG PET overall success is around 27%
  - PET/CT is around 50%

SUV_{max}=11.2
Undifferentiated Ca.

SUV_{max}=4.1
Right vocal cord
FDG PET/CT. Carcinoma of unknown primary: Lymph node metastases from squamous cell carcinoma

- FDG PET overall success is around 27% after all other modalities have failed
  - PET/CT is around 50%
- False positive after recent biopsy
  - Exhaustive conventional evaluation:
    - TC, endoscopy, biopsy

<table>
<thead>
<tr>
<th></th>
<th>PET +</th>
<th>TP</th>
<th>FP</th>
<th>FN</th>
</tr>
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<tbody>
<tr>
<td>Nasopharynx</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>12</td>
<td>5</td>
<td>7</td>
<td>2</td>
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<tr>
<td>Hypopharynx</td>
<td>6</td>
<td>5</td>
<td>1</td>
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<td>Maxilar sinus</td>
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<td>0</td>
<td>1</td>
<td></td>
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<td>Lung/mediastinum</td>
<td>3</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Axila</td>
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<tr>
<td>Bone</td>
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<tr>
<td>Rectum</td>
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<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>Abdomen/multiple</td>
<td>4</td>
<td>2</td>
<td></td>
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<tr>
<td>Total</td>
<td>33/60</td>
<td>18</td>
<td>13</td>
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</table>

**FDG PET/CT. Carcinoma of unknown primary :**
Lymph node metastases from squamous cell carcinoma

- FDG PET overall success is around 27% after all other modalities have failed
  - PET/CT is around 50%

- False positive after recent biopsy
  - Exhaustive conventional evaluation:
    - TC, endoscopy, biopsy

- Non-squamous, less frequent
  - Salivary gland cancer

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**FDG PET/CT imaging of head & neck cancer**
Staging (T)

- Primary tumor identification: comparable to CT/RM
  - Limitation: small tumors (≤ 8-10 mm)

- Advantage: evaluation of submucosal extension
  - PET may understate

- Differentiation between tumor mass and mucus secretion / inflammation in sinonasal tumors.

- Limitation: spatial resolution
  - PET do not report invasion of cartilage or perineural tissue.

**PET/CT**
FDG PET/CT imaging of head & neck cancer
Staging (N)

- Detection of nodal infiltration: FDG PET/CT improvement over CDT (CT and MRI)

**Eppiglotic Epidermoid Tumor**

- SUV\text{max}=6.9
- SUV\text{max}=4.7

FDG PET/CT imaging of head & neck cancer
¿why metabolic imaging?

- Nodal staging with conventional diagnostic techniques (CDT) is suboptimal.
  - FDG PET/CT in cN0?
- The under- and over-staging may compromise tumor control and/or treatment effectiveness.
- The biological heterogeneity has a major impact on tumor response to chemotherapy and radiation therapy.
- The interpretation of CDT after treatment is difficult due to loss of normal anatomical planes, and the presence of oedema, inflammation and fibrosis.
**18F-FDG PET/CT for detecting nodal metastases in patients with oral cancer staged N0 by clinical examination and CT/MRI.**

### Distribution of Findings

<table>
<thead>
<tr>
<th>Patients with N0 neck who underwent elective neck dissection</th>
<th>Neck dissections (26 unilateral, 5 bilateral)</th>
<th>38 neck sides</th>
<th>142 nodal levels</th>
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</thead>
<tbody>
<tr>
<td>31 patients with N0 neck underwent elective neck dissection</td>
<td>38 neck sides</td>
<td>142 nodal levels</td>
<td></td>
</tr>
<tr>
<td>9 metastatic</td>
<td>27 negative</td>
<td>9 metastatic</td>
<td>133 negative</td>
</tr>
<tr>
<td>6 PET +</td>
<td>4 PET +</td>
<td>6 PET +</td>
<td>8 PET +</td>
</tr>
<tr>
<td>3 PET -</td>
<td>23 PET -</td>
<td>3 PET -</td>
<td>127 PET -</td>
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</tbody>
</table>

**Sensitivity:** 67%

**Specificity:** 85%

**Sensitivity:** 67%

**Specificity:** 95%

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**FDG PET/CT VP**

**Ca. oral tongue**

**SUV\text{max}=4,4**

FDG PET/CT false + (lymphocytes)

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In studies in which both 18F-FDG PET and conventional diagnostic tests were performed, sensitivity and specificity of 18F-FDG PET were 80% and 86%, respectively, and of conventional diagnostic tests were 75% and 79%, respectively.


FDG PET/CT:
Estadificación ganglionar

- FDG PET/CT higher sensitivity than CT and MR
  - Detection of lymph node metastases ≥ 5 mm
    - S=80% y Sp=86%
  - In patients with a clinically negative (cN0) neck
    - S=50% in cN0

Sentinel node biopsy
FDG PET/CT: Distant metastases

Ca. undifferentiated of the larinx. Recurrence

FDG PET improves staging and patient management

  - Recommendations on the use of 18F-FDG PET in oncology

  - Prospective, 71 patients
  - FDG PET detects added lesions in 40%
  - FDG PET changes clinical management in 34%

- Lonneux M. J Clin Oncol 2010; 28:1190-1195
  - Multicenter, prospective study, 233 patients
  - PET-FDG altered the management of 13.7% of patients (32/233)
FDG PET/CT: Epidermoid tumor in the larynx
Second primary epidermoid: lung
FDG PET/CT: Larynx carcinoma
Second primary: adrenal cortex carcinoma

FDG PET/CT: Treatment monitoring

- FDG PET has a higher diagnostic yield than CDT
FDG PET/CT: Treatment monitoring

FDG PET/CT en tumores de cabeza y cuello
Valoración precoz de respuesta
**FDG PET/CT: Treatment monitoring**

- **FDG PET/CT higher** **prognostic value** than TDC
  - Connell CA. Head & Neck 2007
    - A complete metabolic response was predictive of overall survival (OS)
  - Hentschel M. Eur J Nucl Med Mol Im 2011;38:1203-1211
    - Prospective, 37 patients
    - Early FDG PET at 10 or 20 Gy under chemoradiotherapy
    - The decrease of SUVmax > 50% is prognostic for **OS, DFS y LRC**
  - Castaldi P. Radiotherapy Oncol 2012; 103:63-68
    - Prospective, 26 patients
    - PET-FDG baseline - 2 weeks - 8-12 weeks
    - Only PET-FDG 8-12 weeks predicts **DFS y DSS** (disease specific S)

**FDG PET/CT: Treatment monitoring (Chemo and Radion therapy)**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>N</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>PNV</th>
<th>Interval</th>
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<tr>
<td>Wong RJ</td>
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<td>143</td>
<td>Local: 97</td>
<td>Local: 79</td>
<td>54</td>
<td>99</td>
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<td></td>
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<td></td>
<td>Regional: 92</td>
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<td>77</td>
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<tr>
<td>Yao M</td>
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<td>85</td>
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<td>98</td>
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<td>Regional: 100</td>
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<td>78</td>
<td>100</td>
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<tr>
<td>Porceddu SV</td>
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<td>12 weeks</td>
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<td>103</td>
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<td>Local: 89</td>
<td>54</td>
<td>98</td>
<td>8 weeks</td>
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<td>Regional: 95</td>
<td>75</td>
<td>96</td>
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<td>36</td>
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<td>59</td>
<td>98</td>
<td>4 weeks</td>
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<td>Regional: 100</td>
<td>Regional: 99</td>
<td>83</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
FDG PET/CT imaging of head & neck cancer:
Detection of disease recurrence

- Previous treatments produce distortion
  - Mucosal surfaces
  - Tissue planes
  - Anatomical structures
- Difficulty in interpreting CDT
  - Soft tissue edema
  - Inflammation
  - Fibrosis
- Early detection of recurrence increases the likelihood of effective treatment.

FDG PET/CT imaging of head & neck cancer:
Detection of disease recurrence

- FDG PET higher diagnostic accuracy than CT/MRI

Laryngectomy
Uncertain recurrence

SUVmax=6.8
FDG PET/CT imaging of head & neck cancer: Detection of disease recurrence

- FDG PET higher diagnostic accuracy than CT/MRI
  - Treatment planning includes surgery, radiation, chemotherapy or combinations
  - FDG PET/CT changes the management in up to 1/3 patients
- Limitation: false positive (Radiotherapy)
  - Chen AY, Head Neck 2006
- Under investigation
  - SUV cut-off value
PET/CT imaging of head & neck cancer:
New radiopharmaceuticals

- Amino acids: $^{11}$C- methionine
  - Radiation Therapy Planning
  - Salivary gland function (IMRT)

- Hipoxy: $^{18}$F- MISO
  - Radiation Therapy Planning
  - Predictive value (response)

- Proliferation: $^{18}$F- FLT
  - Monitoring treatment

- New therapeutic targets:
  - EGFR
  - $^{64}$Cu – EGFR
  - Angiogenesis
  - $^{11}$C – VEGFR y $^{18}$F-galacto-RGD

FDG PET/CT imaging of head & neck cancer:
Summary

- Tumor localization (unknown primary tumor)

- Tumor staging
  - Cervical lymph node staging (cN0)
  - Distant metastasis
  - Detection of synchronous second primary tumors

- Radiation therapy planning

- Metabolic response / Residual disease

- Recurrence
  - High diagnostic accuracy
  - Early detection of recurrence

- New radiopharmaceuticals
  - New therapeutic targets