Vall d'Hebron Hospital

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Lisboa
Parque das Nações
Escola Superior de Tecnologia da Saúde de Lisboa

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IDI
INSTITUT DE DIAGNÒSTIC PER LA IMATGE

"Head and Neck PET/CT imaging: neuroradiology perspective"

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BACKGROUND

90% to 95% of head and neck cancer are squamous cell carcinomas arising from mucosal linings of the upper aerodigestive tract.

The overall annual mortality rate for this cancer is 23% and the 5-year survival rate is 56%

More than 80% of early-stage tumors are cured but…

one-half of patients have evidence of **advanced local** disease or lymph node metastases at the time of diagnosis.

Early diagnosis and accurate staging are essential for treatment planning and can strongly influence prognosis

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Summary

Imaging thecniques in the assessment and management of head and neck malignancies

RM vs PET/CT

- staging: TNM
- the unknown primary carcinoma
- second primary carcinoma
- recurrent disease
- others uses

IMAGING THECNIQUES

CT

Simple technique

Morphological criteria

Best bone evaluation

Contrast-enhancement

Initial diagnostic tool

speed and availability

Limitations

- Poor soft-tissue contrast resolution
- Dental artifacts

MR

Morphological criteria

Best soft-tissue resolution.

Contrast-enhancement

Funtional DWI

Physical principle

Measures motion of extracellular water (Brownian)

↓ ADC = ↑ cell proliferation

CDA: 1.3 X 10^{-3} mm^2/s

Limitations

- Patients cooperation
- Artifacts susceptibility
- Differents technique
- Post processing

PET/CT

Hybrid technique

Morphological criteria CT

Best bone evaluation

Contrast-enhancement

Funtional 18F-FDG

Physical principle

Measures increased cellular glucose metabolism

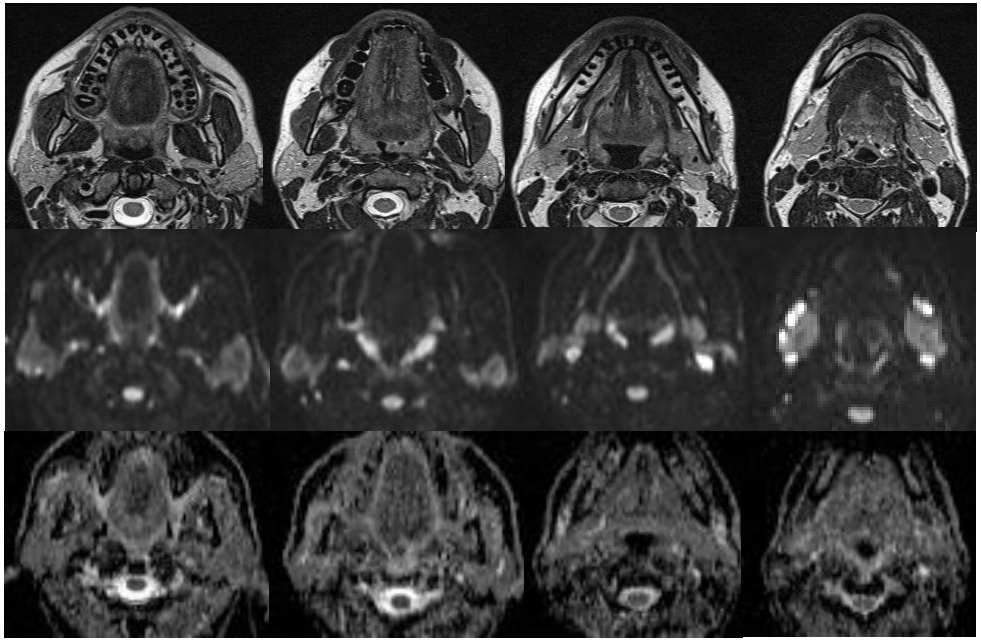
↑ SUV = ↑ cell proliferation

Limitations

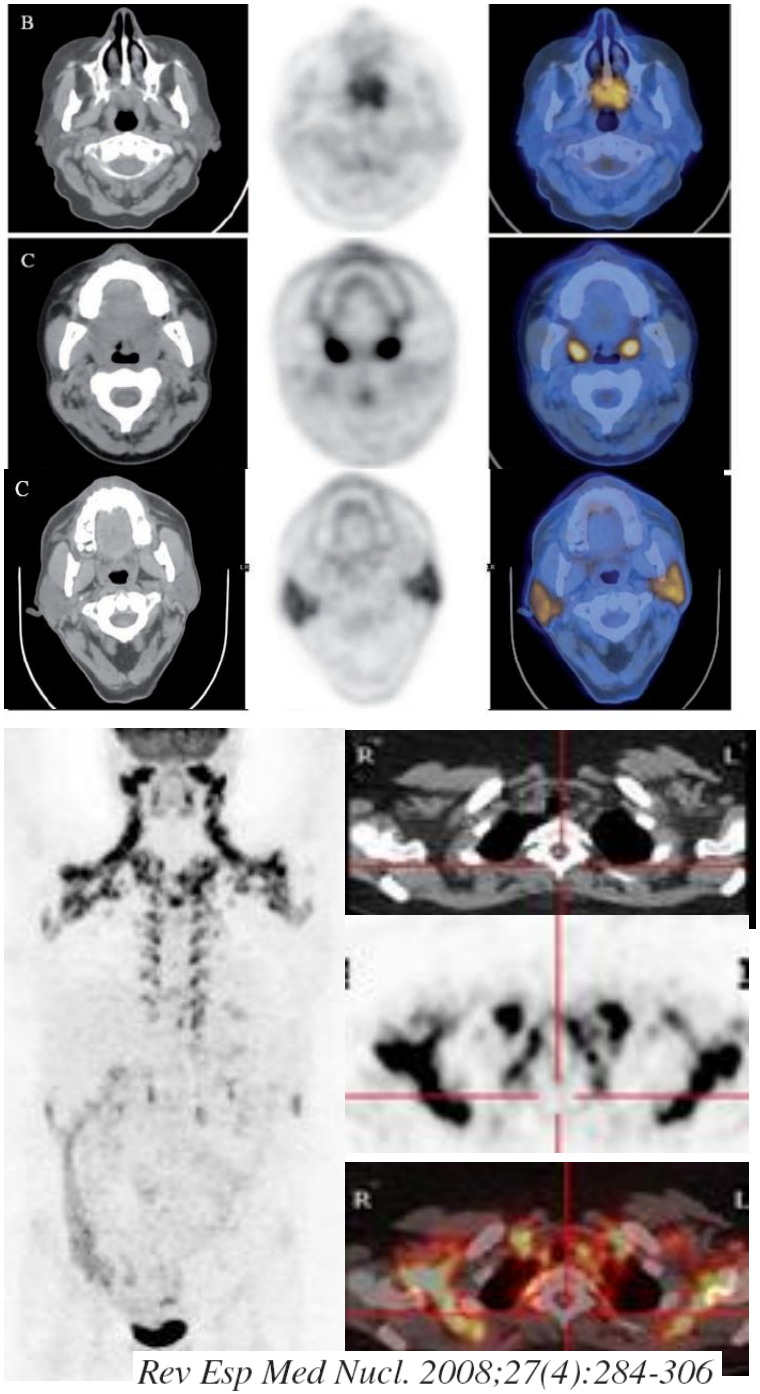
FDG is not a specific marker for cancer

- Physiologic uptake
- Mimickers

Physiological activity/ uptake



DWI/MR



Review CT portion of PET/CT allows correlation of findings with normal anatomic structures reducing the rate of FP

Rev Esp Med Nucl. 2008;27(4):284-306

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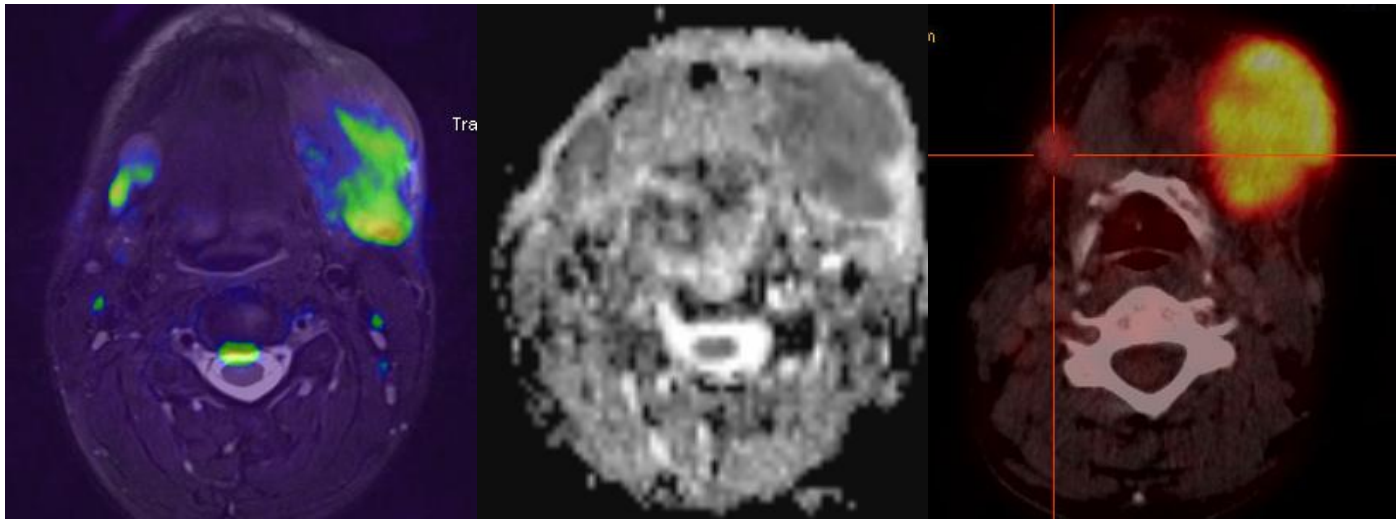
There is no correlation between the FDG uptake and the ADC values in head and neck SCC. Fruehwald-Pallamar J et al Eur J nucl Med Mol Imaging 2011;38:1009-19



SUV and ADC values are independent parameters in HNSCC. Varoquaux A et al. Eur J Nucl Med Mol Imaging 2013

Pretreatment primary tumor SUV max and ADC correlate significantly and negatively and both **may have similar potential to predict disease-free survival or disease** events of HNSCC. Nakajo M et al. Clin Nucl Med. 2012;37:475-60

STAGING OF HNSCC

T Stage

Extent of the lesion and involvement of adjacent structures.

MR imaging

Superior soft-tissue delineation
Better assessment of :

- -Perineural
- -Craneal base
- -Bone marrow extension
- -Vascular invasion

Limitations:

- **-Small tumor**
- -Movement
- -Pacemaker

PET/CT

Superior for detection of primary neoplastic lesion

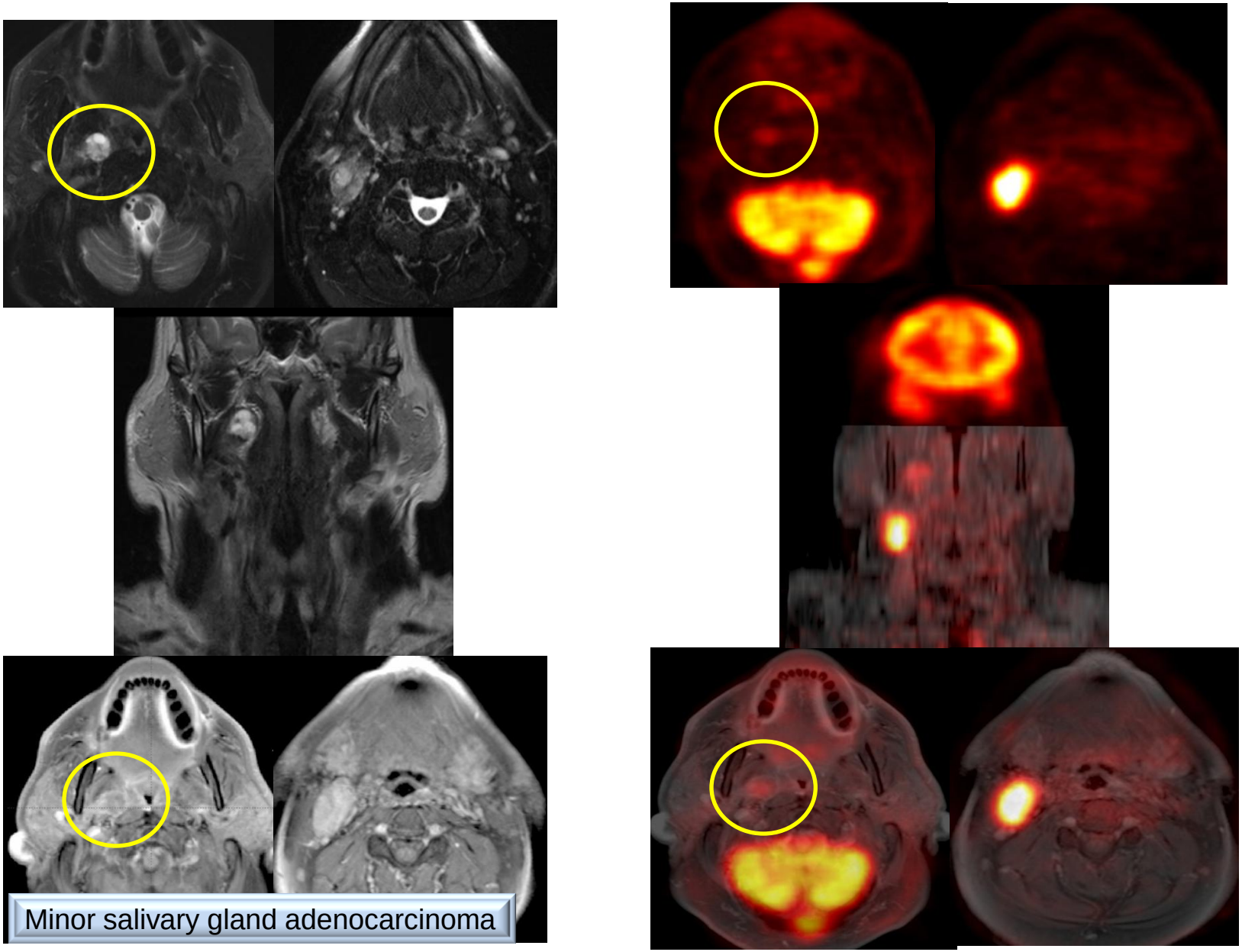
Inferior resolution of anatomic details

Overestimates the size of the lesions.

Limitations:

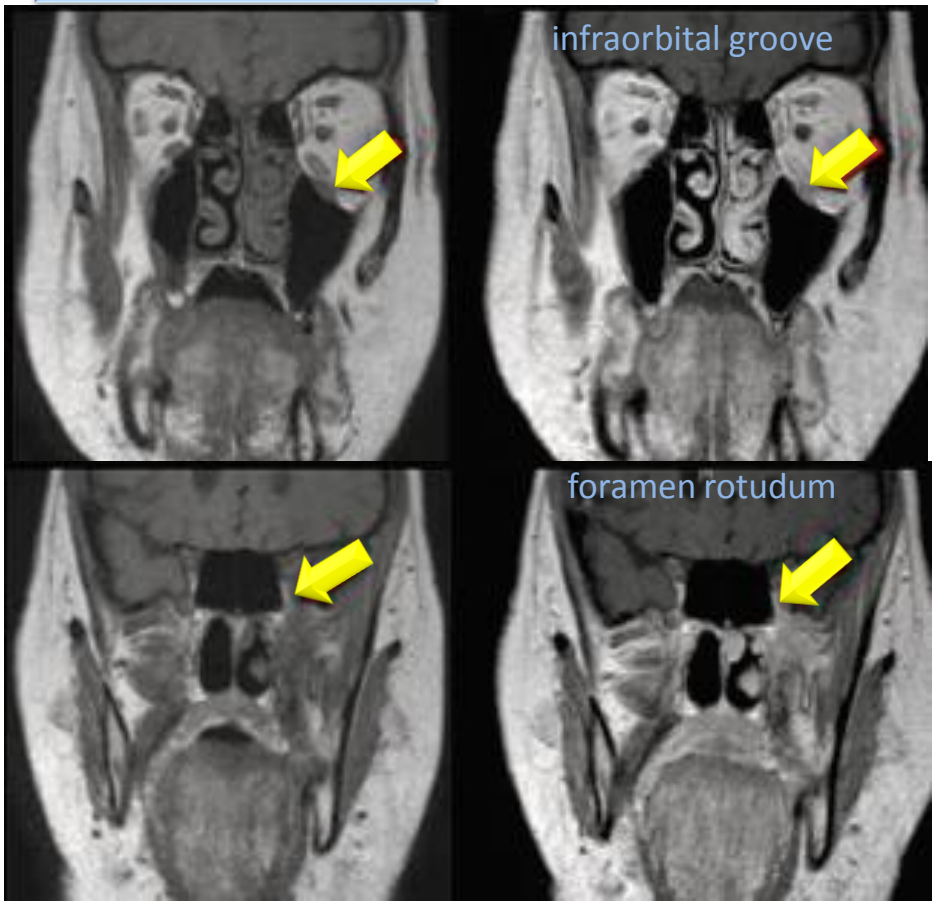
- -**Small tumor**
- -Low affinity FDG
- -Perineural involvement
- -Intracranial extension

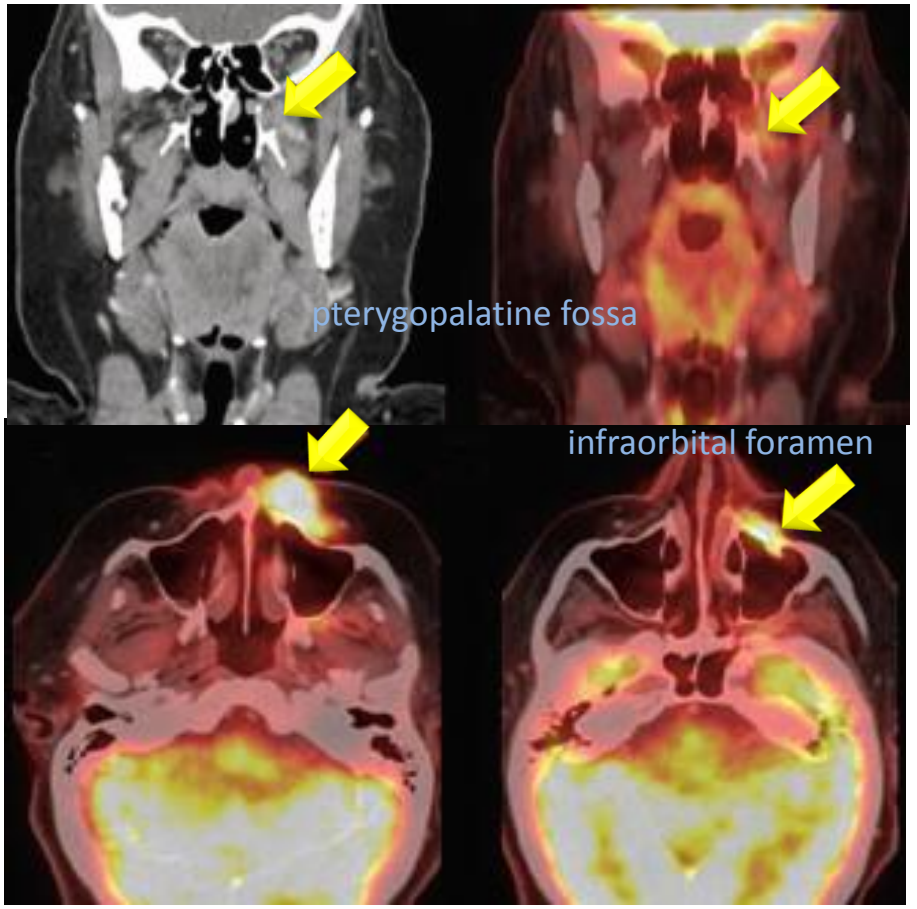
T Stage: Limitations Low affinity FDG



T Stage: Limitations Perineural spread

SCCA of the skin



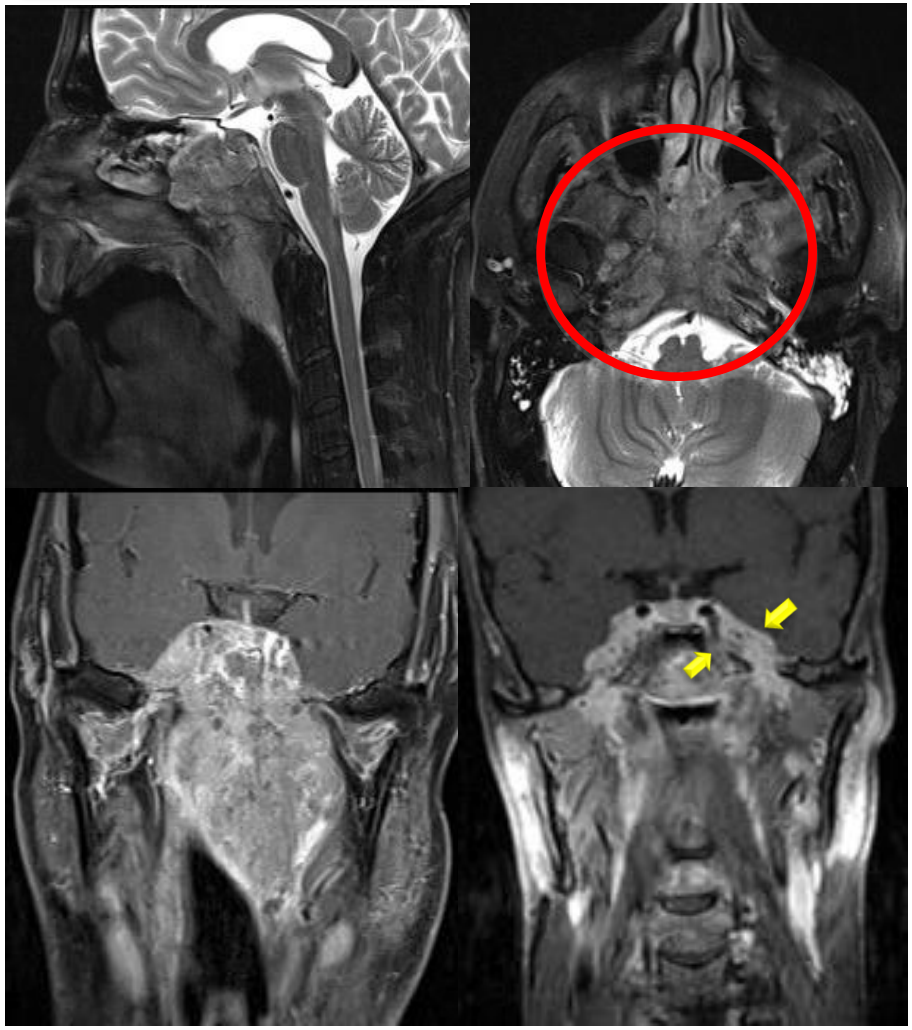


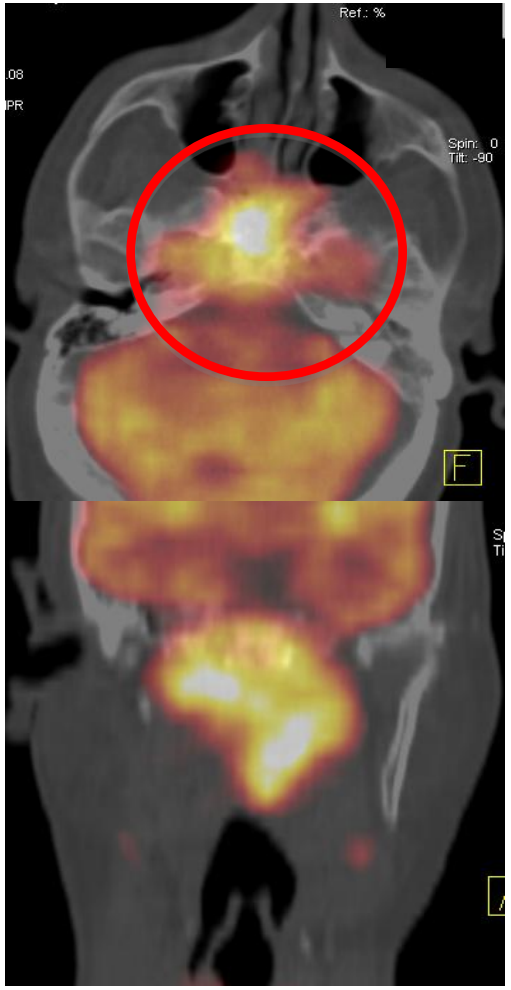
40% of patients are asymptomatic

Associated with decreased survival and higher risk of local recurrence and metastases

T Stage: Limitations skull invasion

Nasopharynx SCC





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STAGING OF HNSCC

- ***N Stage***

  Most important prognostic factor

  Reduces the 5-year disease-specific survival rate in patients with HNSCC

CT / MR imaging

Morphological criteria

-Size and shape
-Extracapsular invasion
-Vascular involvement

Funtional criteria DWI.

≤ 10mm low ADC (0,9 x 10^{-3} mm^2/s)

sensitivity 84% **specificity 94%**

Vandecaveye V et al. Radiology 2009

Diff. diagnosis with reactive nodes

False-negative small and necrotic nodes
False-positive fungal infection

PET/CT

Funtional criteria: FDG uptake

≤ 10 mm but FDG-avid

sensitivity 90% **specificity 93%**

Sadick at all. Otorh Head and Neck Surg. 2012

False-negative

small nodes , necrotic

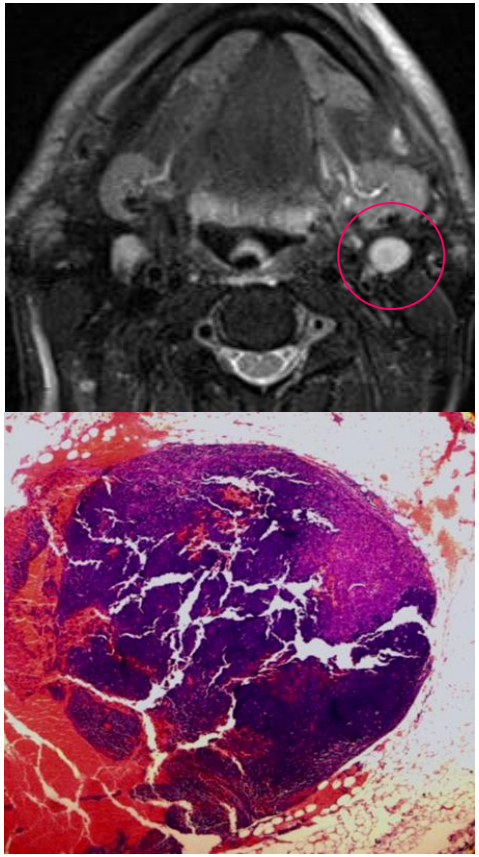
Andrade et al. J Radiat Oncol Biol Phys 2006

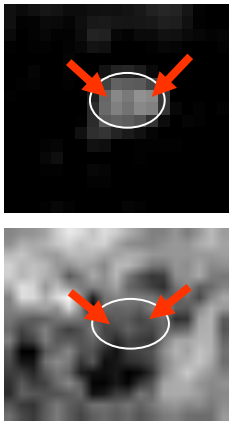
False-positive

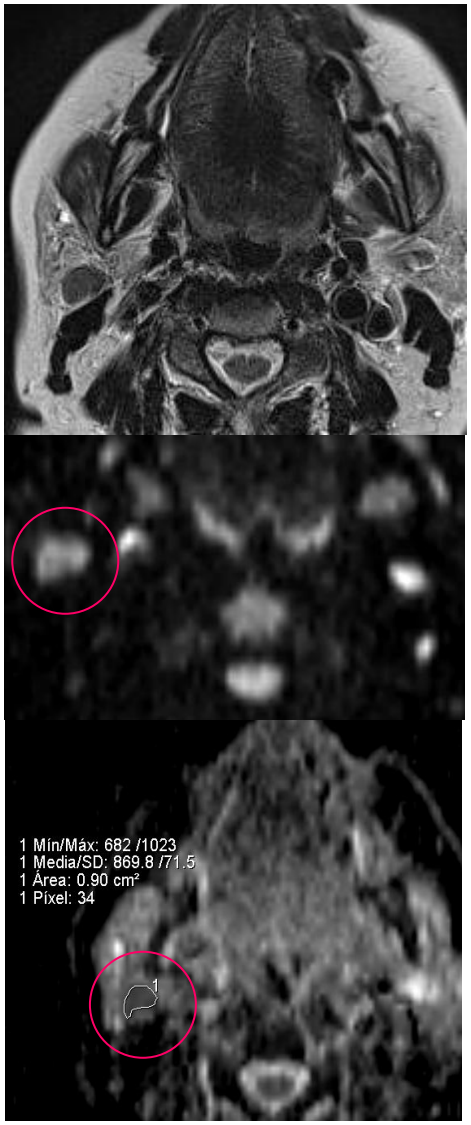
Reactive nodes

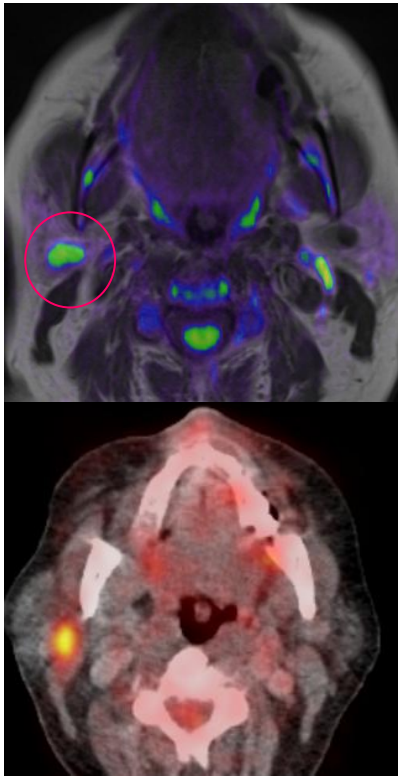
Funtional MR

50% of lymph node metastases are <10mm (Don et al. Laryngoscope 1995)





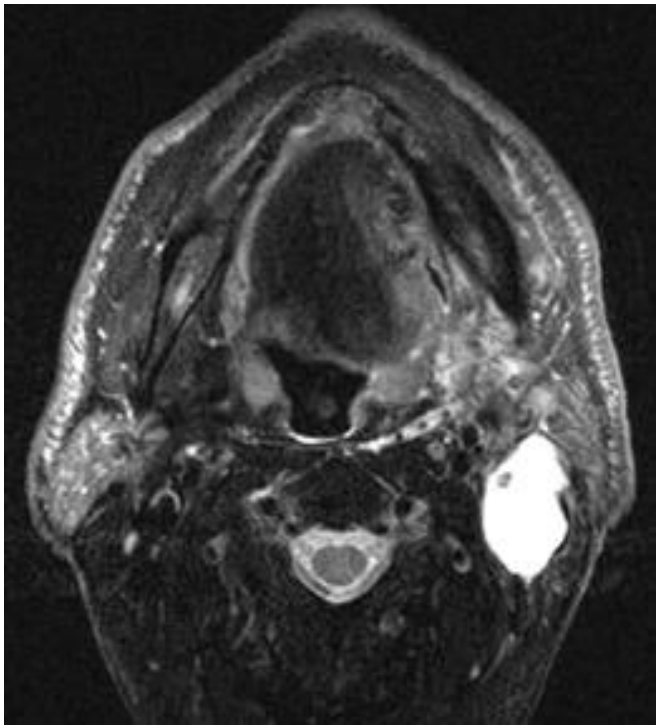


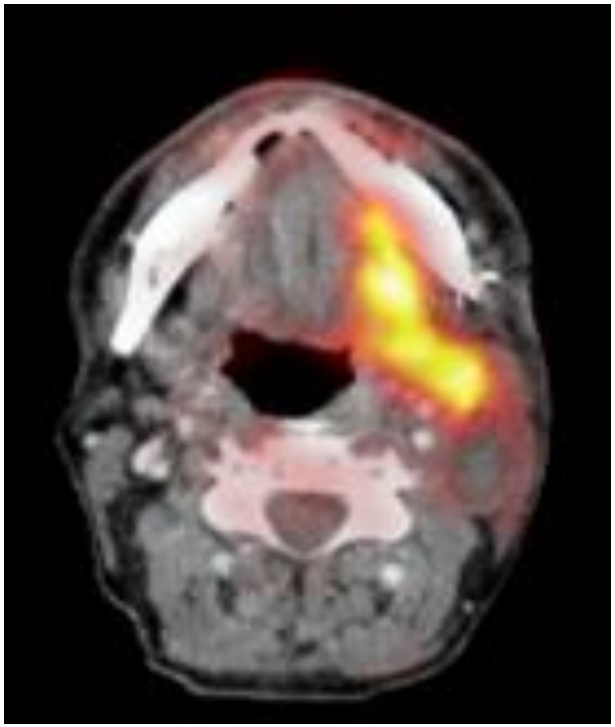


ADC (0,9 x 10^{-3} mm^2/s)

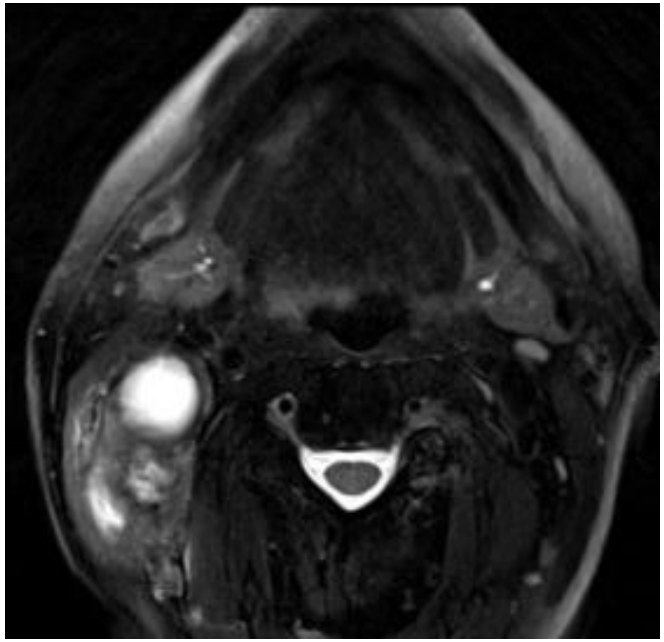
(Vandecavaye et al. Radiology 2009)

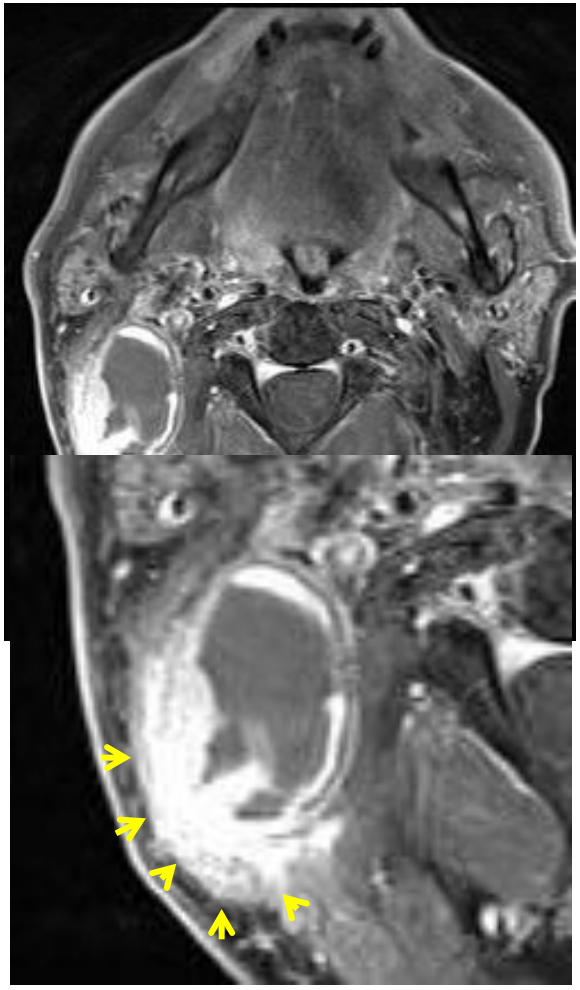
N Stage: Limitations necrotic lymph node.

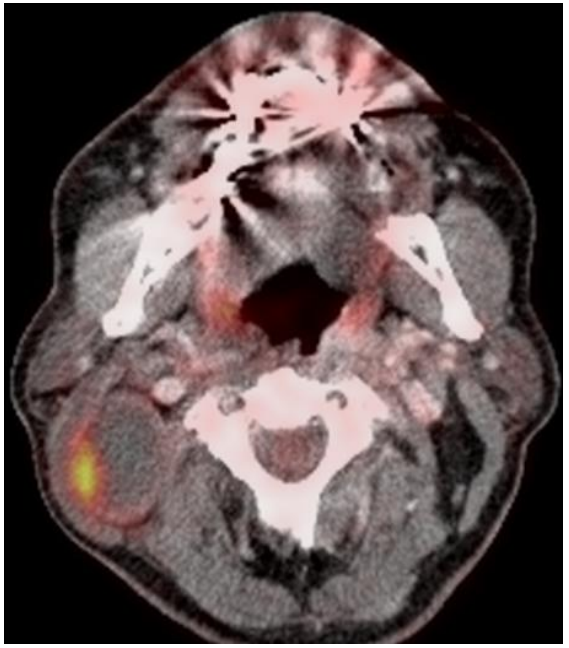




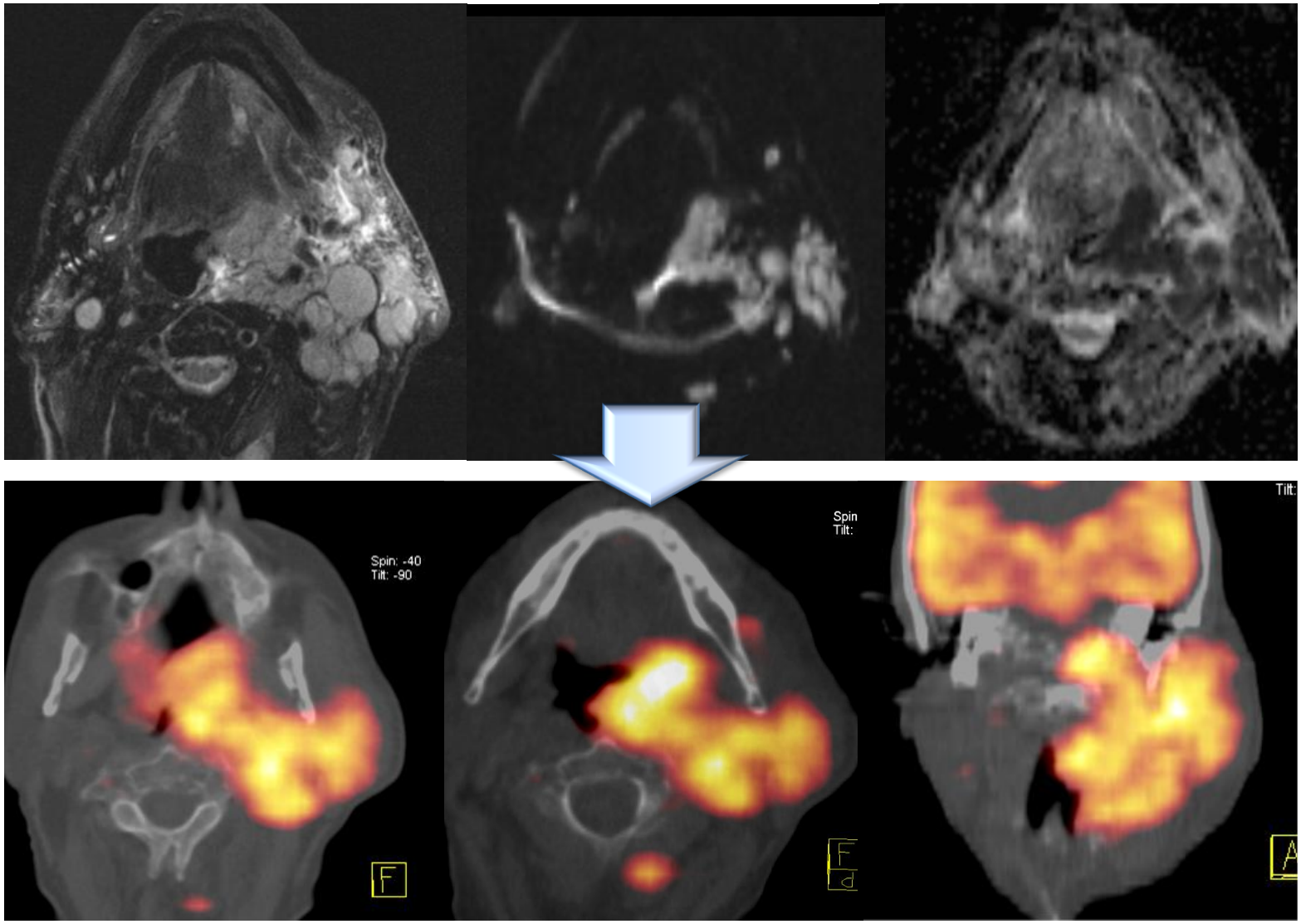
N Stage: Limitations extracapsular spread.





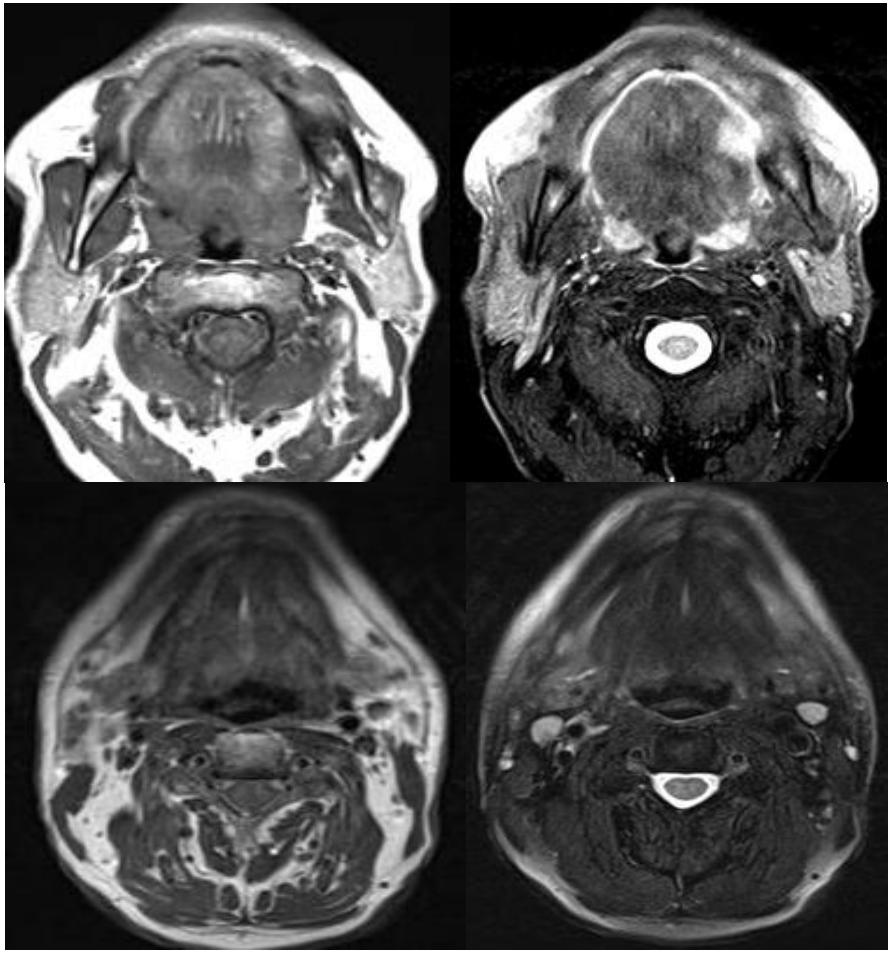


N Stage: Limitations nodes that cannot be separated anatomically from the primary tumor.

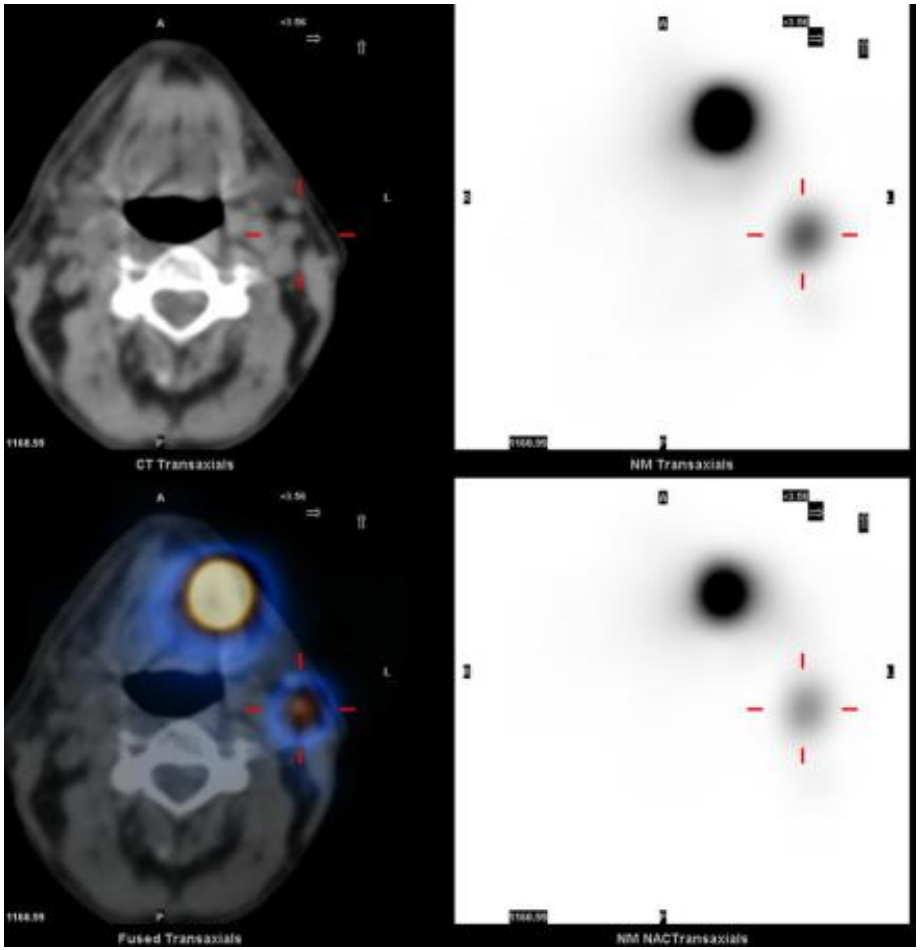


N Stage: Limitations small nodes

15-25% N0 necks have nodal metastasis

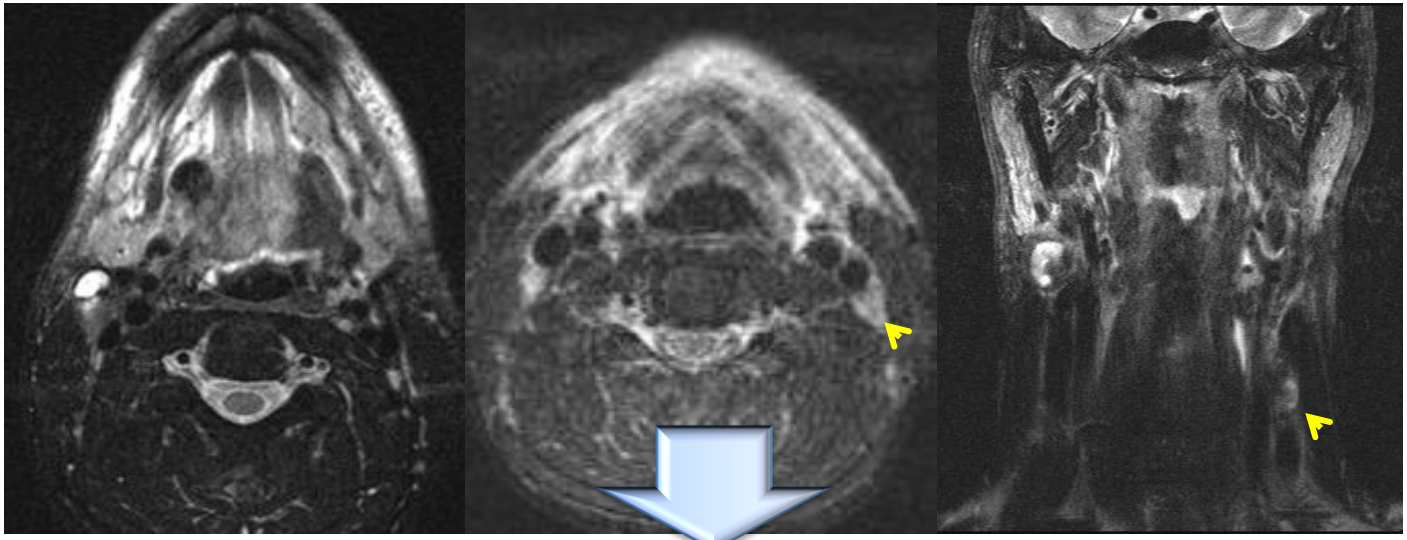


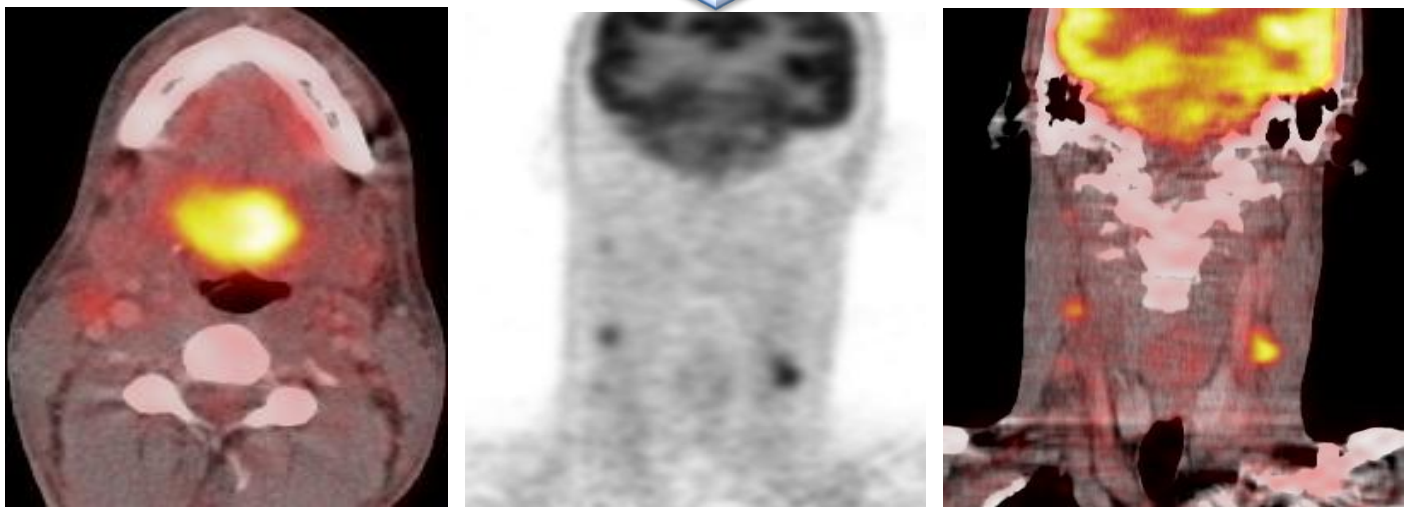
Lingual SCC T1N0



Sentinel lymph node

N Stage: Indications bilateral involvement in midline disease



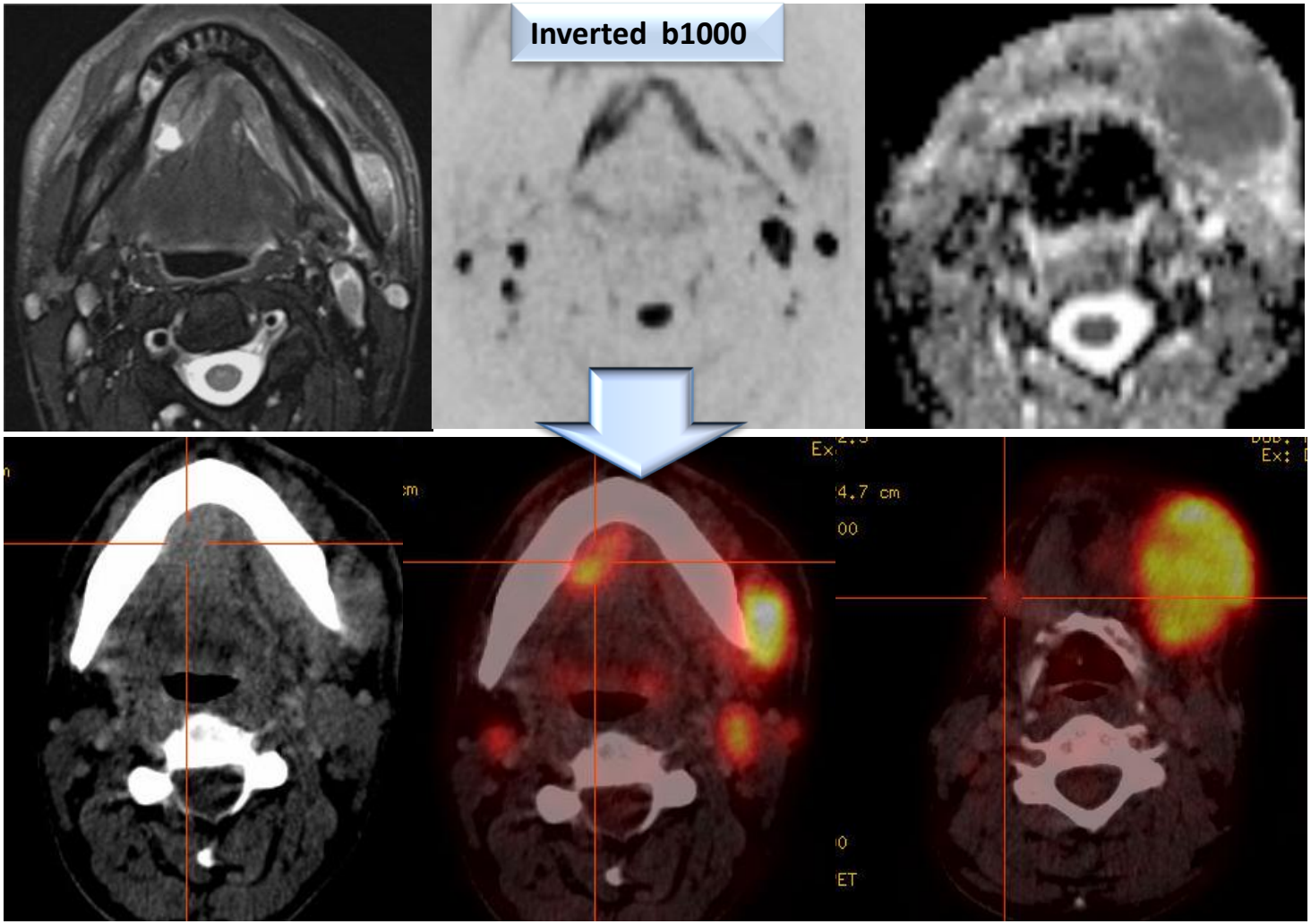


Specificity 93%

Sensitivity 80%

The methodology for calculating sensitivity and specificity differs among studies (based on patient, on neck level, and on individual node)

N Stage: Indications Bilateral involvement in unilateral disease



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STAGING OF HNSCC

M Stage

- PET/CT is extremely valuable in identifying distant metastases
- Most common sites: lungs, mediastinal nodes, bone, and liver.

PET/CT

Whole body imaging

High risk of distan metastases

T3-T4 HNSCC

Lymph nodes metastases

- ≥ 4
- bilateral
- > 6 cm
- Zone IV

Recurrent HNSCC

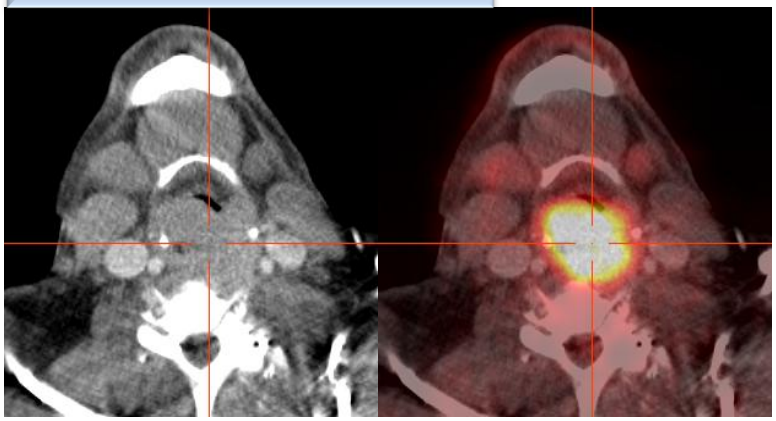
Second primary tumor

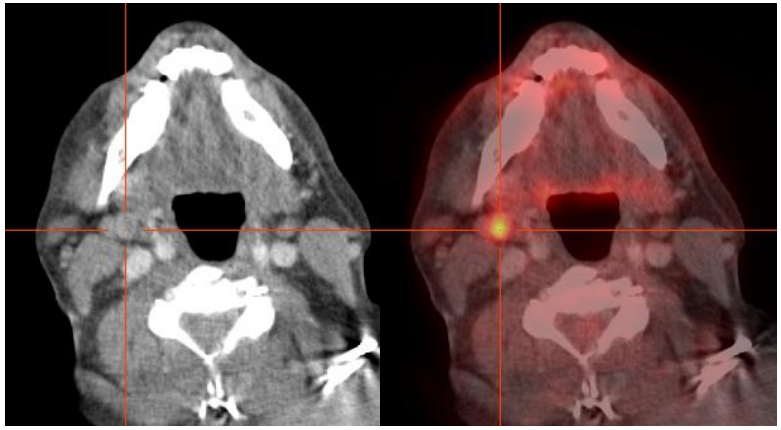
Sensibility: 97%
Specificity: 95%
PPV: 70%
NPV: 99%

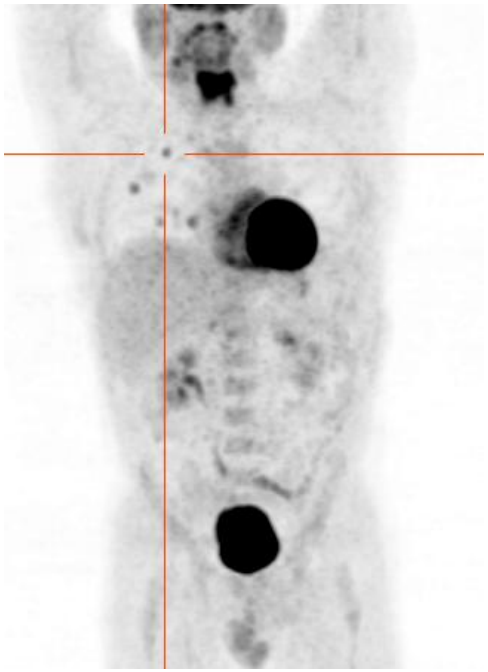
Haerle et al./Oral Oncology 47 (2011)

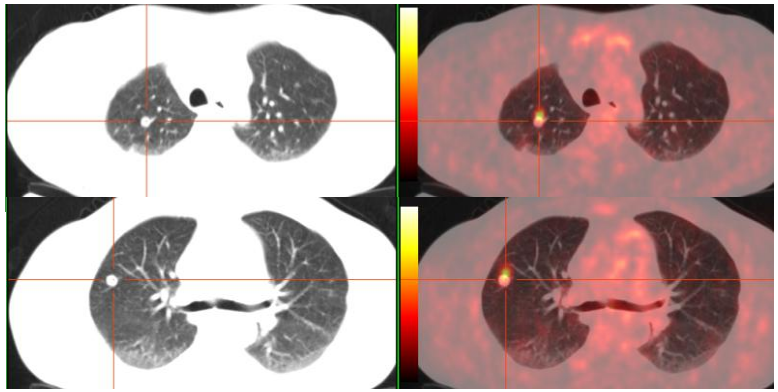
M Stage : Indications T3-T4 HNSCC

T4 N1 Oropharinx



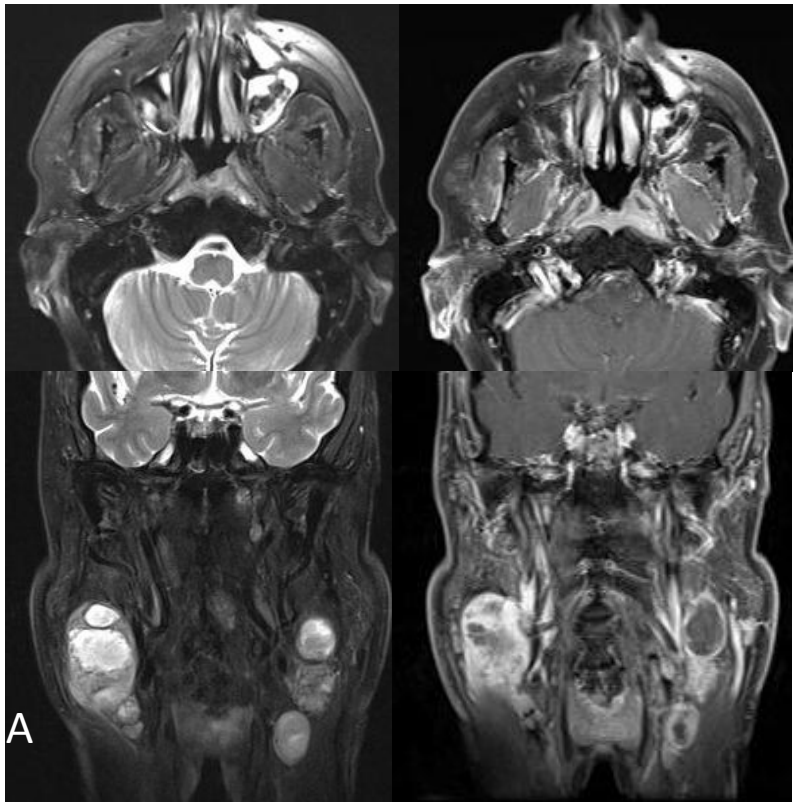


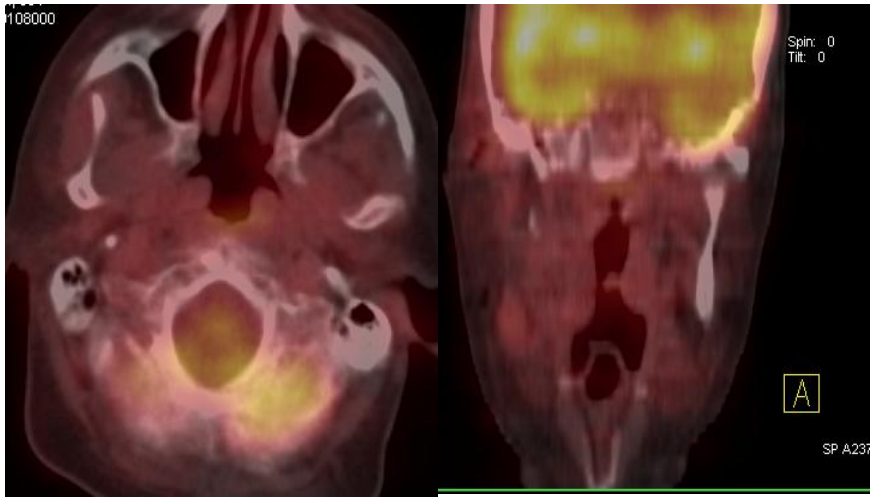


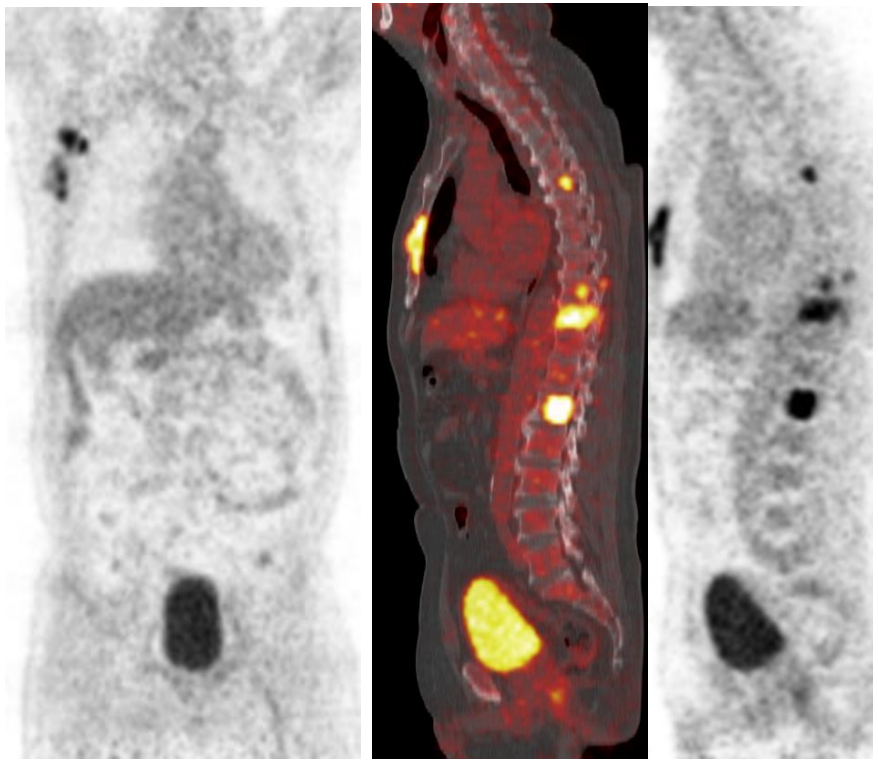


18F-FDG PET/CT alters theTNM classification in 34% of cases , resulting in a change in radiation therapy technique in 29%

Mak D.et al. Q J Nucl Med Mol Imaging . 2011





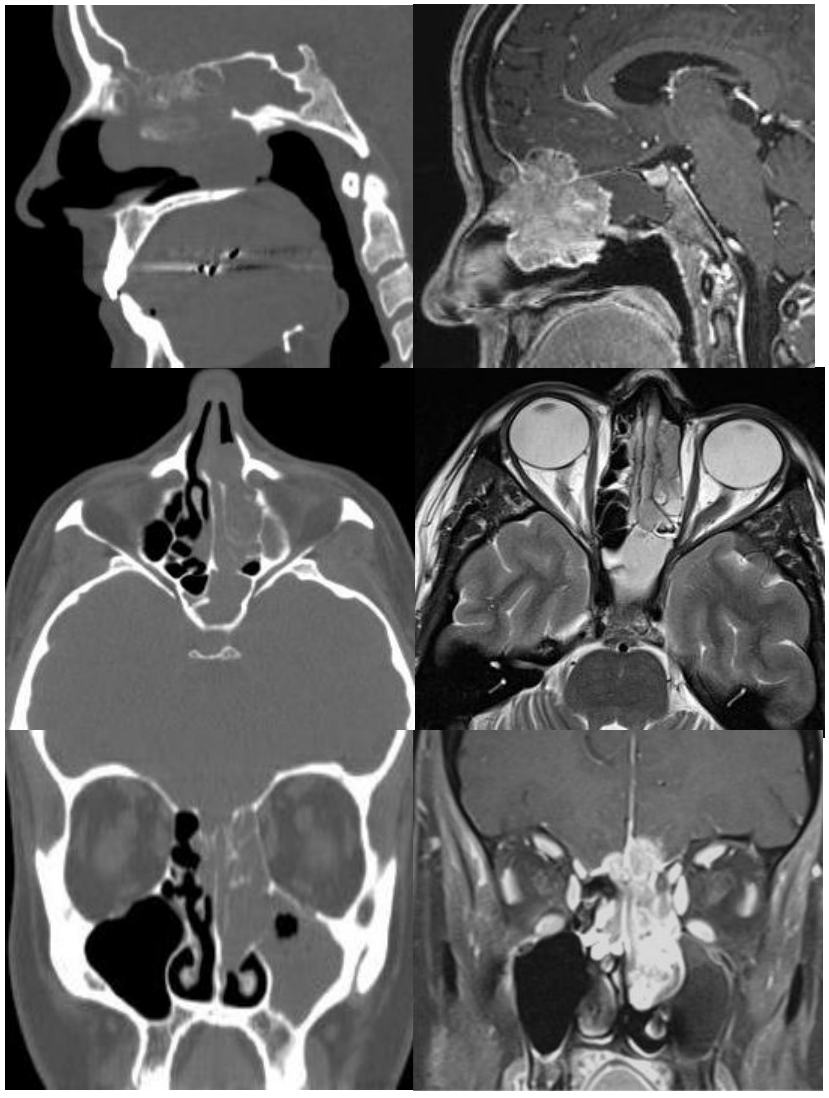


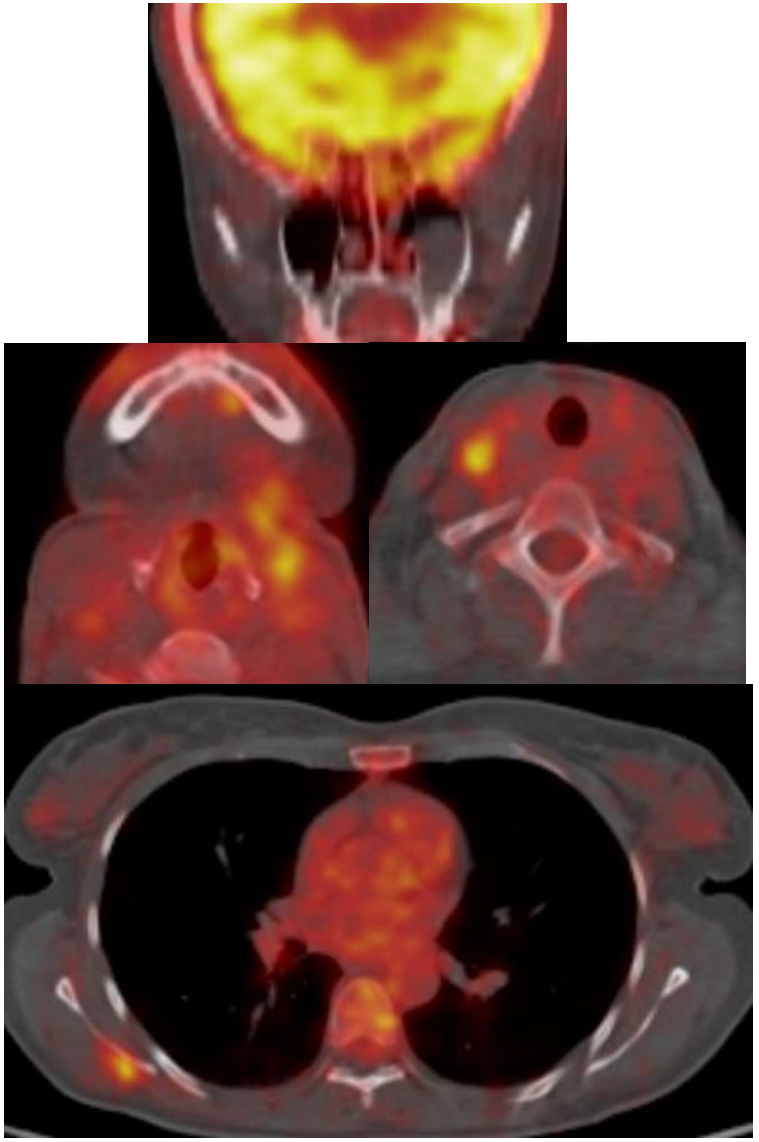
T1 N2c Nasopharinx

≥ 4 lymph nodes metastases

Bilateral lymph nodes metastases

Esthesioneuroblastoma





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THE UNKNOWN PRIMARY CARCINOMA

- 2 to 9% of patients with lymph node m. have a hidden tumor.

  Primary tumor too small (<5 mm) to be seen

  Location (tonsillar crypts, base of tongue, pyriform sinus).

- Identification of occult primary sites, decrease treatment-related morbidity

MR

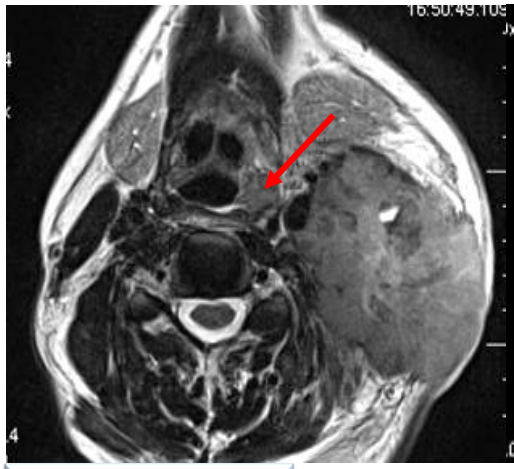
Front line study

when fails

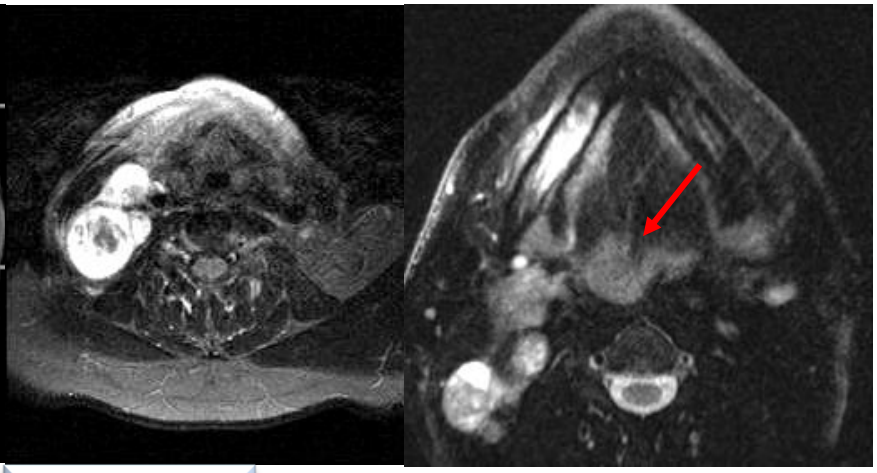
PET/CT

Sensitivity 88%
Specificity 75%
Accuracy 79%

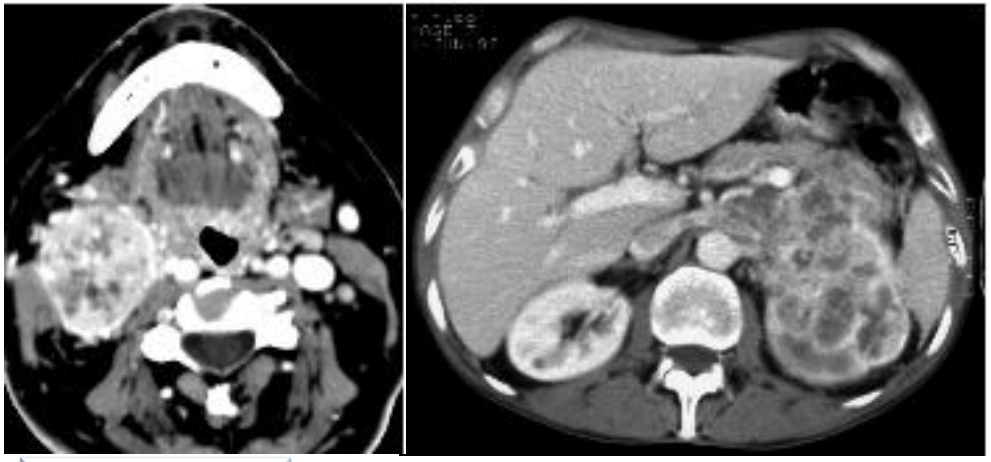
Lower sensitivity for base of tongue cancers, and a lower specificity for tonsil cancers Rusthoven et al . Cancer ;2004.



pyriform sinus



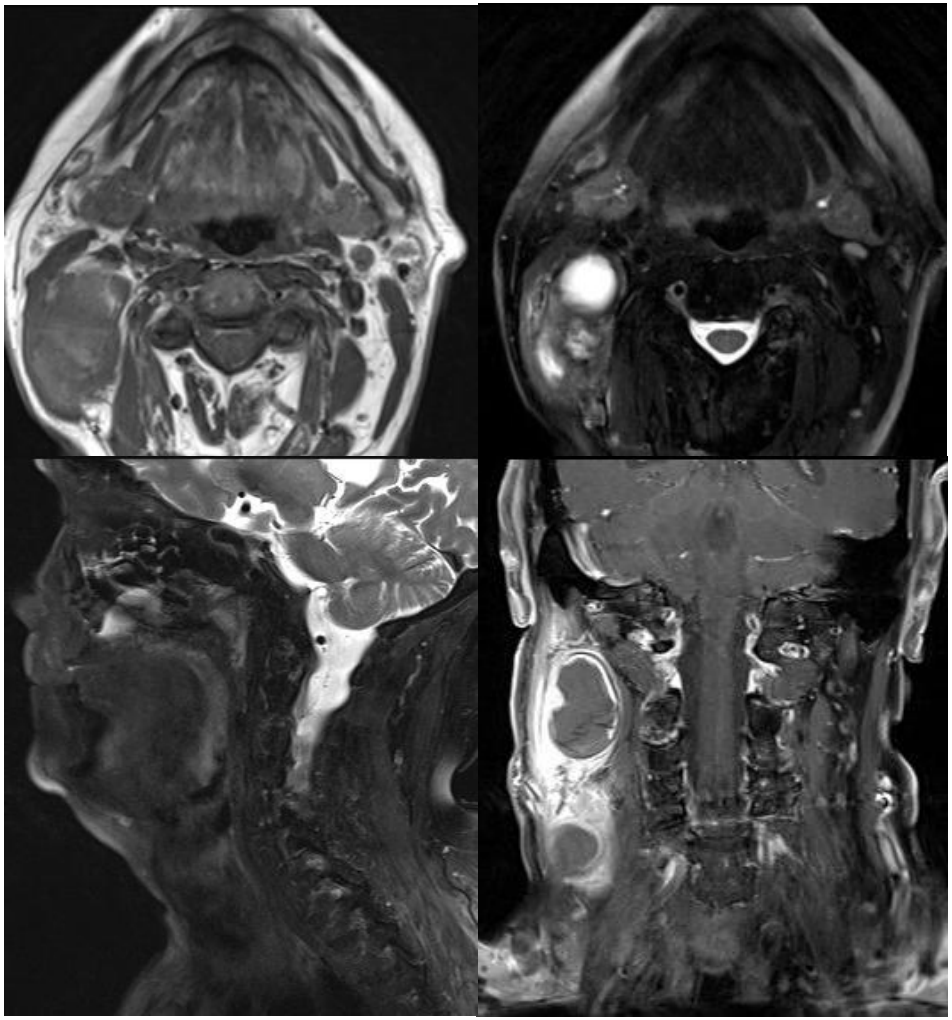
base of tongue



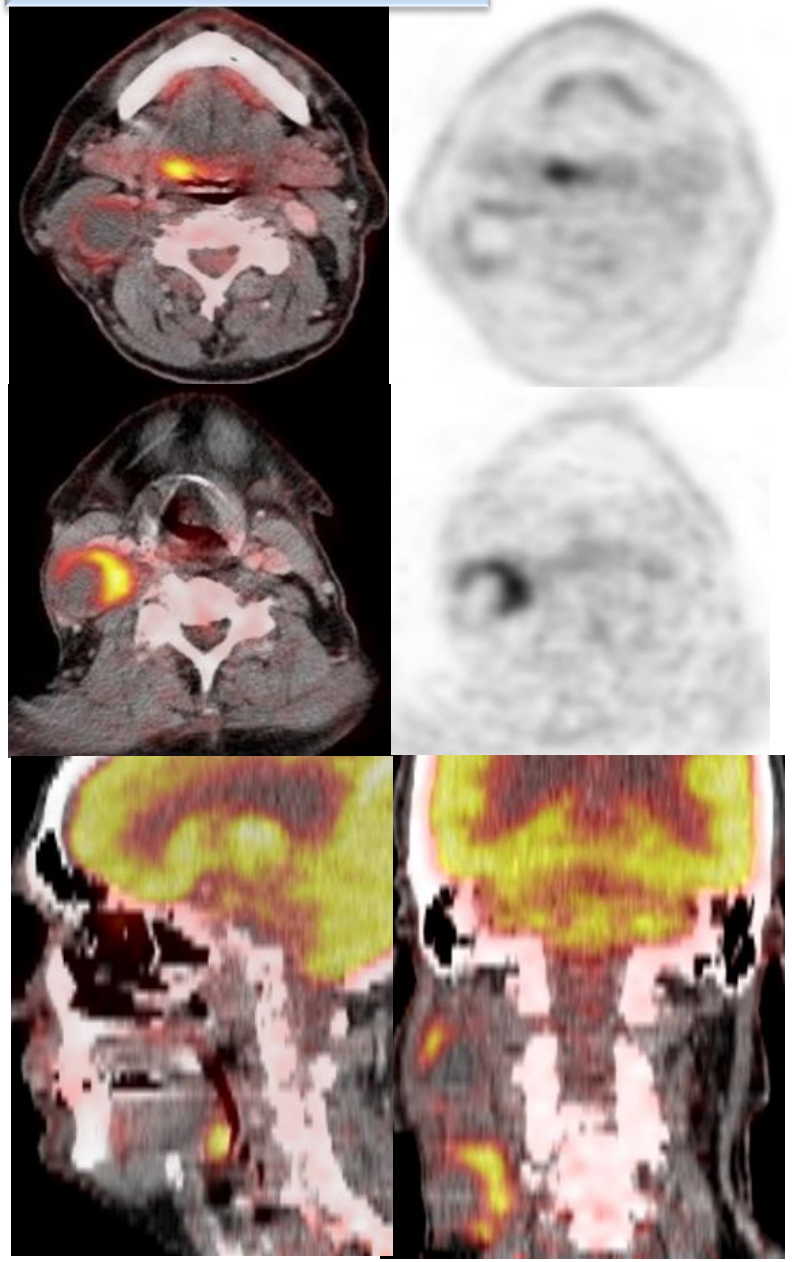
Hipernefroma

FDG-PET should be performed whith negative CT / MR

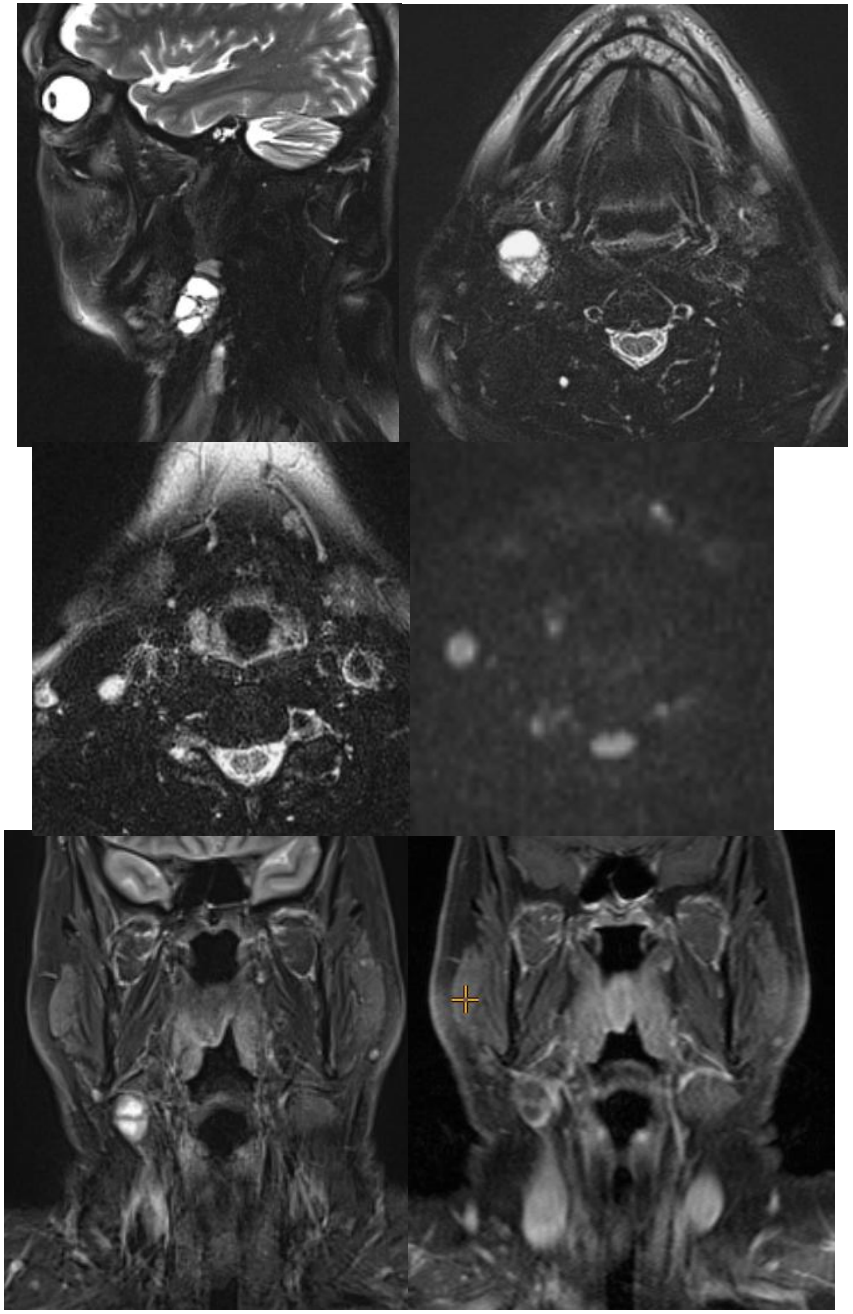
Tx N2b UPC

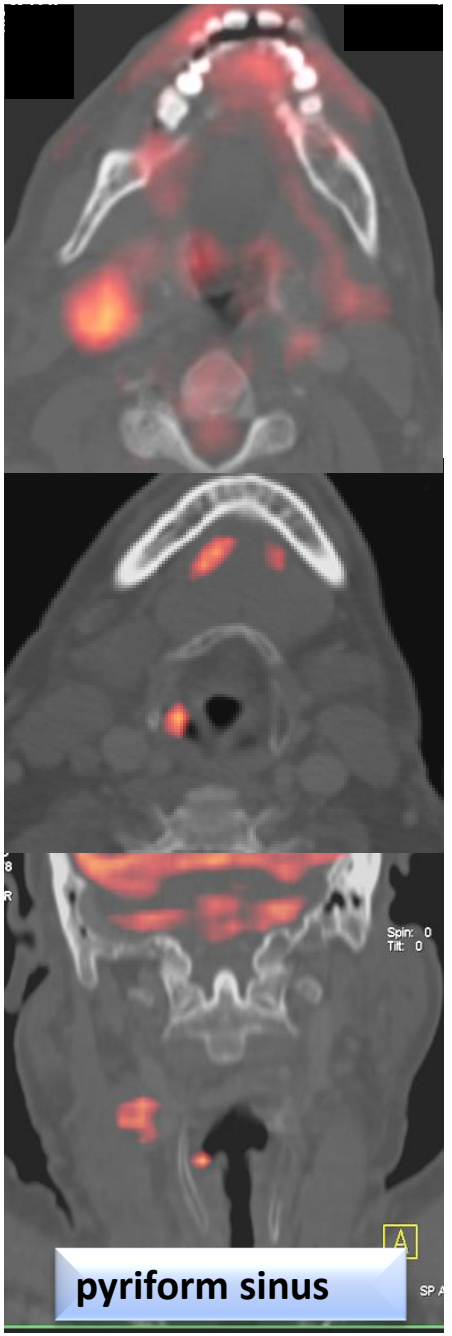


Lingual tonsil T1 N2b



Lymph node metastases levels II-IV from unknown scc




pyriform sinus

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SECOND PRIMARY CARCINOMAS

HNSCC ⬆ rate of developing SPC (3- 5% p/y) *(León et al. Head Neck; 1999)*

Toxic effects from tobacco and alcohol

- **Second cancers**

  Synchronous: same time

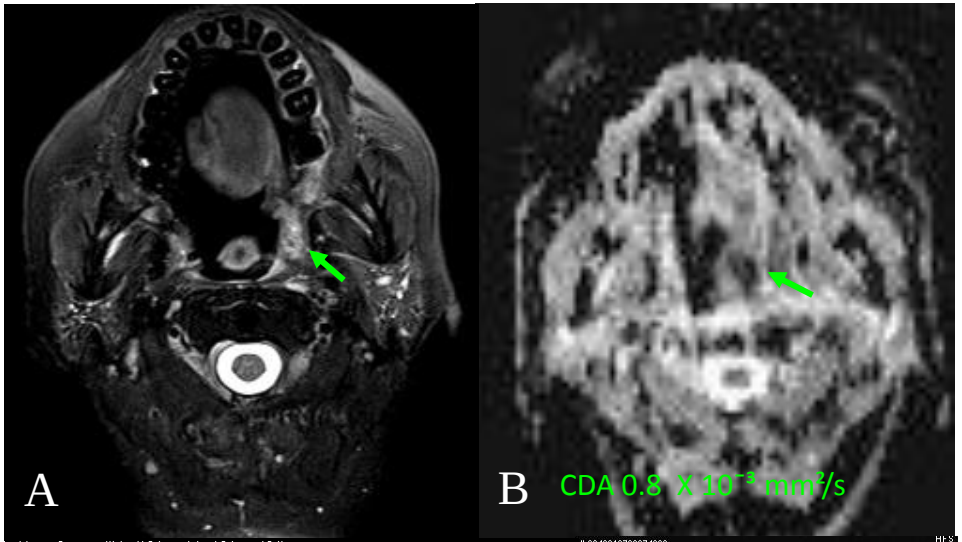
  Metachronous: 6 or more months.

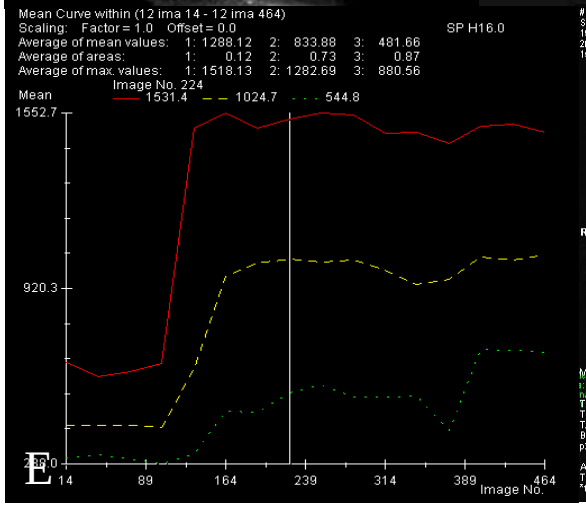
Major sites : lung and esophagus.

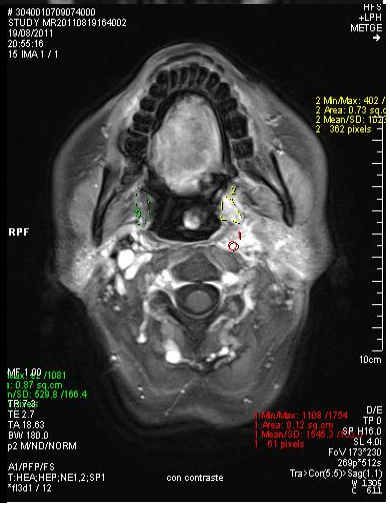
4 % T1 stage *(Huaghey et al. Ann Otol Rhinol Laryngol ;1992)*

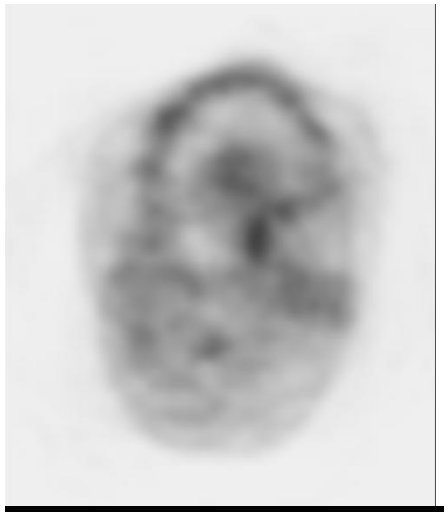
15 a 33% T3 y T4 or level IV metastatic node

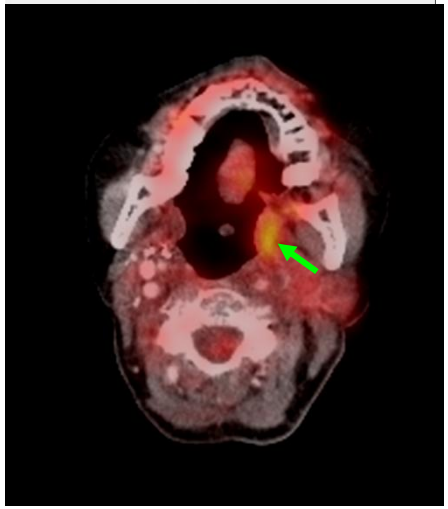
Second primary carcinoma



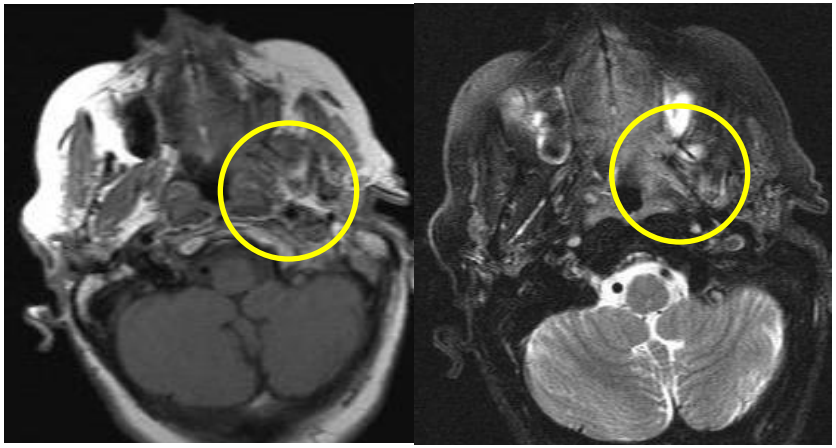


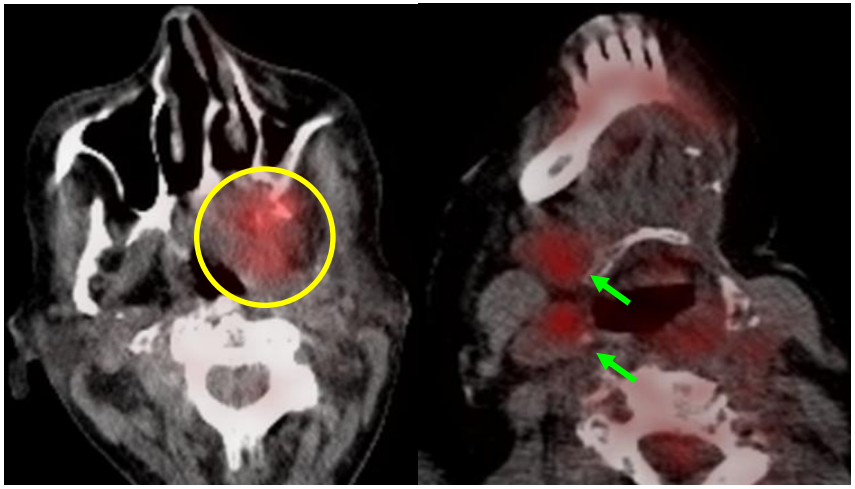


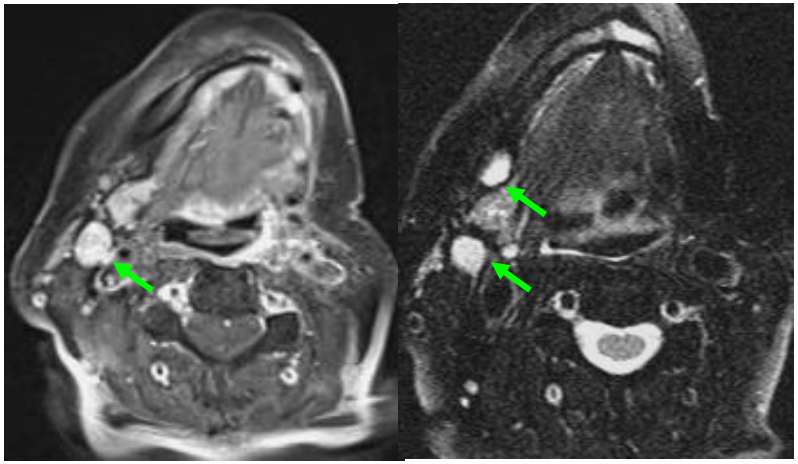


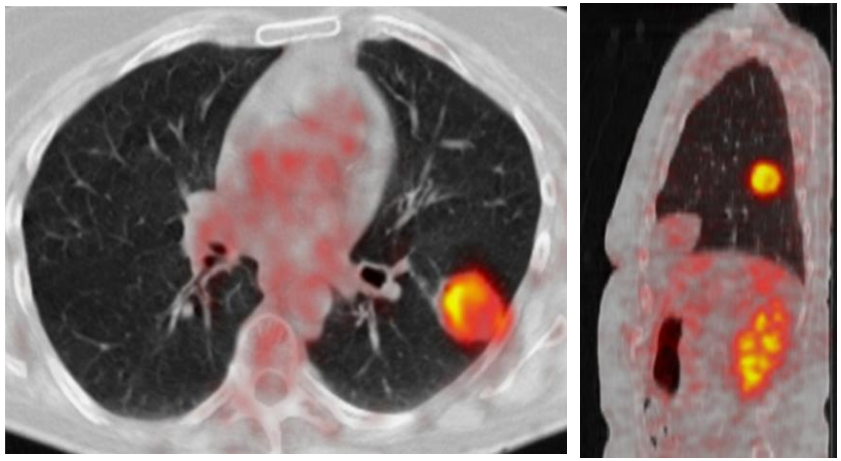


Second primary carcinoma









MR: Recurrent N & perineural spread

PET-TC: Recurrent N, perineural spread & lung second primary carcinoma

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RECURRENT DISEASE

Early detection after treatment = challenging task.

Objective assessment of treatment efficacy
Residual Disease
Recurrences: high incidence of local recurrence

76%: during the first 2 years after treatment

11%: 3rd year

CT/MR

Changes post surgical / post QT/RT

distortion of normal anatomy, edema, residual soft tissue, thickening or scar

Low sensitivity to small focus of remaining disease = treatmet delay

MR DWI

sensitivity	84 al 94%
specificity	90 al 95%

(Vandecaveye V et al, Neuroradiology 2010)

Vall d'Hebron Hospital

RECURRENT DISEASE

PET/CT > **CT / MR**

metabolic approach **anatomic approach**

The **most widespread** applications has been for the assessment of recurrent disease following therapy for HNSCC.

Sensitivity 84–100% Specificities (61–93%).

False positive: inflammation, infection or recent biopsies

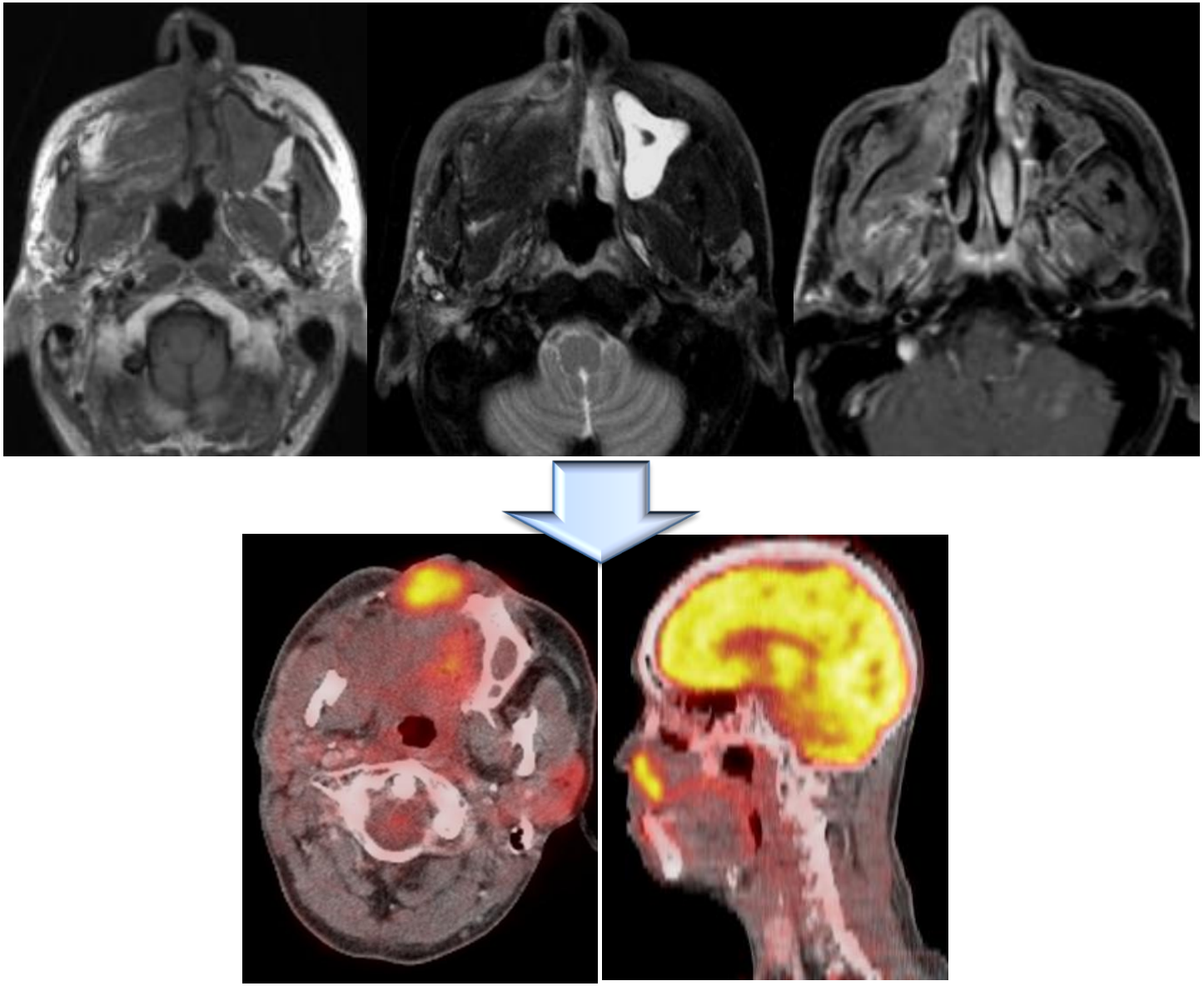
Optimal time interval highest accuracy (94%) ≥ 3 months after the completion of radiation therapy Porceddu et al. Head & Neck; 2011.

"In patients treated for HNSCC, a single PET/CT with negative findings carries a NPV of 91%, whisch is not adequate to defer further radiologic surveillance

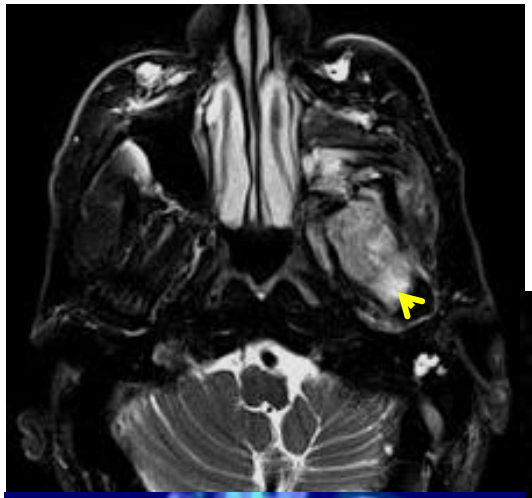
Two consecutive PET/CT examinations with negative findings within a 6-month period, however resulted in a NPV of 98% which could obviate further radiologic imaging in the absence of clinical signs of recurrence."

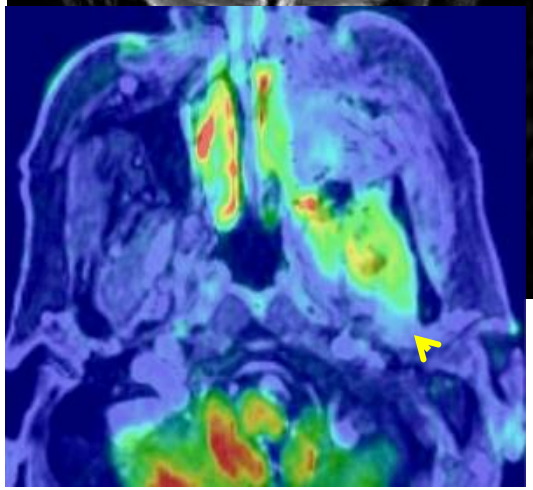
Mak Dermot et al. AJNR Aug; 2013 (Epub)

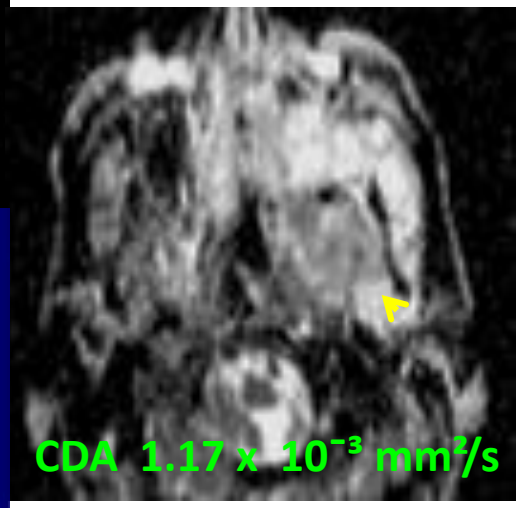
Post surgical Granulation tissue vs recurrent neoplasm

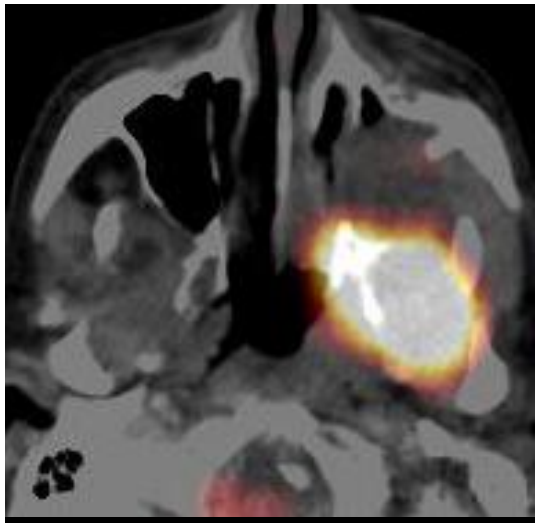


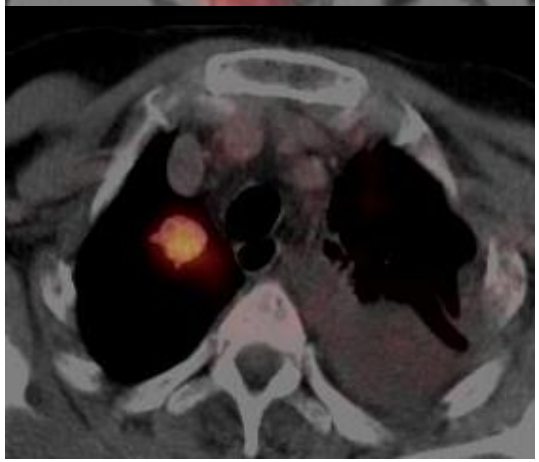
Post surgical recurrence no clinical suspicion



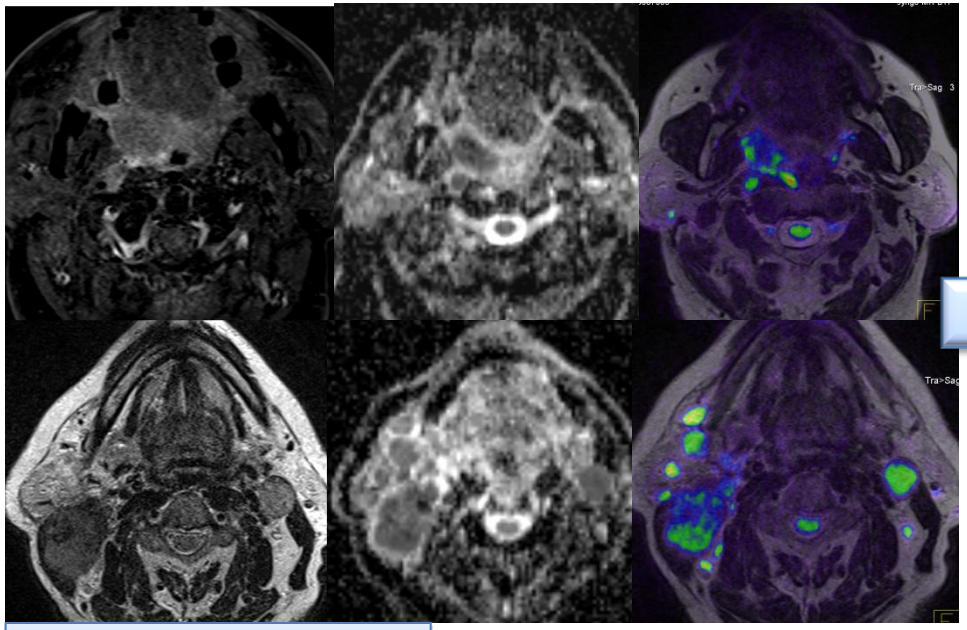


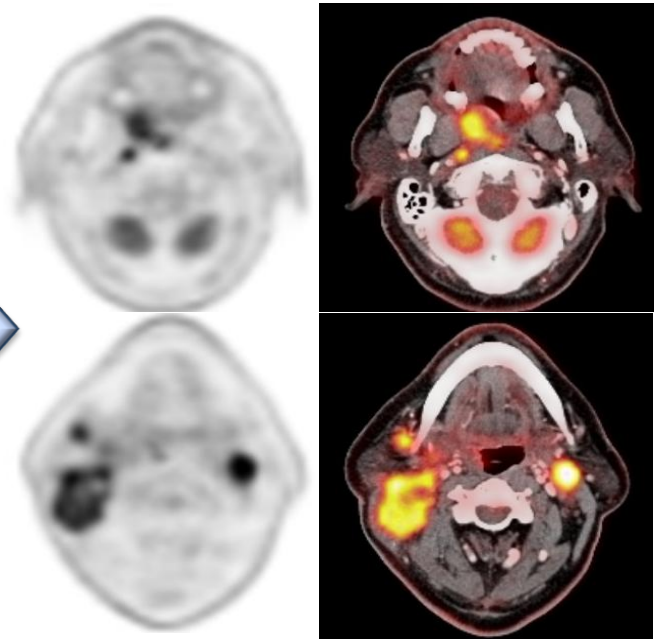




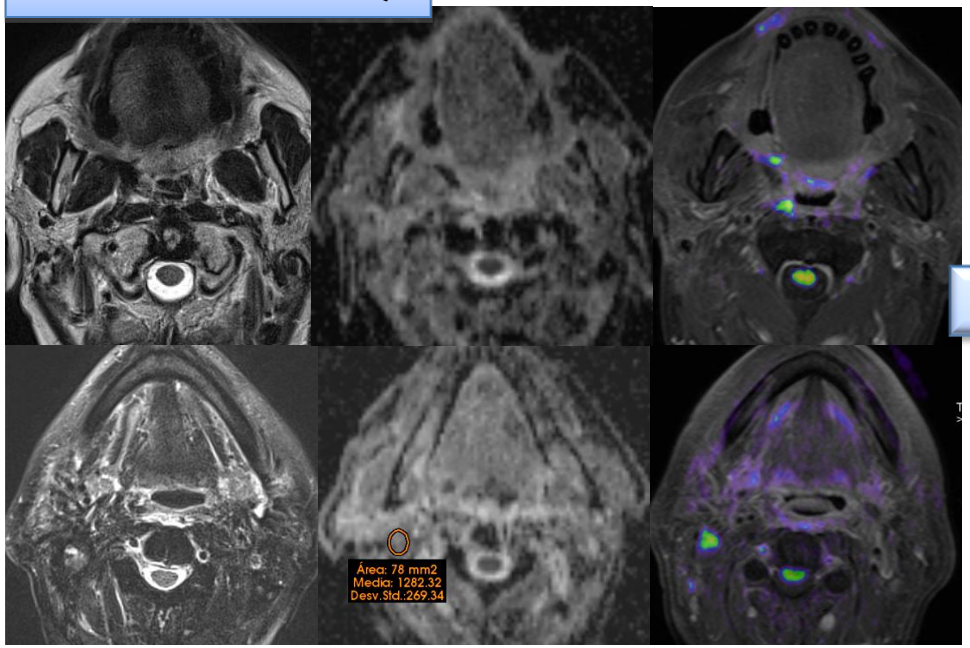


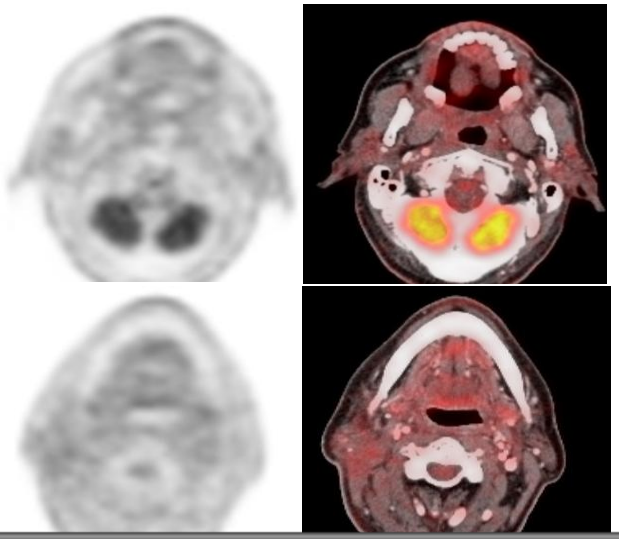
Oropharynx T4 N2c





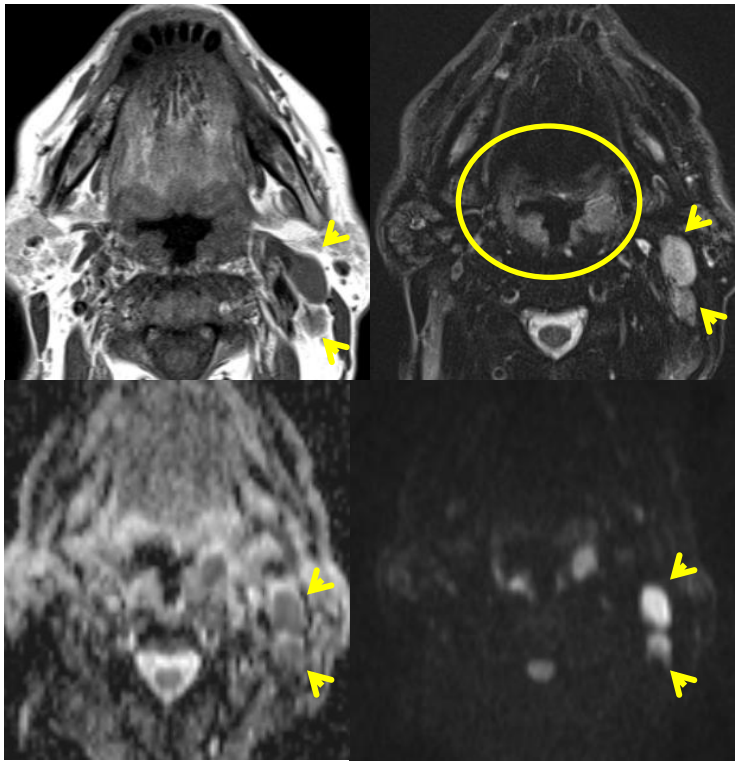
3 months after Rx Qx





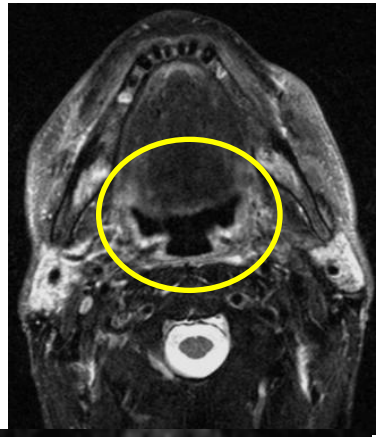
18F-FDG PET/CT reduce the number of unnecessary neck dissections Pryor DI et al. Head and Neck ;2012 Epub

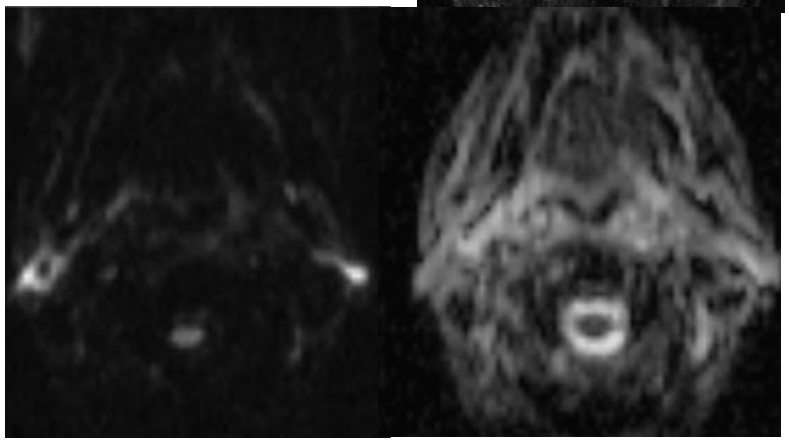
Post RTx recurrence



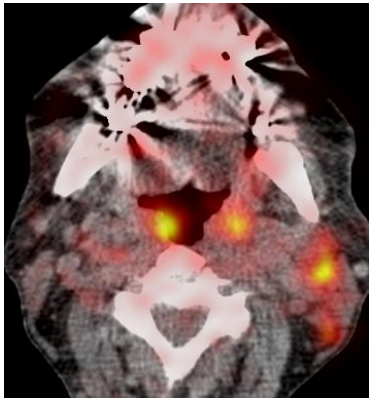
Sensitivity 84-94%
Specificity 90- 95%

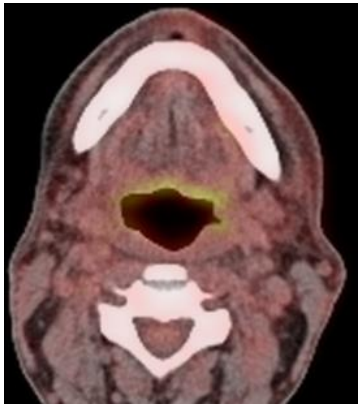
RTx





Oropharynx T4 N2c

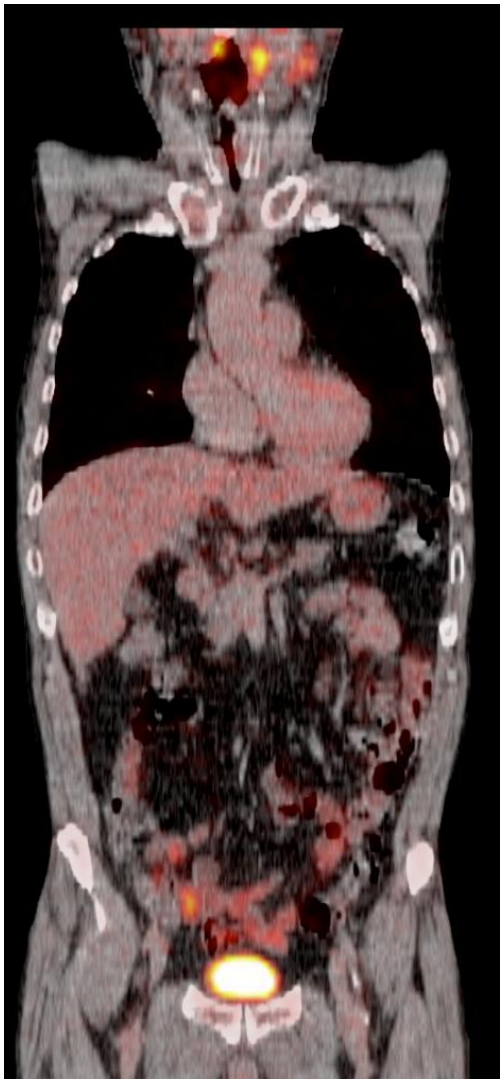


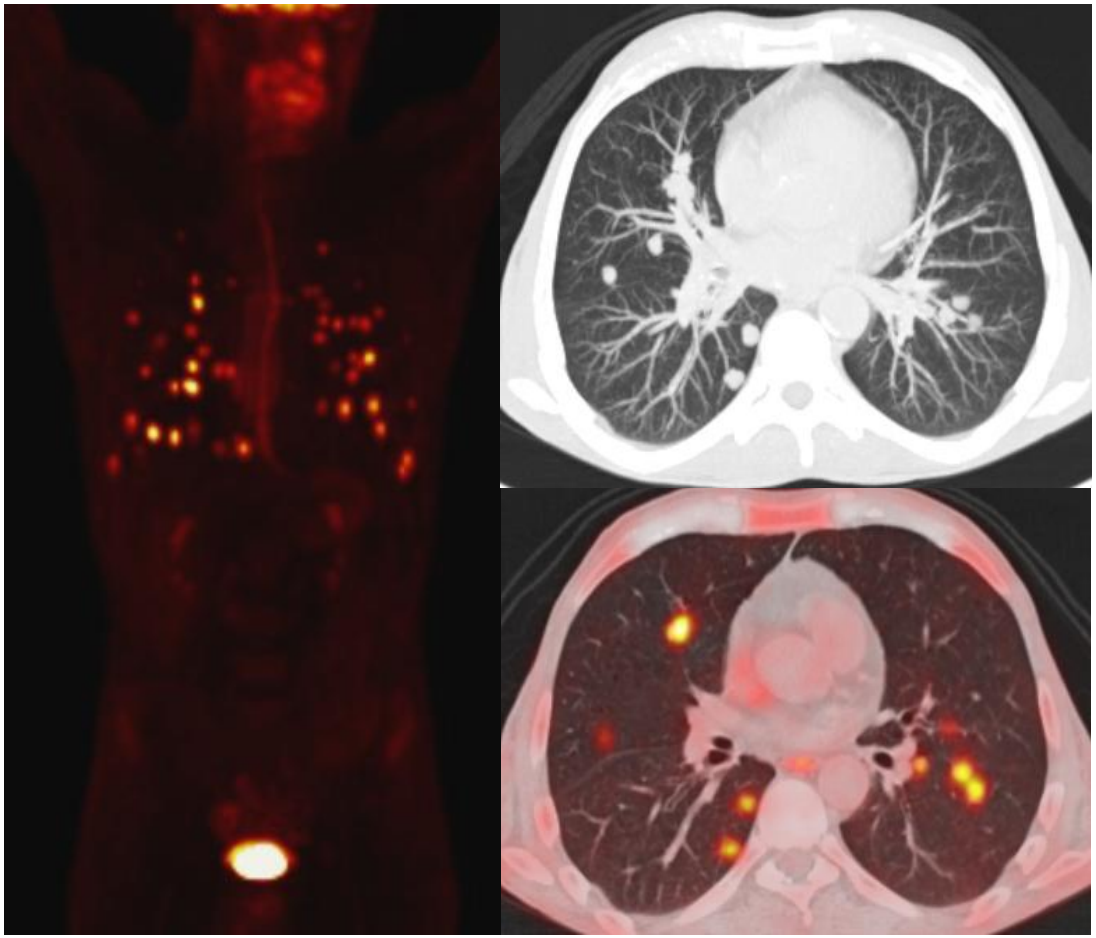


Sensitivity 84-100%
Specificity 61- 93%

06/02/2012

01/10/12



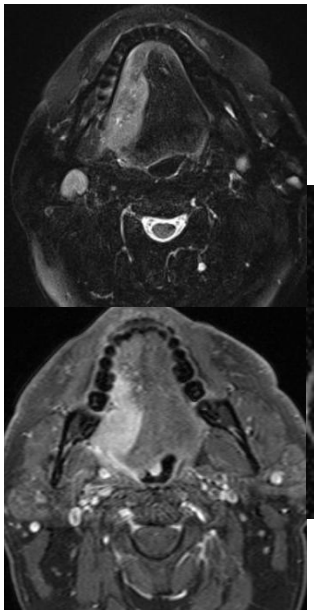


Oropharynx T4 N2c lung M1

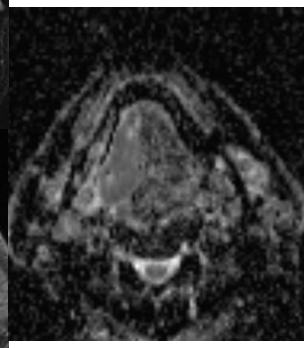
Post RTx

Inflammatory effects from RT or QT may contribute to inaccuracies by FDG-PET scans performed at early

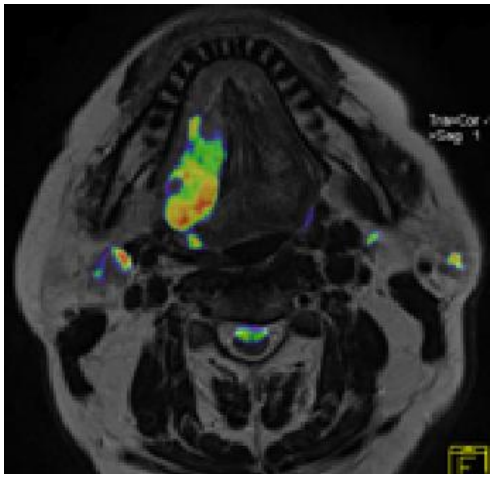
PET/CT FP (< 3 MONTHS)

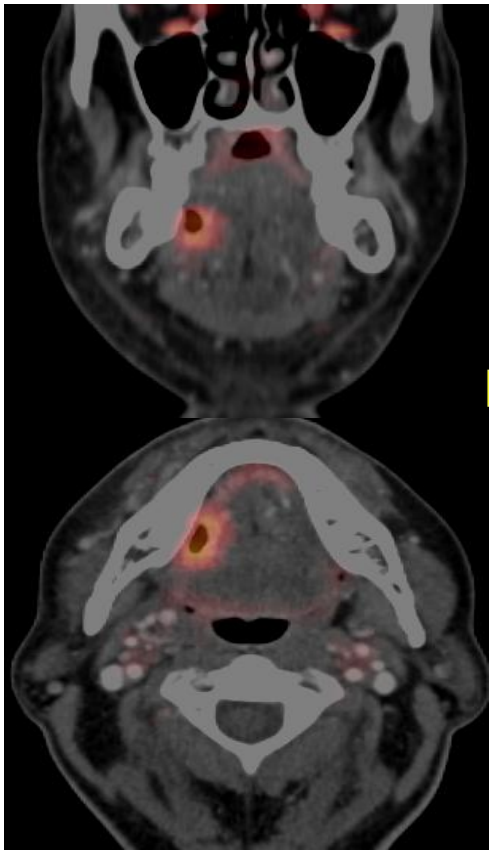


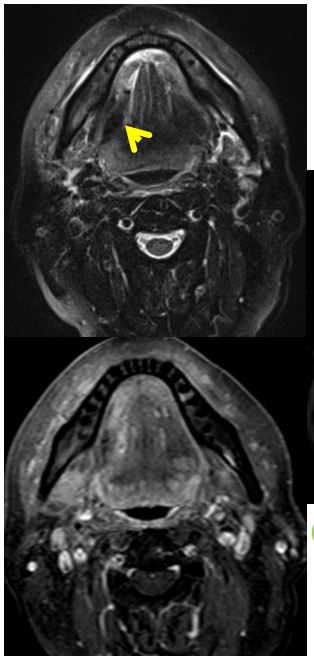
03/04/2013

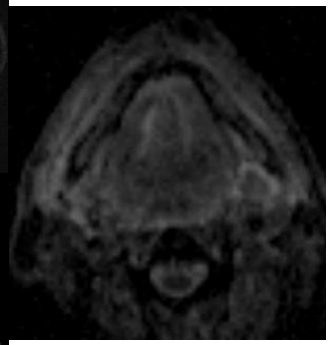


CDA 0.9 X 10-3



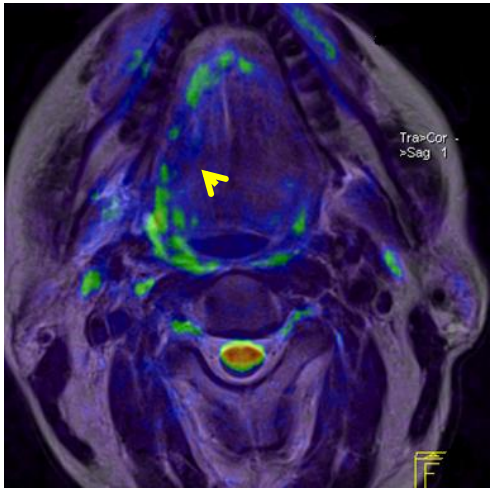


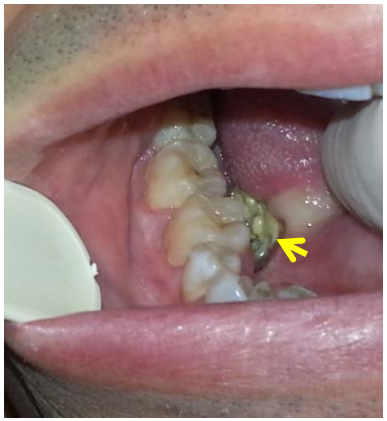




CDA 1.3 X 10-3

22/08/2013





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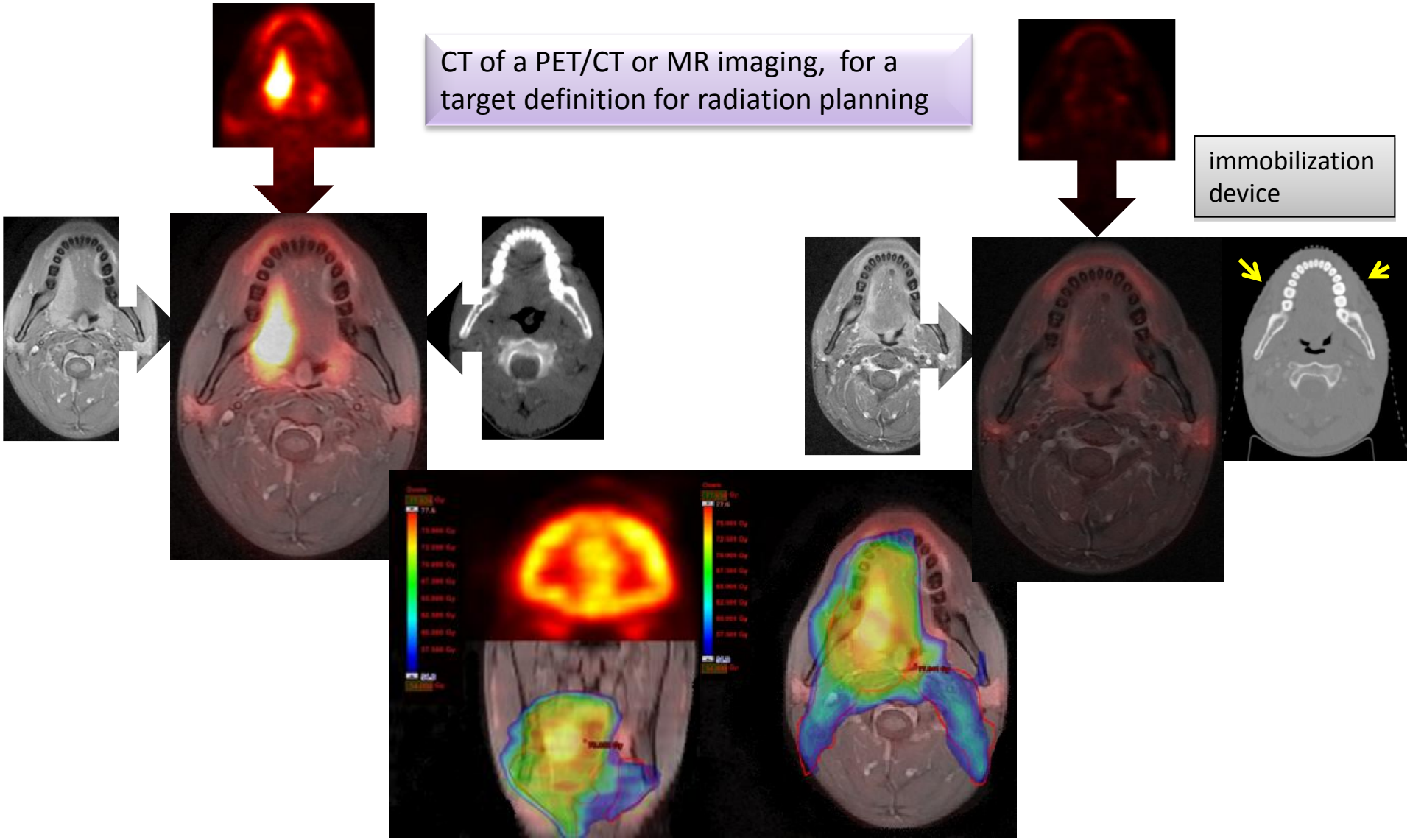
PET/CT FOR IMRT PLANNING

CT of a PET/CT or MR imaging, for a target definition for radiation planning

immobilization device



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Indications CT / MR

Tumor staging (T & N)

Unknown Primary Cancer.

Monitoring treatment

Indications PET/CT

Tumor staging (N & M)

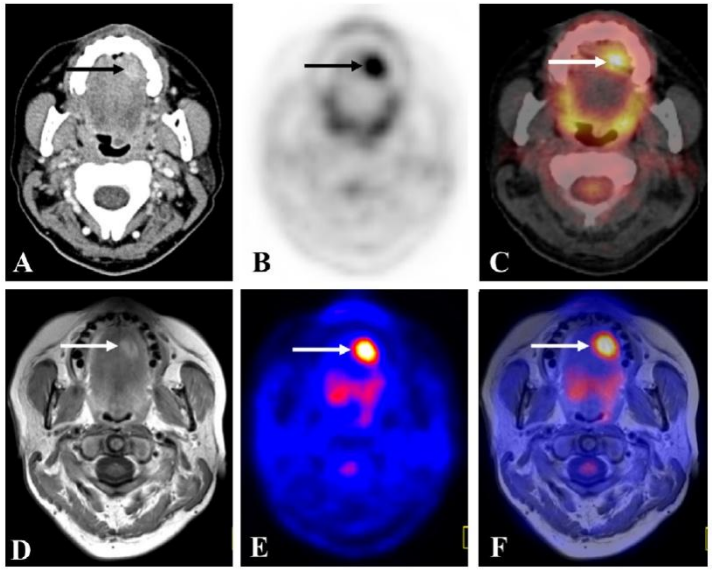
Unknown Primary Cancer **if**
MRI / TC –
Recurrence diagnosis

FDG PET/CT should be avoided in

Poor prognosis and advance cancer stage (paliative)

No relevant therapeutic impact on inevitable decease

PET-RM



Eur J Radiol (2011), doi:10.1016/j.ejrad.2011.10.005

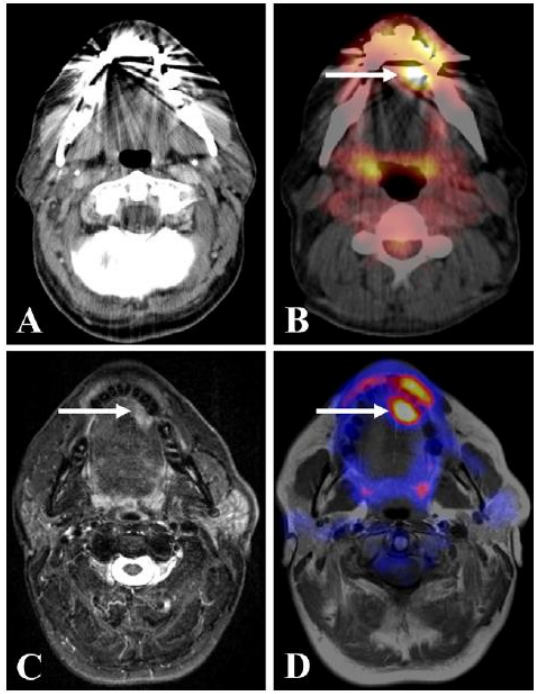
BrainPET* for MAGNETOM Trio, A Tim System

Advantages

Precise delineation of recurrence
Characterization of lymphadenopathy

Exclusion of perineural spread
Radiotherapy planning
Artifacts Metal

Increased sensitity /specificity



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Summary

-MR is more available, lower cost and with high contrast resolution, which provides better assessment of the primary tumor.

-PET-CT is superior to MRI in detecting lymph node metastases, synchronous tumors and distant metastases, so you should consider its use especially in advanced stages, because you can change the staging and therapeutic approach.

-**Both techniques should be considered complementary and not exclusive** which ever value in each particular case, the need to use them in isolation or together.

-Further analyses will be necessary, however, to determine the cost-effectiveness of routine