

PET-CT (MRI) in Head and Neck Cancer

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Outline

- PET-CT vs. PET-MRI
- Indications
- TNM staging
- Post-treatment evaluation
- Pitfalls
 - False Positives
 - False Negatives

PET-CT vs. PET-MRI

Head and Neck Cancer

PET-CT

- Established
- Less expensive
- Fast
- Whole body scanning
- Lung nodules better seen
- Attenuation correction/SUV straightforward
- Limited soft tissue resolution
- Metal artifacts worse

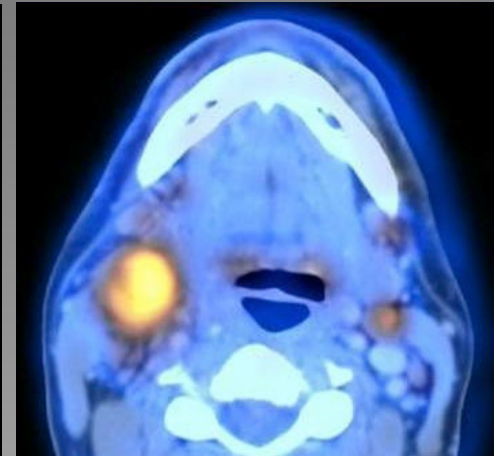
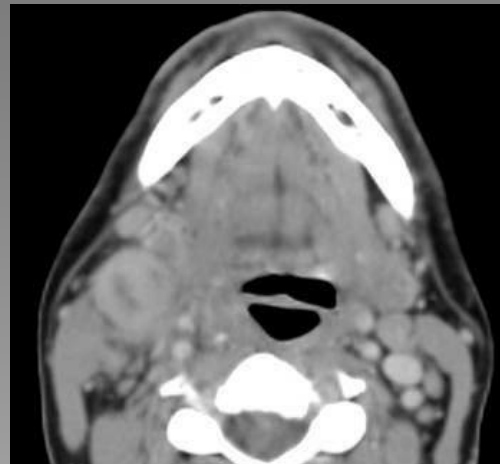
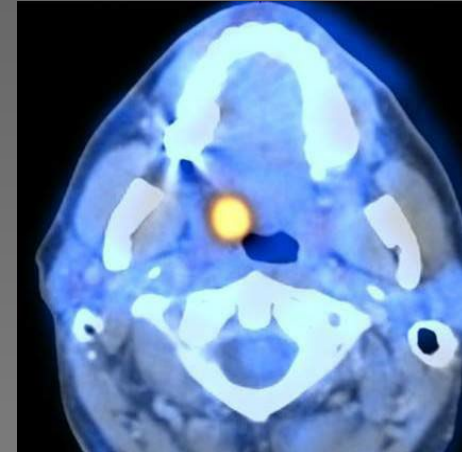
PET-MRI

- Superior soft tissue resolution
- Metal artifacts less
- Expensive
- Longer acquisition
 - Simultaneous scanning
- Small lung nodules missed
- Attenuation correction/SUV improved but not the same
- Coils and counts works in progress
- Clinical applications still being defined
- MRI technology catching up

40 yo man with enlarged tonsil

- What is your diagnosis?

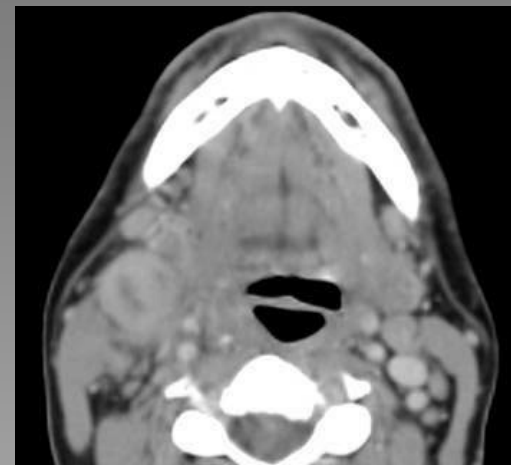
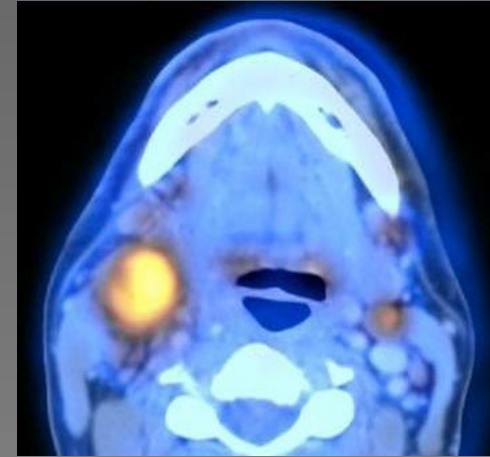
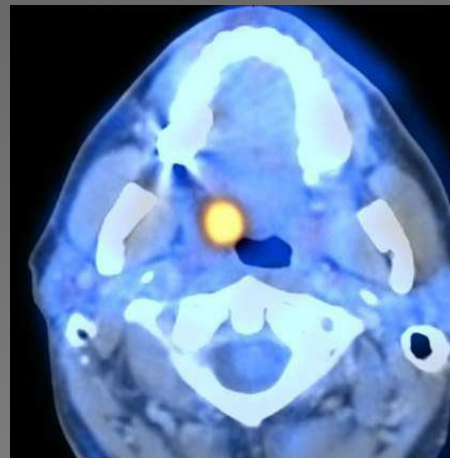
1. Tonsil Ca+ bilat adenopathy
2. BOT Ca+ bilat adenopathy
3. Tonsil Ca+ right sided adenopathy
4. BOT Ca+ right sided adenopathy
5. None of the above



40 yo man with enlarged tonsil

- What is your diagnosis?

1. Tonsil Ca+ bilat adenopathy
2. BOT Ca+ bilat adenopathy
3. Tonsil Ca+ right sided adenopathy
4. BOT Ca+ right sided adenopathy
5. **None of the above**



FALSE POSITIVE - Inflammatory nodal disease

- Right palatine tonsil SUV max. 9.2
- Right IIa node max. SUV 4.3
- Tonsillectomy: squamous mucosa with ulceration and inflammation. No evidence of carcinoma.
- Biopsy lymph nodes: acute lymphadenitis lymphogranuloma venereum.
- Adenopathy resolved within 3 months.

FDG-PET

- FDG acts as a glucose analog
- Provides a measure of metabolic activity of tissue
- Not specific to tumor

Question

- PET-CT is most helpful in which of the following scenarios in H&N Ca.?
 1. Establishing diagnosis of cancer
 2. T staging
 3. N staging
 4. M staging
 5. Post-treatment follow-up

Question

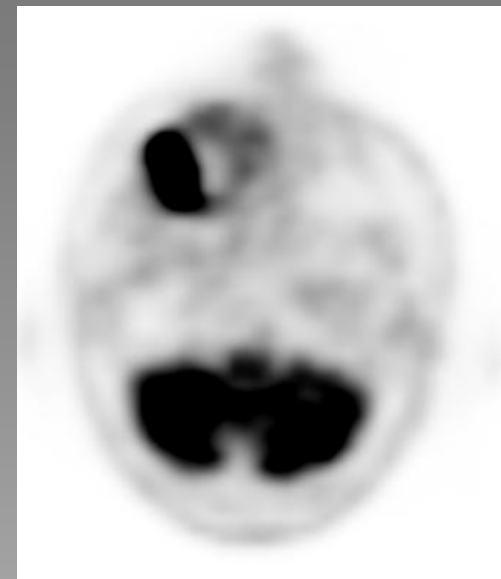
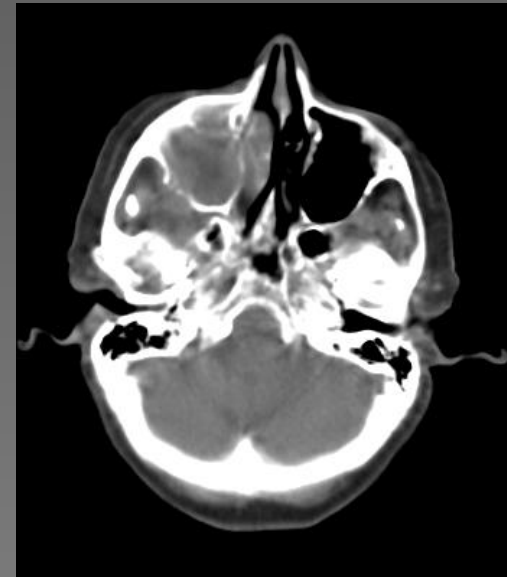
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Head and Neck Cancer

- 45 K/ year new cases excluding thyroid Ca.
- 1/3 early diagnosis
- 2/3 advanced stage
- Treatment options
 - Surgery: Primary tumor, nodal dissection, minimally invasive
 - Radiotherapy: IMRT, Brachytherapy, proton, neutron
 - Chemotherapy
- Trade off
 - Oncological outcome
 - Quality of Life

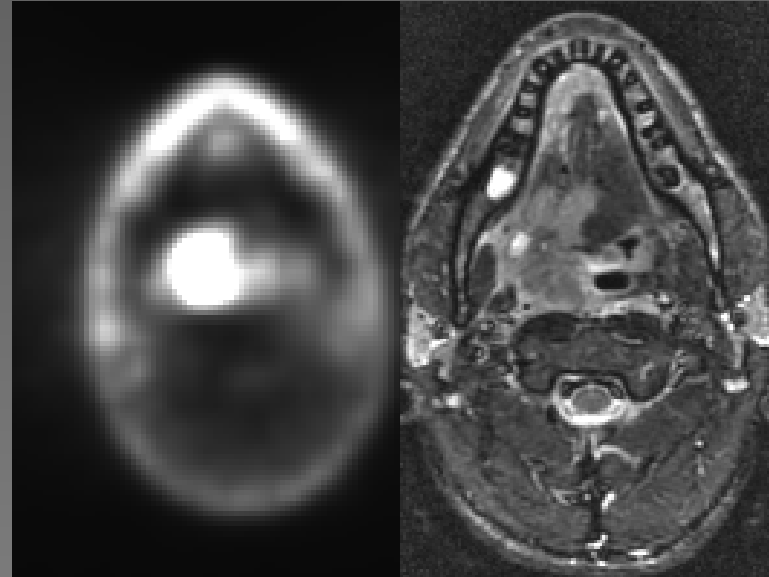
TNM Staging

- To determine the best course of action
- Clinical exam
 - Office endoscopy
 - Panendoscopy under GA
 - Biopsy
- Imaging
 - US
 - CT
 - MRI
 - PET-CT
 - PET-MRI
- Pathology
- PET-CT better than CT/MRI individually at staging



PET-CT(MRI) and T-Staging

- Primary tumor
 - Site
 - Size
 - Depth
 - Extension to neighboring structures
 - Perineural spread
- High resolution imaging/panendoscopy
“informed by PET”



N-Staging

- Is there a nodal met? (N0 x Nn)
- Number and size
- What nodal site(s) involved?
- Is there extracapsular spread?

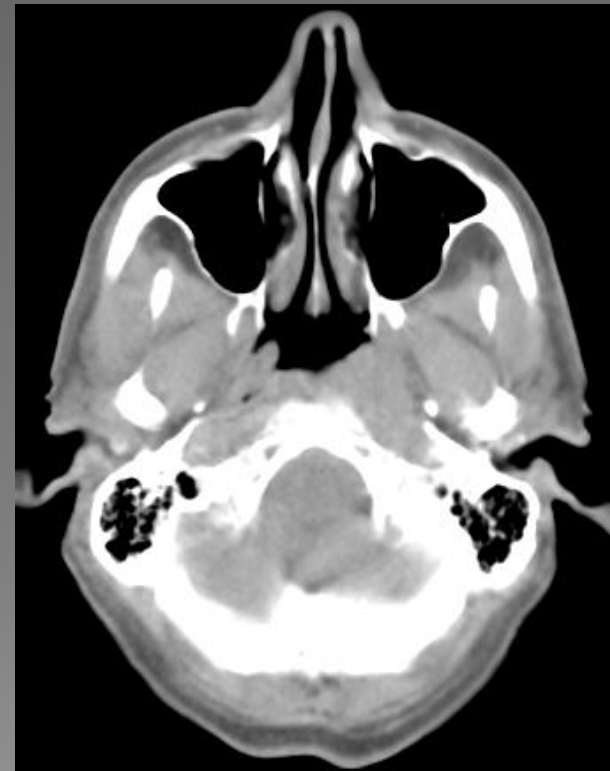
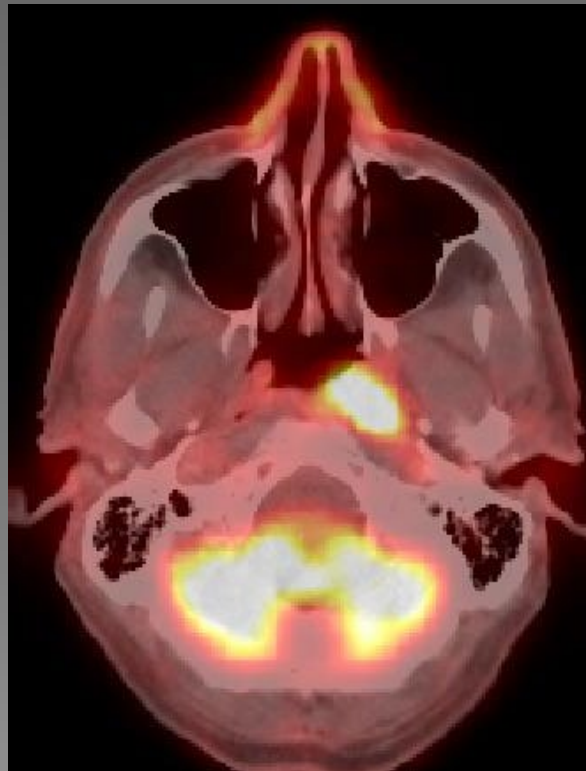
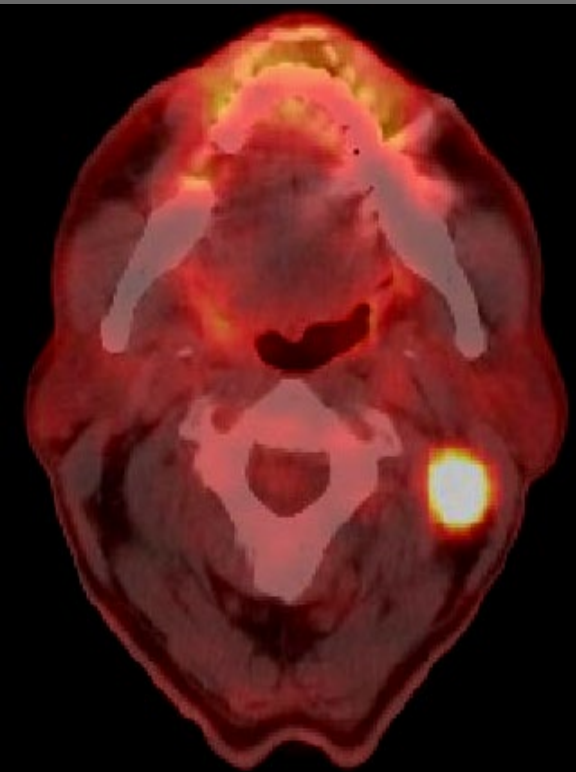
Nodal Metastasis and PET-CT(MRI)

- Sensitivity ~ 70-90 %
- Specificity ~ 80-95 %
- NPV~90%
- Slightly superior to anatomic imaging

SCC Unknown Primary and Nodal Metastasis

- 2-5% of HN cancer
- No clinical or imaging evidence of primary Ca.
- Decreasing prevalence
- Tonsillectomy and blind biopsy
- PET-CT may reveal the primary in 15% -30%

“Unknown Primary”



PET-CT and M-Staging

- Distant metastasis; advanced disease
 - Lungs, mediastinum, bones
- M0 x M1; upstages to IV, impacts treatment
- PET-CT covers the entire body
- Sensitivity 94%, specificity 90%
- False positive

Post-treatment Evaluation

- Difficult radiologic and clinical assessment;
 - Anatomic deformity
 - Fibrosis
 - Inflammation
- Clinic/CT/MRI follow-up
- Enlarging “lesion” → recurrent tumor
- New treatment strategies mandate close follow-up and early recognition of treatment failure; “salvage therapy”

Question

- What is the best time to image following completion of RT?
 - 4 weeks
 - 8weeks
 - 12 weeks
 - 16 weeks

Question

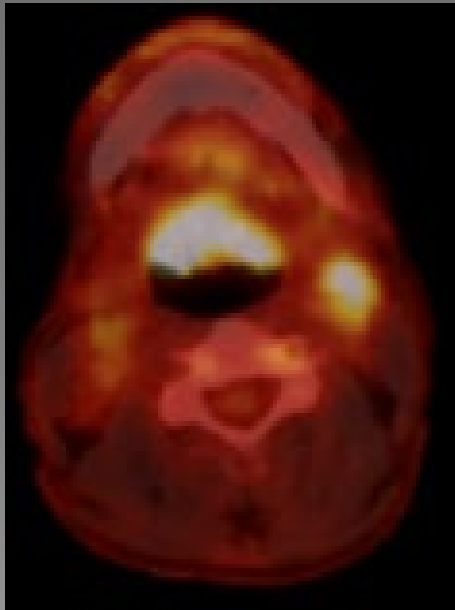
- What is the best time to image following completion of RT?
 - 4 weeks
 - 8weeks
 - 12 weeks
 - 16 weeks

Timing

- Significant edema and inflammation early after treatment.
- Inflammation picks up FDG
- Tissue reaction varies depending on type of treatment: **Radiotherapy**, surgery, chemo

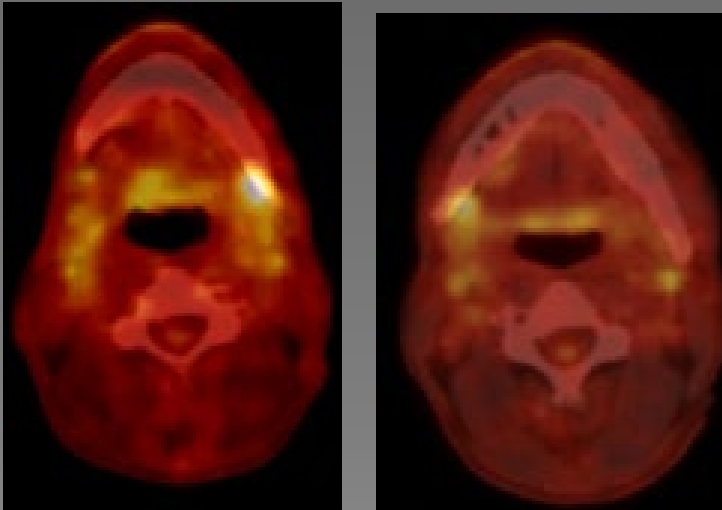
F/U after CRT: Case

- Pre-treatment PET/CT
- 56 yo man
- CT: larger than 3 cm, infiltrating BOT and bilateral adenopathy (T2N2c)
- Biopsy: Infiltrating basaloid SCC



Post CRT Inflammation

- 2 mo Post CRT PET/CT

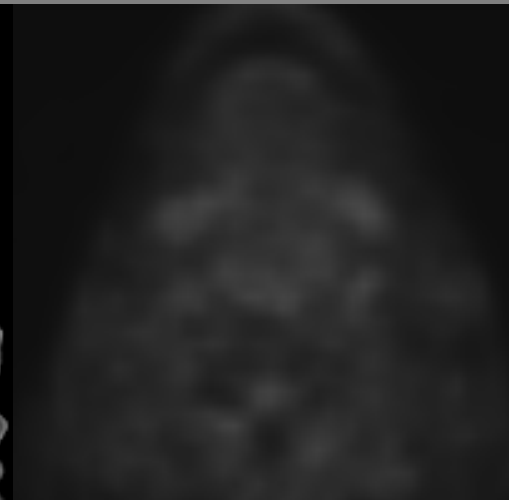
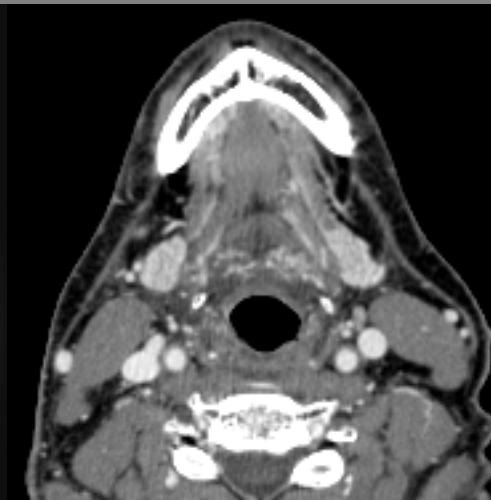
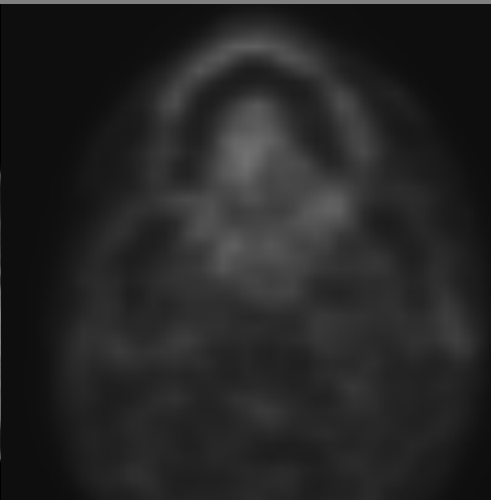
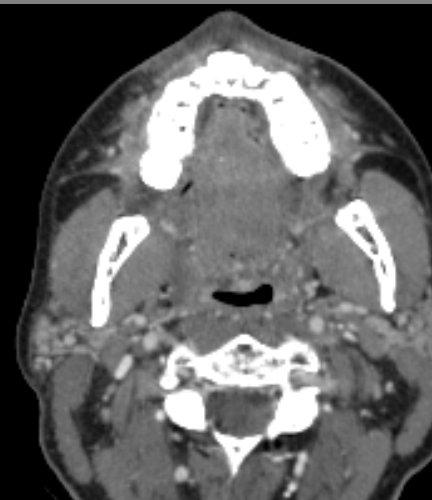
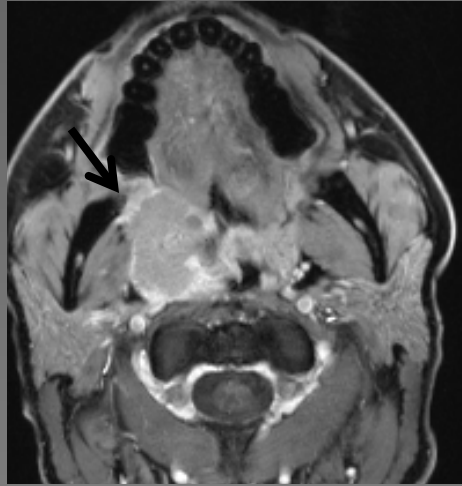


- Endoscopy and biopsy: primary negative
- Bilateral neck dissection: negative (~100 nodes)

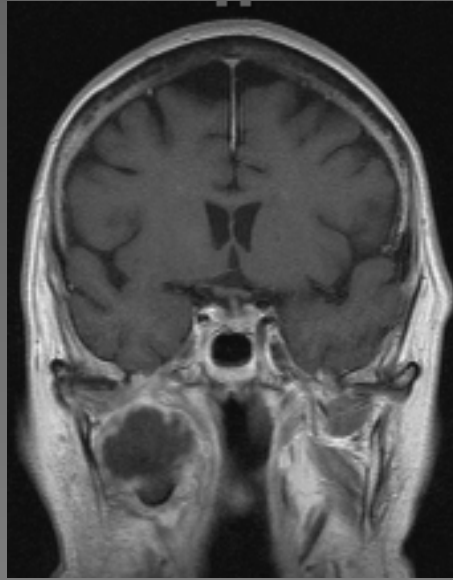
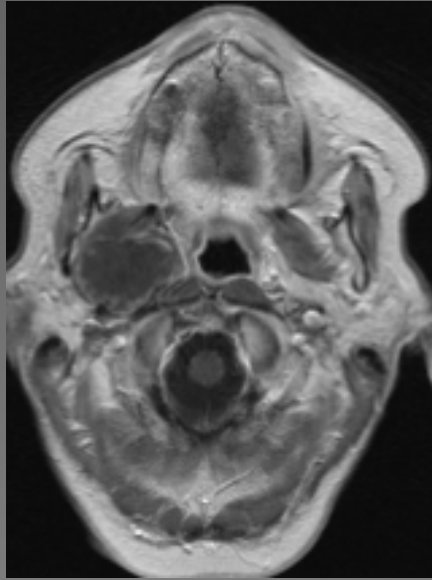
Timing

- Within 4 weeks 70%-80% intense FDG uptake (false +)
- False+ rate decreases gradually, minimum after 4-6 months.
- 12 weeks is a good compromise in most cases

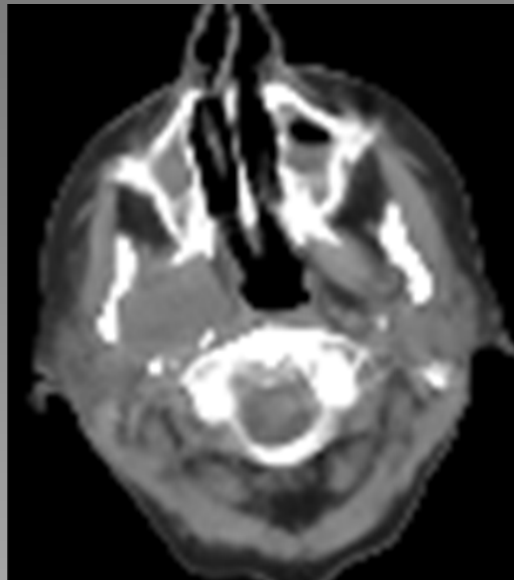
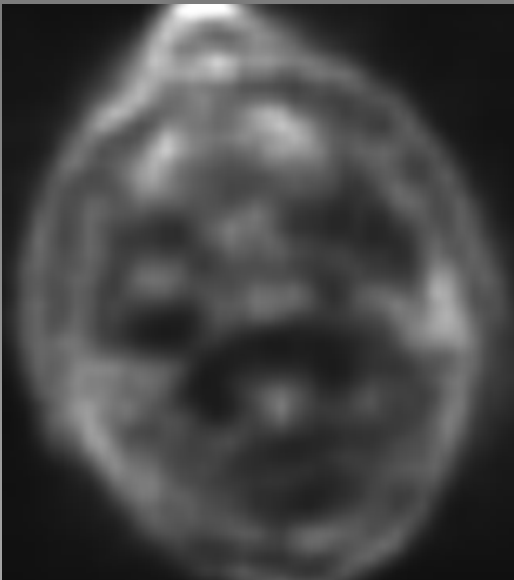
T2N2a SCC of Oropharynx: Complete Response



Parotid deep lobe Ca.



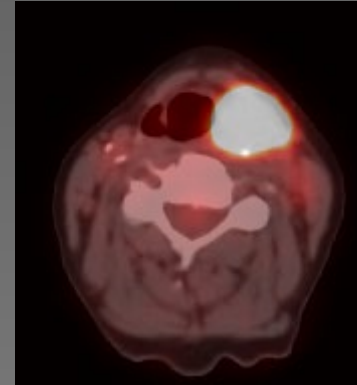
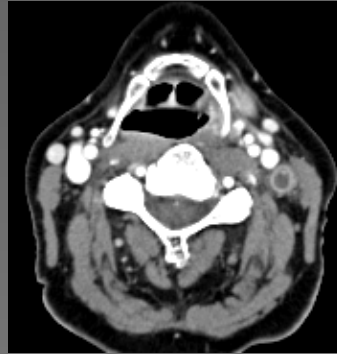
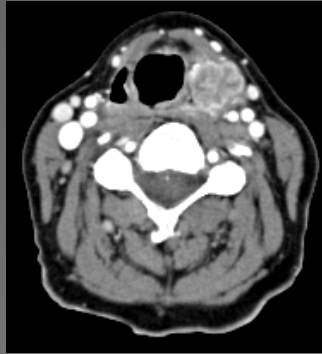
Baseline



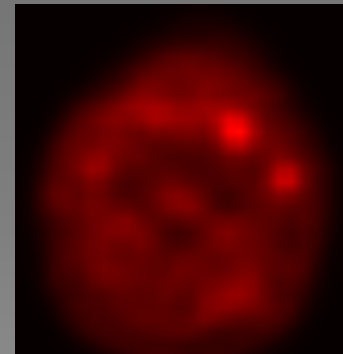
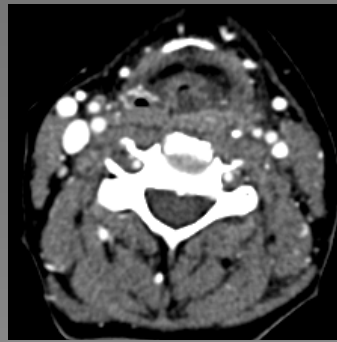
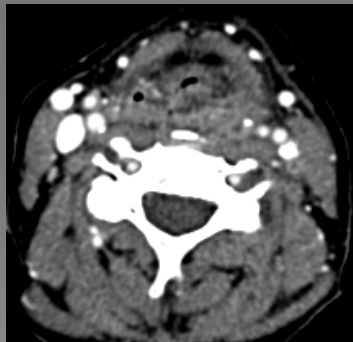
F/U

T4a N2b Piriform sinus SCC s/p CRT: Partial Response

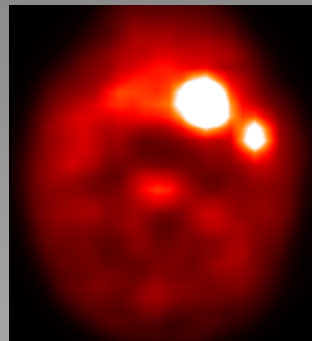
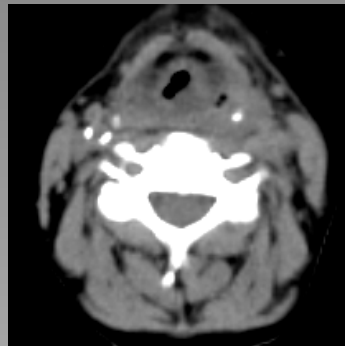
Baseline



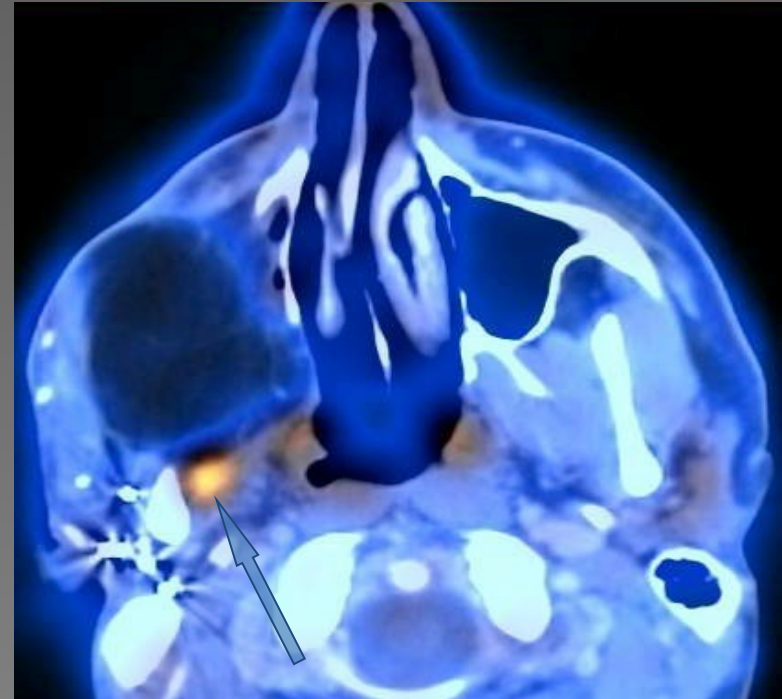
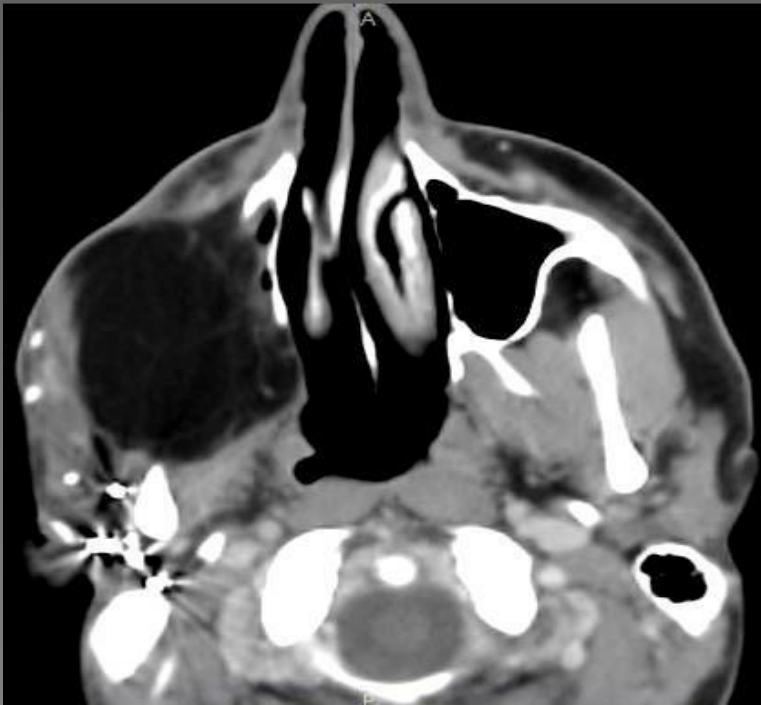
3-month fu



5-month fu



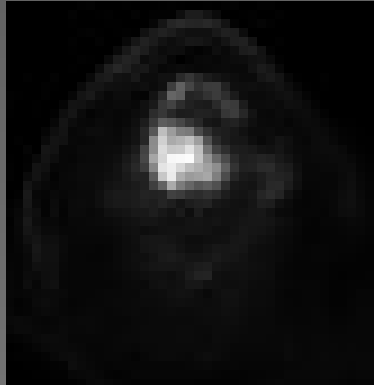
Status post surgical resection with myocutaneous flap



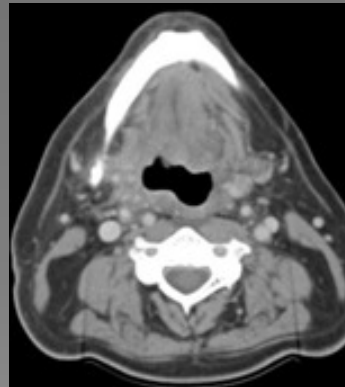
recurrent rhabdomyosarcoma

- Normal muscle flap may simulate disease particularly after recent surgery. Careful correlation with operative records, pathological record and patient symptoms is necessary.

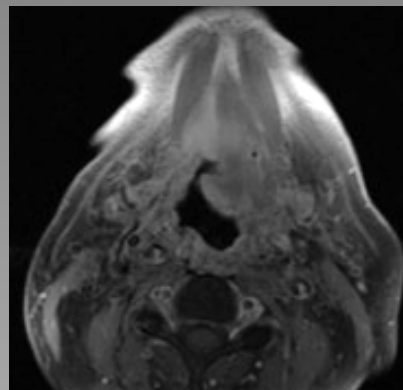
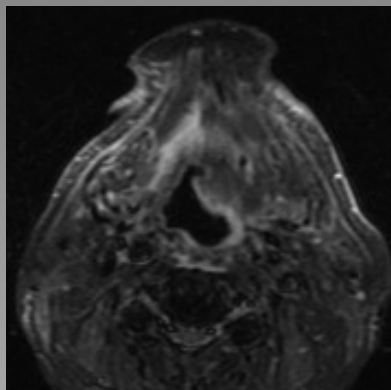
Soft Tissue Radiation Necrosis



Pre-tx



1st F/U



F/U MRI

Question

- Which of the following PET-CT(MRI) results is least frequent after CRT?
 1. True positive
 2. True negative
 3. False positive
 4. False negative

Question

- Which of the following PET-CT results is least frequent after CRT?
 1. True positive
 2. True negative
 3. False positive
 4. False negative

Meta-analysis of PET following RT or CRT

- 27/1871 studies reported accuracy data

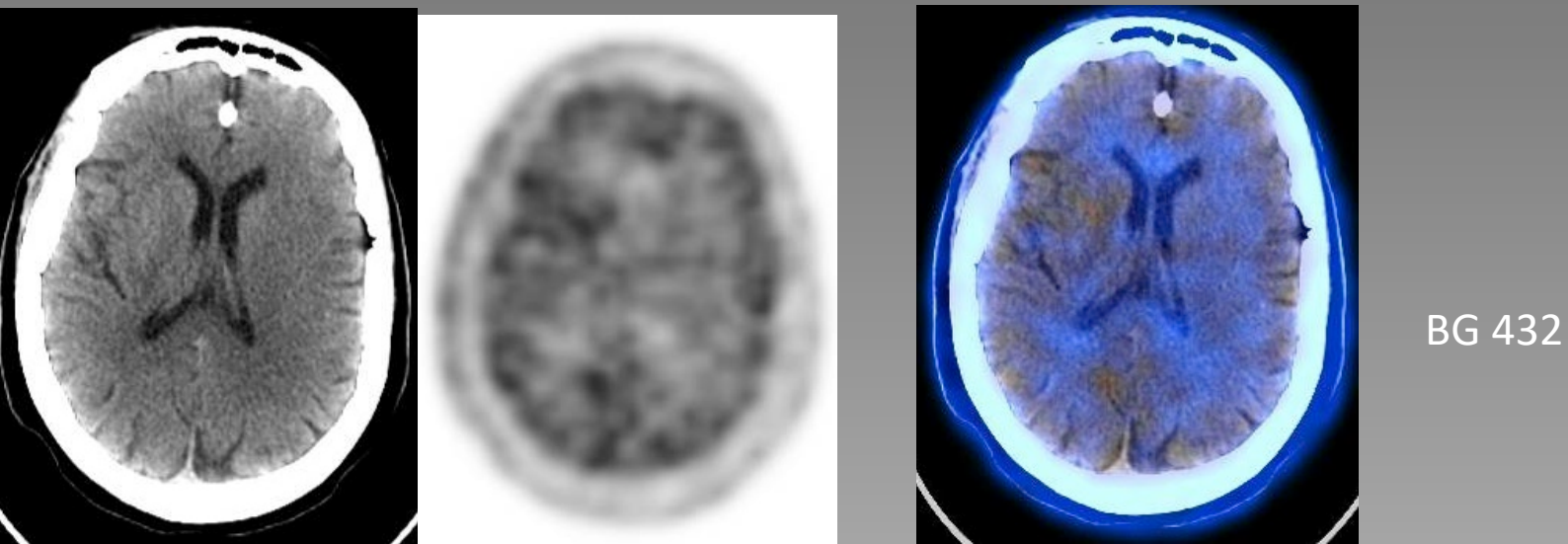
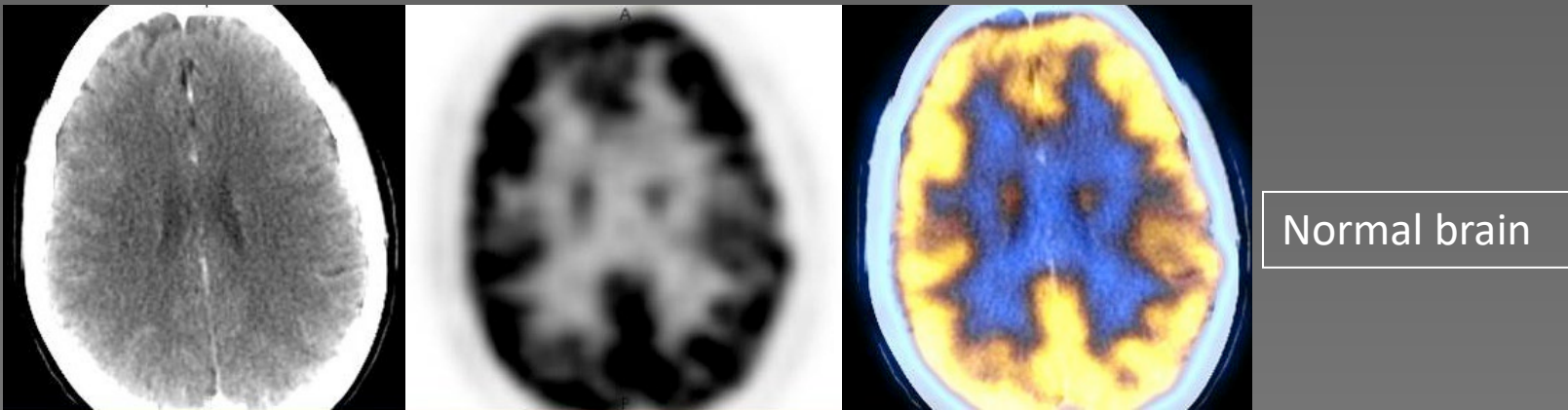
	Primary site	Neck disease
Sensitivity	94% (95% CI: 87-97%)	74% (95% CI: 50-89%)
Specificity	82% (76-86%)	88% (74-95%)
PPV	75% (68-82%)	49% (29-70%)
NPV	95% (92-97%)	95% (84-99%)

- Meta-analysis of PET by Isles MG, et al Clin.Otolaryngol 2008: 33, 210-222

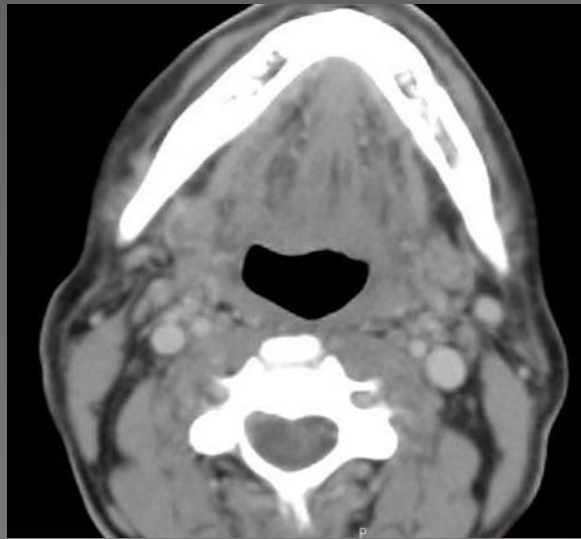
False Results in PET

- Pitfalls in image **ACQUISITION**
- **Technical**
 - Blood glucose
 - Weight
- **Patient Related**
 - Muscle activity
 - Motion
- Pitfalls in image **INTERPRETATION**
- **FDG avid benign tissue**
 - Inflammation
 - Benign tumors
- **FDG avid normal tissue**
 - Tonsils
 - Salivary gland
 - Brown fat
- **Low grade malignancy**
 - Well-differentiated thyroid Ca
 - Salivary gland Ca.
- **Small tumor**
 - Perineural spread
 - Micrometastases

ACQUISITION - Abnormal glucose metabolism

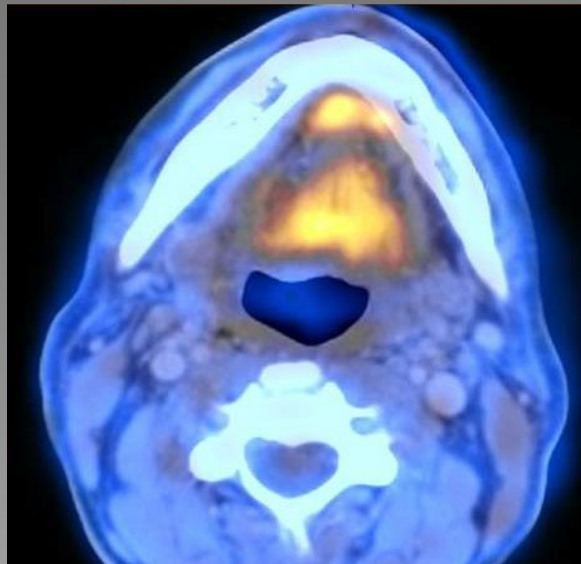


ACQUISITION - Tongue motion

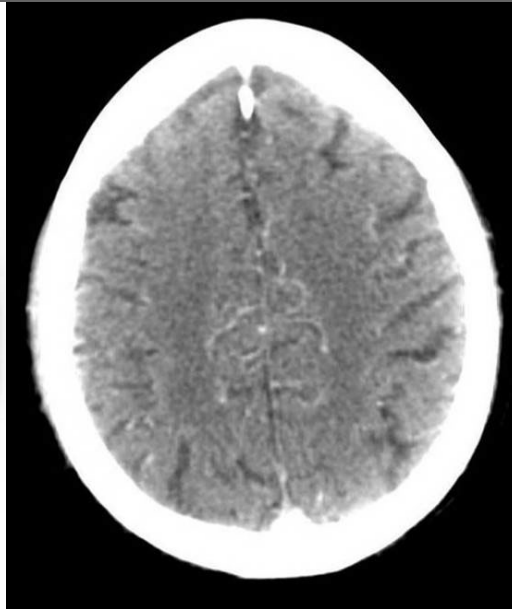


xerostomia

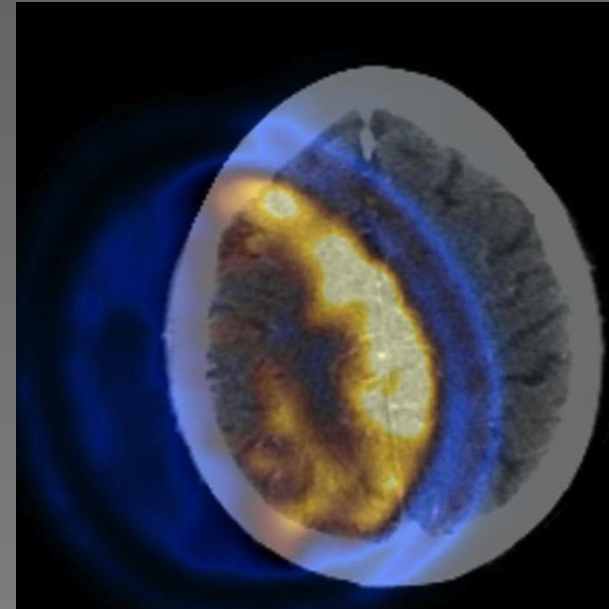
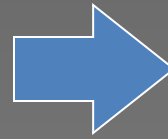
- The technologist reported that the patient continually tried to moisten his mouth during accumulation phase.

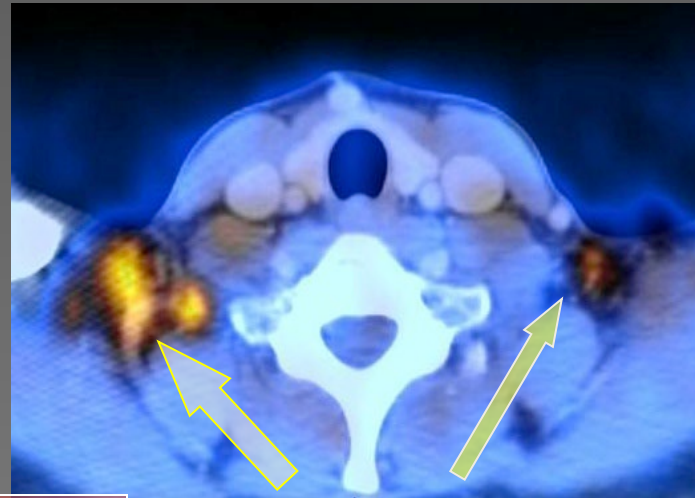


ACQUISITION - Misregistration due to patient motion

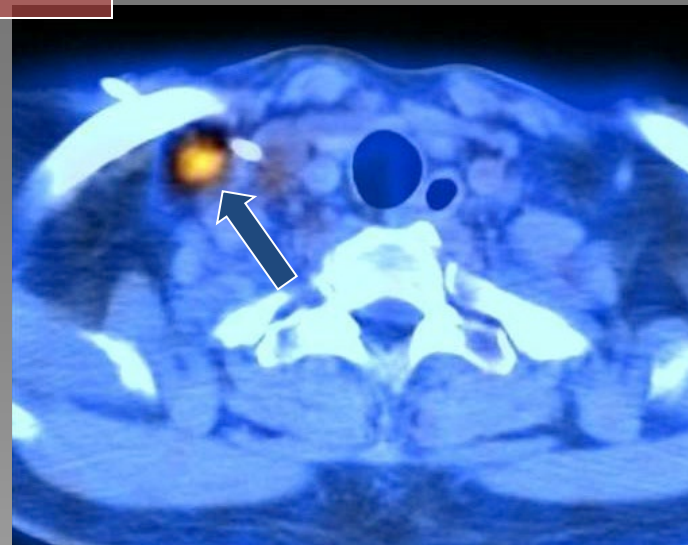
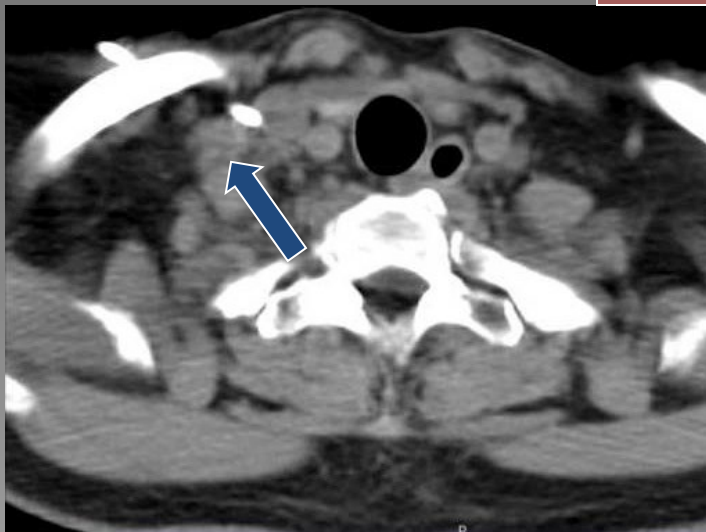


head tilt



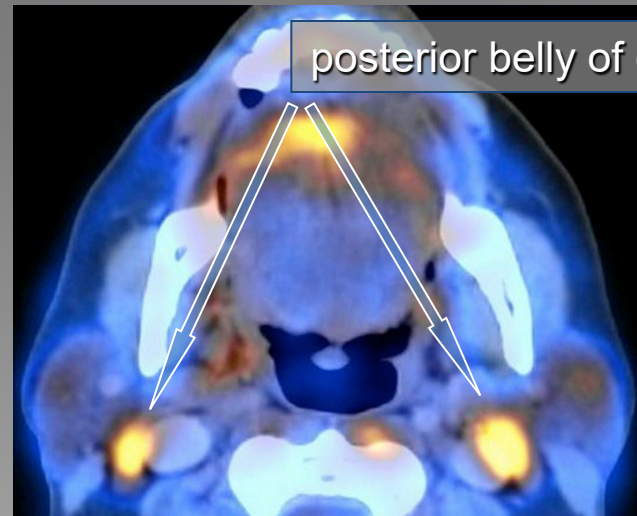
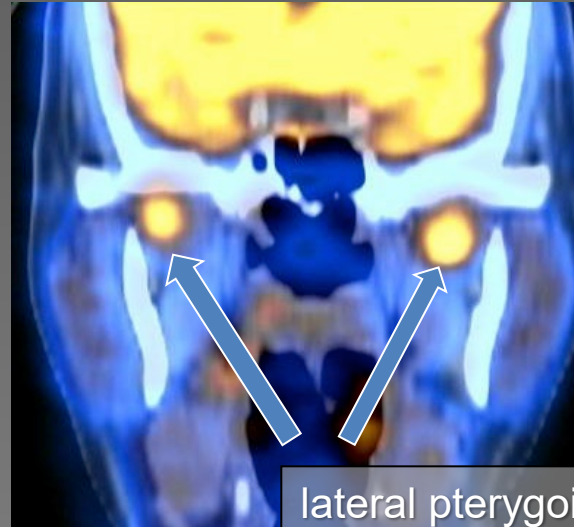


brown fat

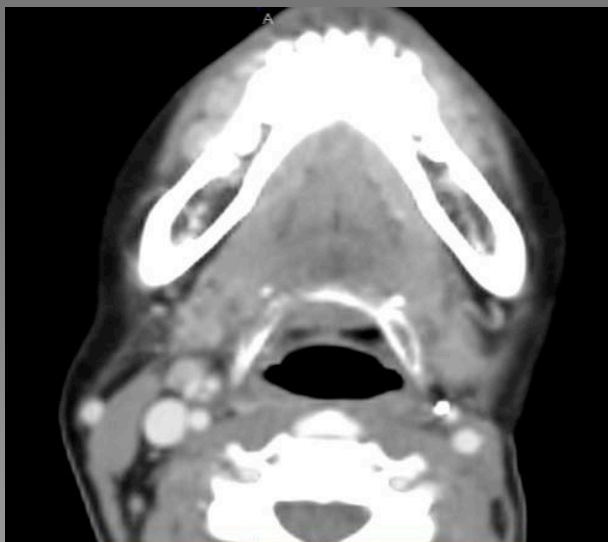
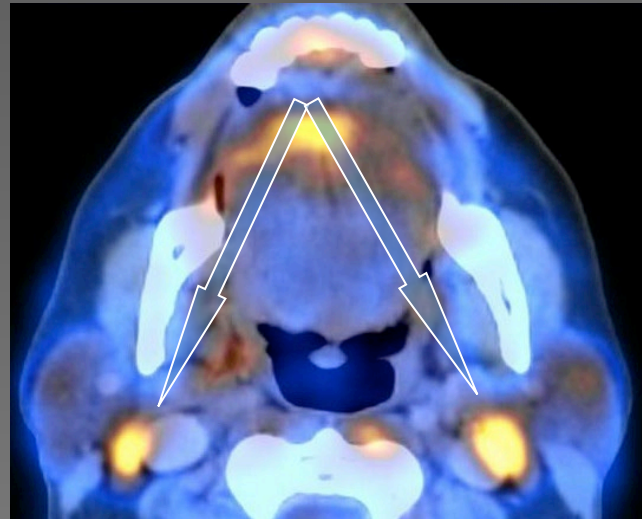


metastatic adenopathy

ACQUISITION - Misdirection of radioisotope secondary to excessive muscle activity

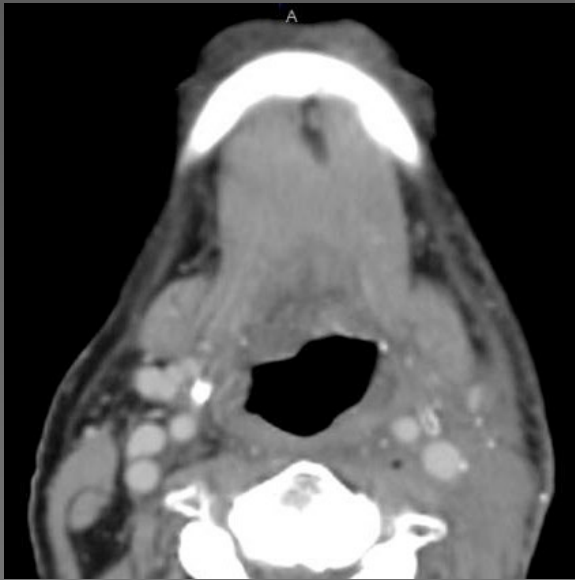


posterior belly of digastric muscles



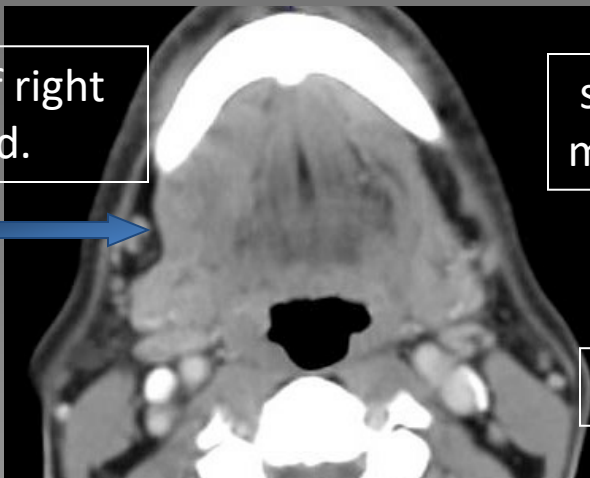
Ila lymph node

Looks like: normal muscle activity
Diagnosis: pathologic lymph node



mylohyoid muscle

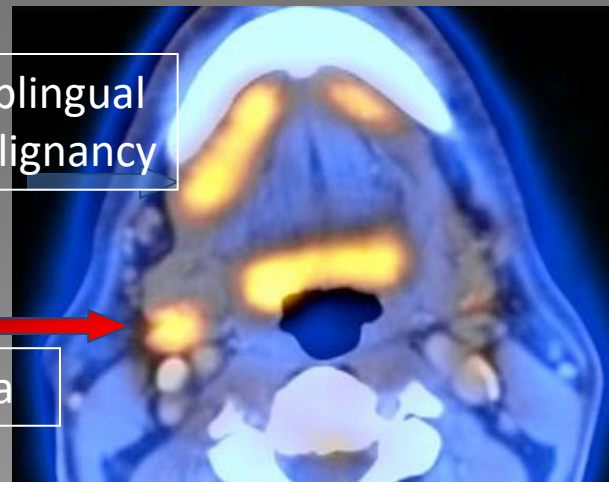
enlargement of right sublingual gland.



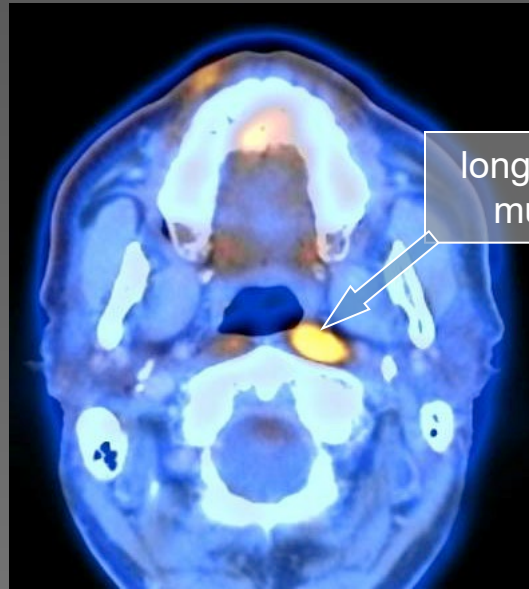
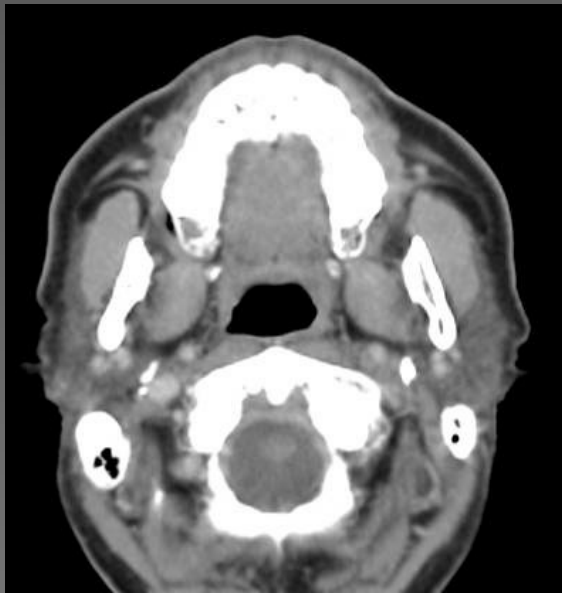
sublingual malignancy



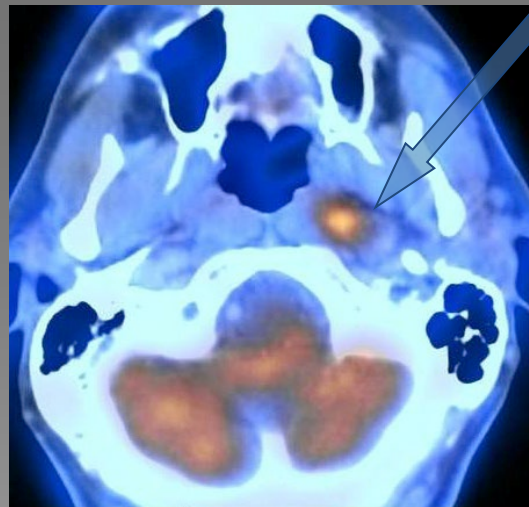
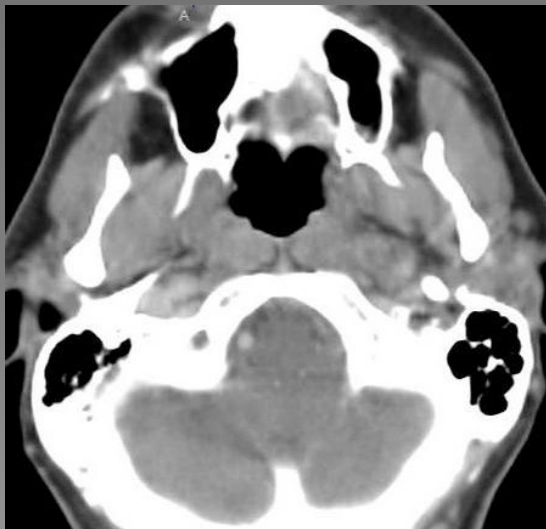
Ila



Adenoid cystic carcinoma of the right sublingual gland



longus colli
muscle



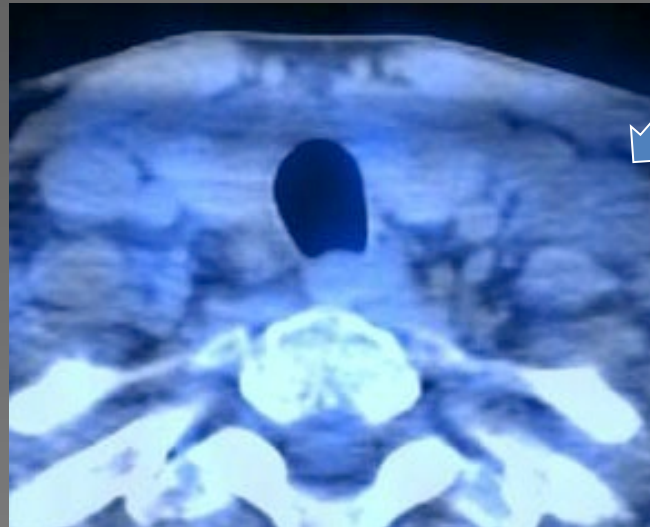
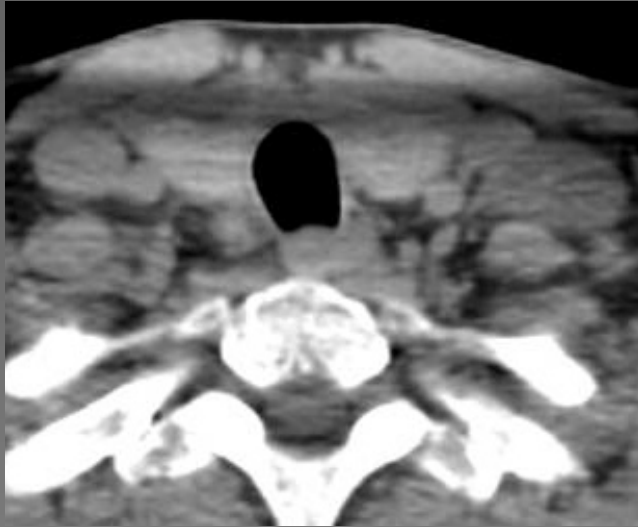
retropharyngeal
lymph node

Looks like: excessive muscle activity
Diagnosis: pathologic lymph nodes

Thyroid Ca and PET

- Well-differentiated Thyroid Ca may not be FDG avid (radioiodine better)
- Poorly differentiated thyroid Ca may not be radioiodine avid (FDG-PET better)
- 30-35 % of incidental PET + thyroid nodules are malignant
- Hashimoto's thyroiditis causes diffuse FDG uptake

FALSE NEGATIVE - Well-differentiated carcinoma



- Well-differentiated papillary thyroid carcinoma
- Enlarged level III and IV nodal disease on the left side of the neck are nonhypermetabolic.
- staging.I-131 whole body scan provides functional staging in cases of well differentiated thyroid malignancies.

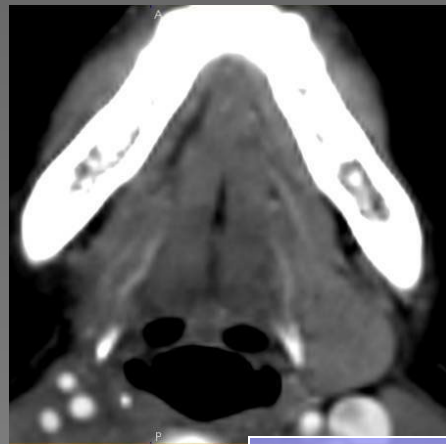
Salivary Gland Ca and PET

- Great histopathologic variability in tumor aggressiveness
- Lower sensitivity (increased background)
- Lower specificity (benign tumors)
- Incidental parotid FDG uptake
 - Diffuse
 - Focal

FALSE NEGATIVE - Malignancies with low metabolic activity



Sublingual gland mucoepidermoid carcinoma



Mylohyoid m.

- 75-year-old woman with recurrent mucoepidermoid carcinoma of the right sublingual gland presenting with mean SUV up to 3.1
- Salivary gland neoplasms may not be FDG avid

FDG PET/CT may not be as reliable

Summary

- PET-CT(MRI) should not be used before establishing cancer diagnosis
- FDG is not specific to tumor or malignancy
- Indispensable in post-tx f/u
- Many sources of false results
- Should always be interpreted within the clinical context