IAEA RTC
PET/CT imaging of head & neck cancer

Maria José García Velloso
Servicio de Medicina Nuclear
Clínica Universidad de Navarra
mjgarciave@unav.es

Glucose metabolism and FDG uptake

\[ \text{Glucogen} \]

\[ \text{Glicolisis} \]

\[ \text{Pentoses-P} \]

Lack of group OH in C2

1^8FDG-1P

1^8FDG-6P

1^8FDPGL

GLUT-1

1^8FDG

HK

G6Pase

\[ \text{TRAPPED} \]

\[ \text{TRACER} \]

\[ \text{Isomerase} \]

\[ \text{PGmutase} \]
FDG uptake

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

UCLA
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%
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

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

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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

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)

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.


FDG PET/CT VP

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
    Kyzas PA. J Natl Cancer Inst 2008
    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 larnix. Recurrence
  - SUV$_{max}$=17.5
  - SUV$_{max}$=20.7
  - SUV$_{max}$=9.7
  - SUV$_{max}$=10.8

- 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: 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)

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<th>N</th>
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FDG PET/CT:
Treatment monitoring (Chemo and Radion therapy)
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