Neck Imaging Reporting and Data System:

An Atlas of NI-RADS Categories for Head and Neck Cancer

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Disclosures

The authors have no relevant disclosures.

Introduction to NIRADS

- Developed for surveillance imaging in patients with treated H&N cancer
  - In accordance with ACR's charge to deliver patient centered, data driven, outcomes based care
- Modeled after BI-RADS system
- Aims to:
  - Provide numerical levels of suspicion to guide patient care
  - Standardize approach with linked management recommendations
  - Generate data-mineable reports to further optimize surveillance algorithms, accuracy, inter-observer variability
  - Highlight radiologists' added value in patient care

Introduction to NIRADS

- Surveillance: CECT with concurrent PET for initial follow up 12 wks after H&N cancer treatment
  - These categories are easily adapted to MR

- Limited management options:
  - Keep patient on routine surveillance if imaging is negative
  - Recommend directed inspection or shorter term follow up
  - Proceed to additional imaging: PET, MR, etc
  - Biopsy

- Therefore, simple suspicion categories were established in accordance with input from ENT, radiation oncology, hematology/oncology, and pathology colleagues to guide care

NIRADS Categories

Category 1 – No evidence of recurrence

Category 2 – Low suspicion of recurrence

Ill-defined, only mild or moderate FDG uptake

Category 3 – High suspicion of recurrence

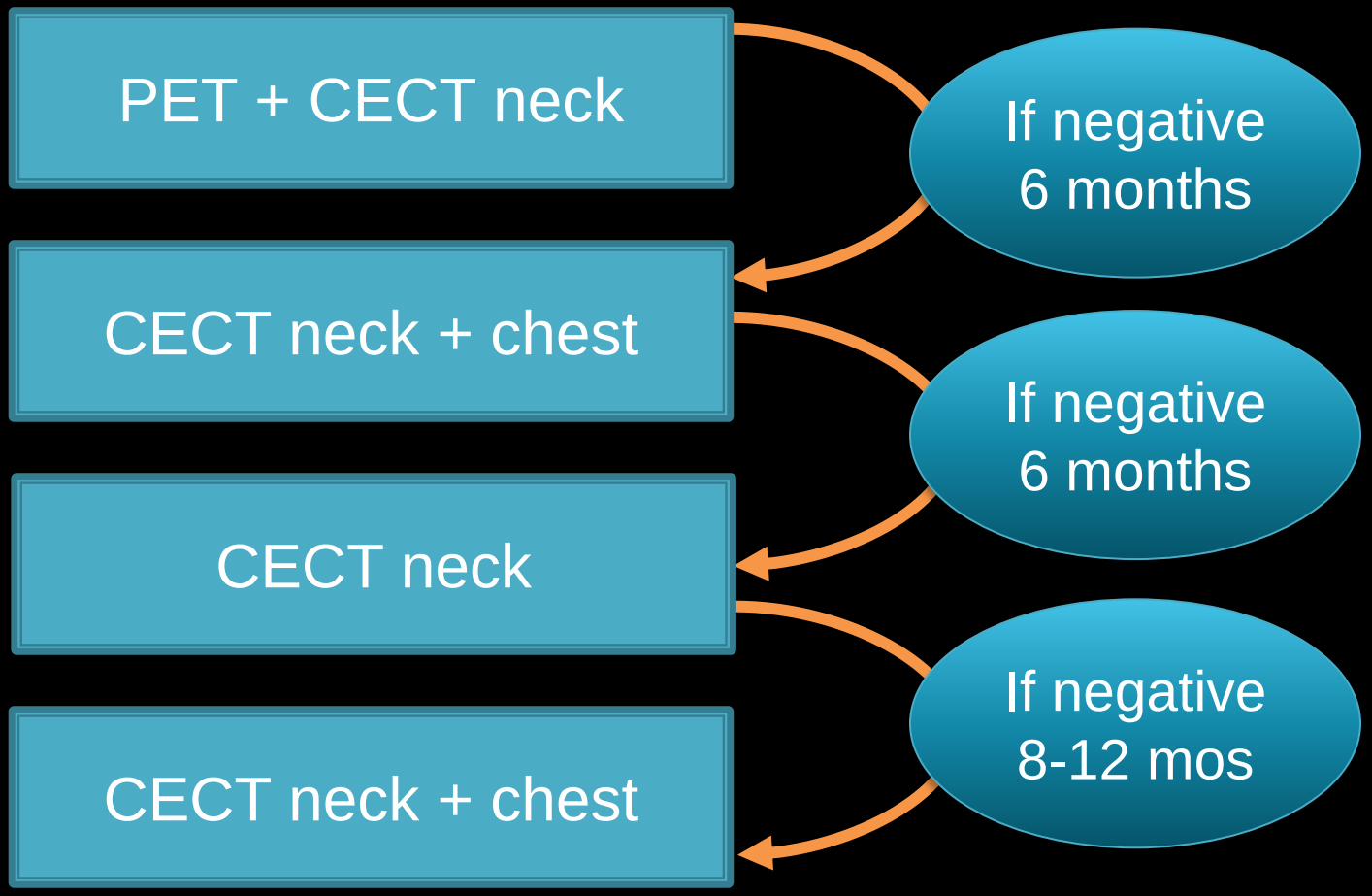
Discrete, new or enlarging, intense FDG uptake

Category 4 – Definitive recurrence

Path proven, clinical or radiographic progression

Surveillance Algorithm here

At our centers, initial follow up is 8-12 wks after surgery or completion of CRT



NIRADS Recommendations

Category	Linked Recommendation
NIRADS 1	Routine f/u (6 mo)
NIRADS 2	Short f/u (3 mo), PET, or direct inspection
NIRADS 3	Biopsy
NIRADS 4	Clinical care of recurrence

NIRADS 2 Subcategories

NIRADS category 2 is defined as questionable recurrence

Divided into two subcategories for the *primary site*:

a) **Superficial (mucosal surface) – recommend direct inspection**

b) **Deep, ill-defined soft tissue – recommend short interval f/u or PET**

NIRADS category 2 should be considered when CECT and PET findings are *DISCORDANT*:

- Robust enhancement *without* associated FDG uptake
- Focal FDG uptake *without* anatomical correlate

NIRADS Template

Findings are succinct and efficiently reported, saving time for the radiologist

In the impression, a NIRADS category is assigned to the primary site and neck separately, as they are managed separately

Distant disease can optionally be included, if the chest and abdomen are included in the scan

INDICATION: [ ]
Subsite & HPV status: [ ]
Surgery & Chemoradiation :[ ]
TECHNIQUE:

COMPARISON: [<None.>]

FINDINGS:
[<No evidence of recurrent disease is demonstrated at the primary site. >]

[<No pathologically enlarged, necrotic, or otherwise abnormal lymph nodes. >]

Expected post-treatment changes are noted including [<supraglottic mucosal edema and thickening of the skin and subcutaneous soft tissues.>]

There are no findings to suggest a second primary in the imaged aerodigestive tract.

Evaluation of the visualized portions of brain, orbits, spine and lungs show no aggressive lesions suspicious for metastatic involvement.

IMPRESSION:
Primary: [1}. [<Expected post-treatment changes in the neck without evidence of recurrent disease in the primary site >]

Neck: [1}, [<No evidence of abnormal lymph nodes.>]

NIRADS Template Legend

A legend is included at the bottom of every NIRADS report

Allows interpretation by any clinician viewing the report with direct guidance based on category making NIRADS accessible to any physician

CECT Surveillance Legend:

Primary

1: No evidence of recurrence: routine surveillance

2: Low suspicion

a) Superficial abnormality (skin, mucosal surface): direct visual inspection

b) Ill-defined deep abnormality: short interval follow-up*or PET

3: High suspicion (new or enlarging discrete nodule/ mass): biopsy

4: Definitive recurrence (path proven or clinical progression): no biopsy needed

Nodes

1: No evidence of recurrence: routine surveillance

2: Low suspicion (ill- defined): short interval follow-up or PET

3: High suspicion (new or enlarging lymph node): biopsy if clinically needed

4: Definitive recurrence (path proven or clinical progression): no biopsy needed

*short interval follow- up: 3 months at our institution

NIRADS Lexicon

Non-mass like soft tissue
- Hypo-enhancing distortion of soft tissue and fat planes (1)

Masses
- Morphology: Ill-defined (2) versus discrete (3)
- Enhancement: Mild (2) versus robust (3)
- FDG uptake relative to background: Mild (2) versus intense (3)

Mucosal abnormality
- Mucoid density (1)
- Diffuse linear enhancement (benign radiation mucositis) (1)
- Focal mucosal enhancement of FDG uptake (2a)

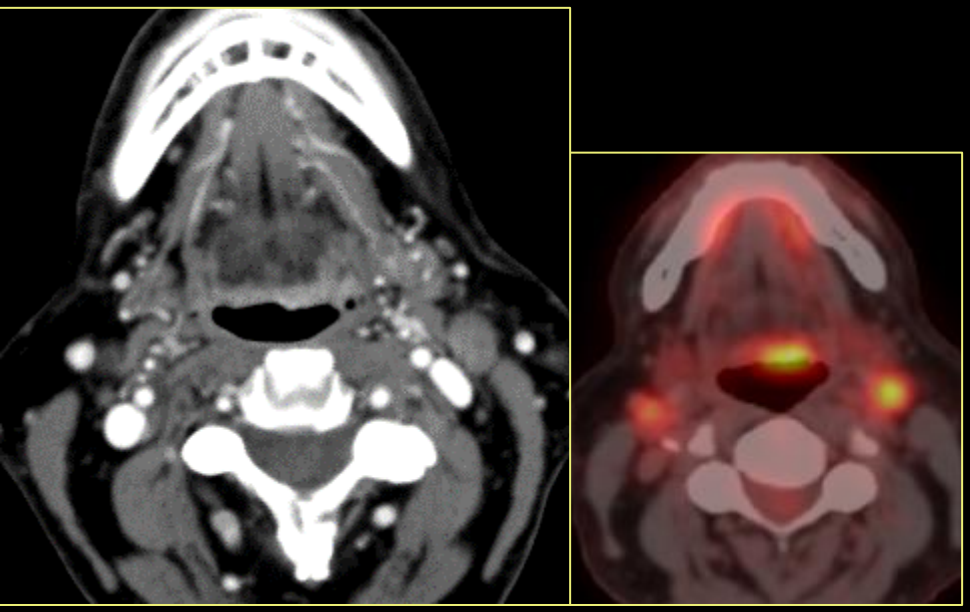
NIRADS Lexicon

Lymph nodes

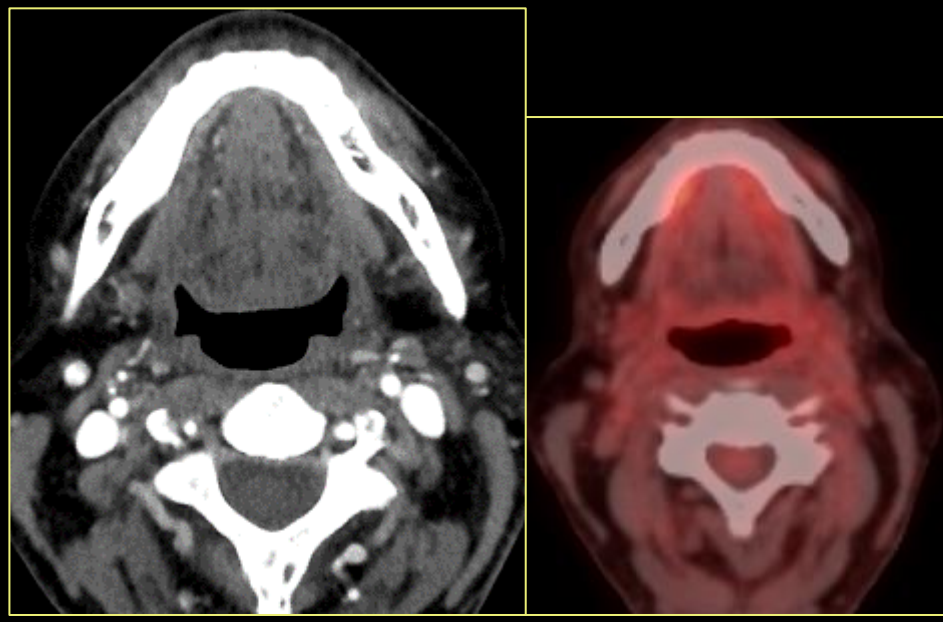
- Residual nodal tissue with:
  - No FDG uptake relative to backgroun(1)
  - Mild FDG uptake relative to background(2)
  - Intense FDG uptake relative to background (3)

- Growing lymph node:
  - Along expected nodal drainage without definite abnormal morphology (2)
  - With abnormal morphology (3)
  - With intense FDG (3 or 4)

NIRADS 1 Primary/Neck



Staging scan
T1 N2c BOT SCCA



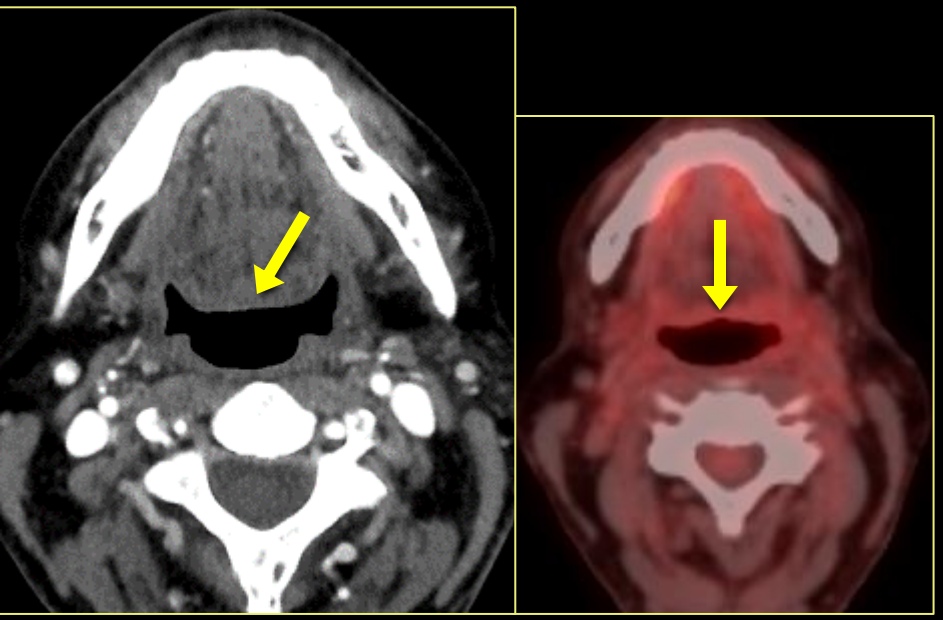
3 mo post CRT

Primary: 1

Neck: 1

Routine surveillance, 6 mo CECT

NIRADS 1 Primary/Neck



3 mo post-CRT

No abnl soft tissue
No abnl FDG uptake

Primary: 1 **Neck: 1**

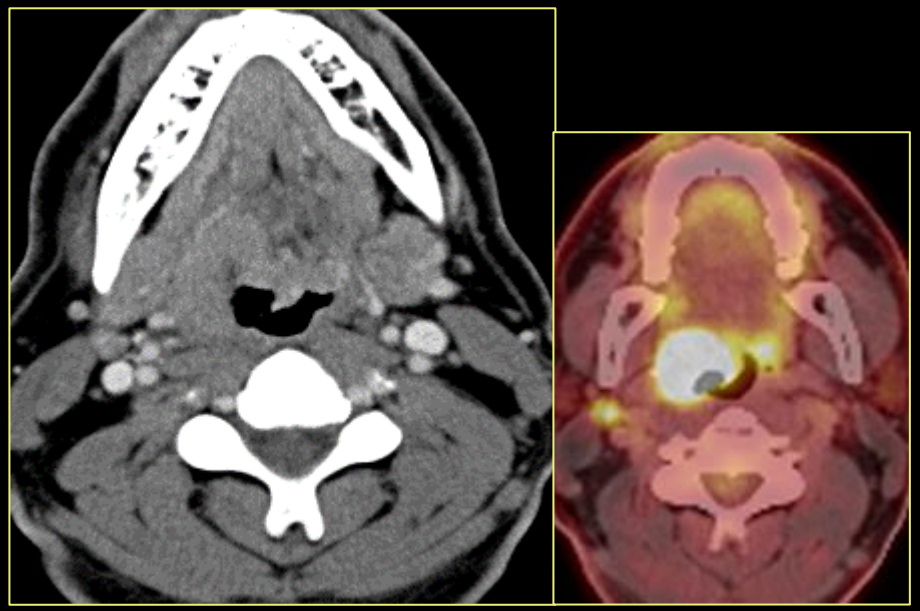
Routine surveillance, 6 mo CECT

NIRADS 1 imaging findings:

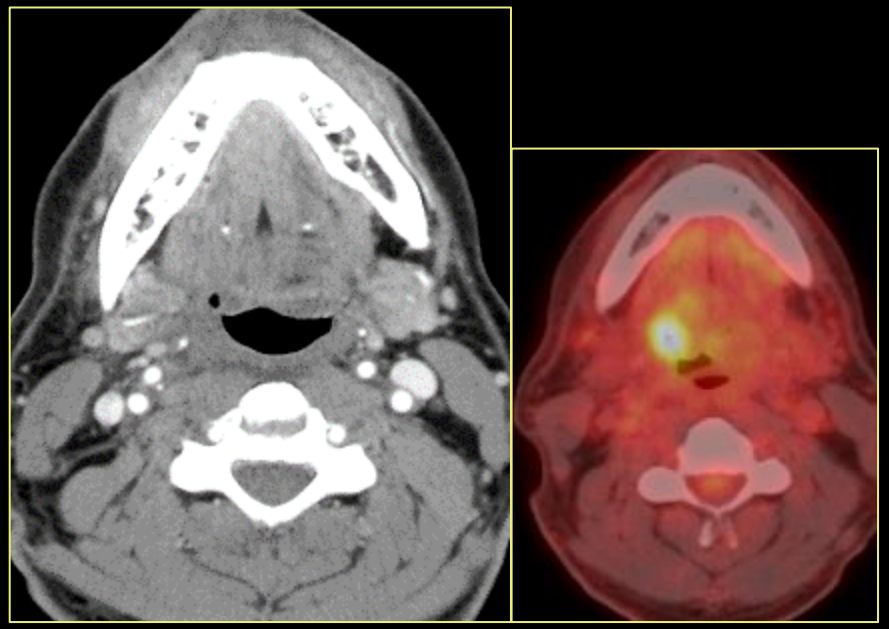
- No abnl soft tissue
- Non-mass like distortion of soft tissues
- “Mucoid” density mucosal edema
- Diffuse linear mucosal enhancement after radiation
- No abnl FDG uptake

Approximately 4% are positive for disease

NIRADS 2a Primary

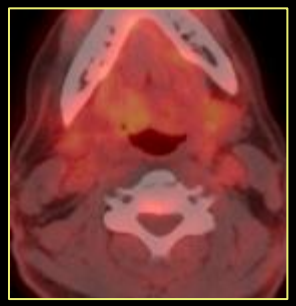


Staging scan
T4a BOT SCCA



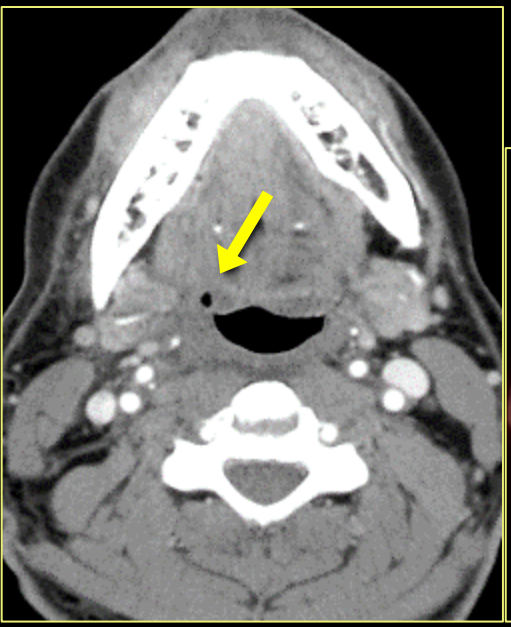
3 mo post CRT

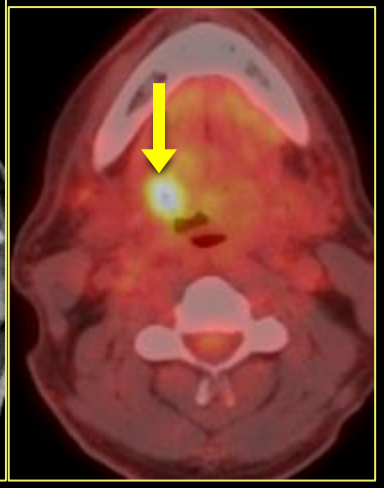
Primary: 2a



Direct inspection: radiation injury, f/u PET neg

NIRADS 2a Primary





3 mo post CRT

- No abnl soft tissue enhancement
- Moderate FDG uptake

NIRDAS 2 primary site imaging findings:

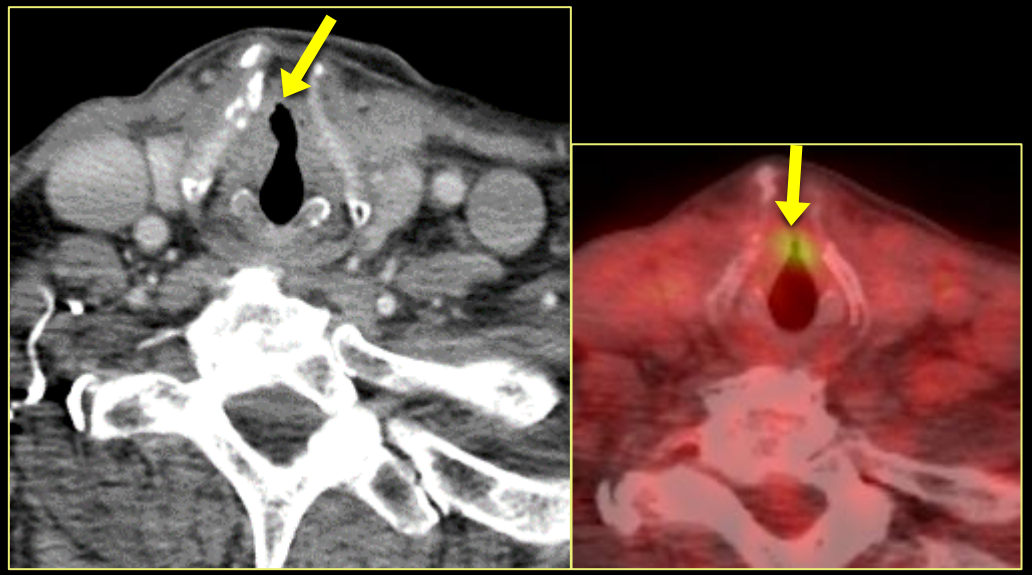
- Focal superficial mucosal enhancement
- Focal mucosal FDG uptake

NIRADS 2 is most useful when CECT and PET findings are DISCORDANT:

- Abnl enhancement with no FDG uptake (i.e. scar or granulation tissue)
- Ulceration with avid FDG uptake (i.e. radiation effect)

Primary: 2a

NIRADS 2a Primary



T2N0 glottic SCCA s/p CRT 2011
Poor follow-up, new hoarseness

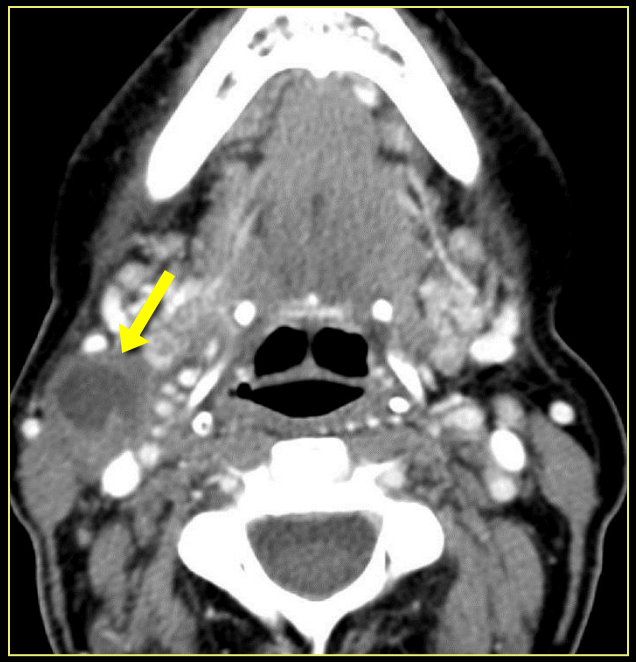
- No abnl soft tissue enhancement
- Moderate FDG uptake

Primary: 2a

Direct inspection & endoscopic biopsy: SCCA

- Most NIRADS 2a are *false positive*:
  - Only 17% are positive for disease
- Goal of NIRADS 2a is to **direct clinical inspection** and biopsy if necessary

NIRADS 2 Neck



2 mo post treatment

- Enlarged right level Iia lymph node
- Central necrosis

NIRADS 2 neck imaging findings:

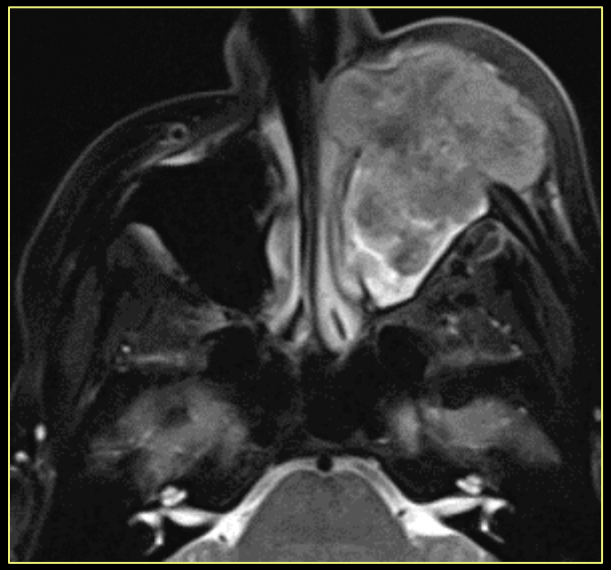
- Questionable nodal recurrence or residual nodal disease with mild or intermediate FDG uptake

Neck: 2 | Recommend PET

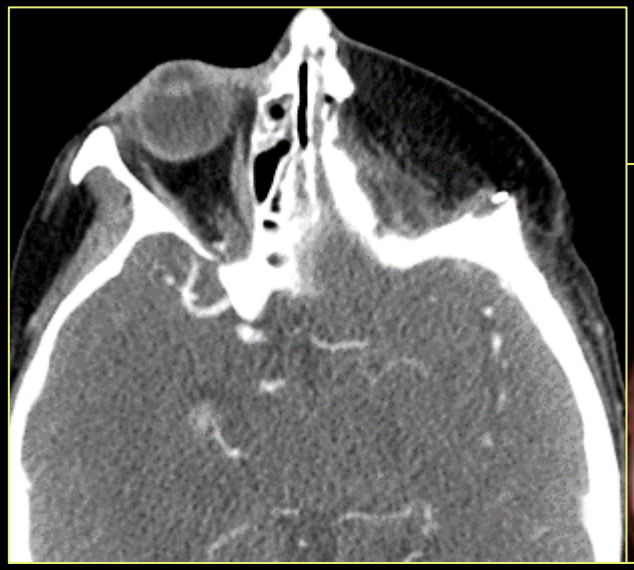
Follow up: Salvage ND was negative

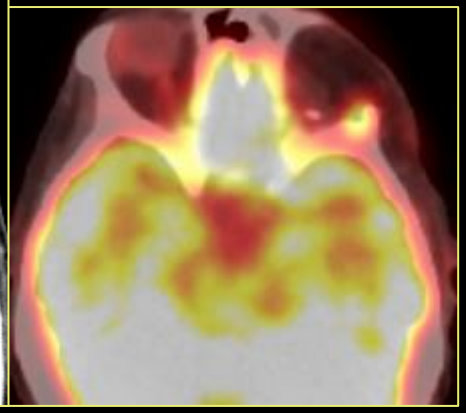
Note: This pt was imaged at OSH with CECT only (no PET), and surgeon elected to proceed with salvage ND Current practice would dictate obtaining a PET prior to proceeding to ND

NIRADS 3 Primary



Staging MRI
Maxillary SCCA

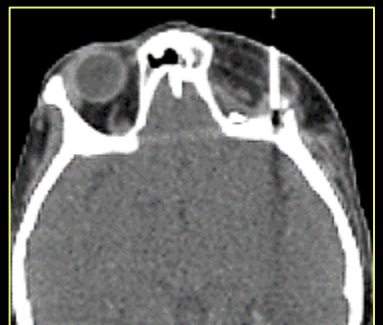




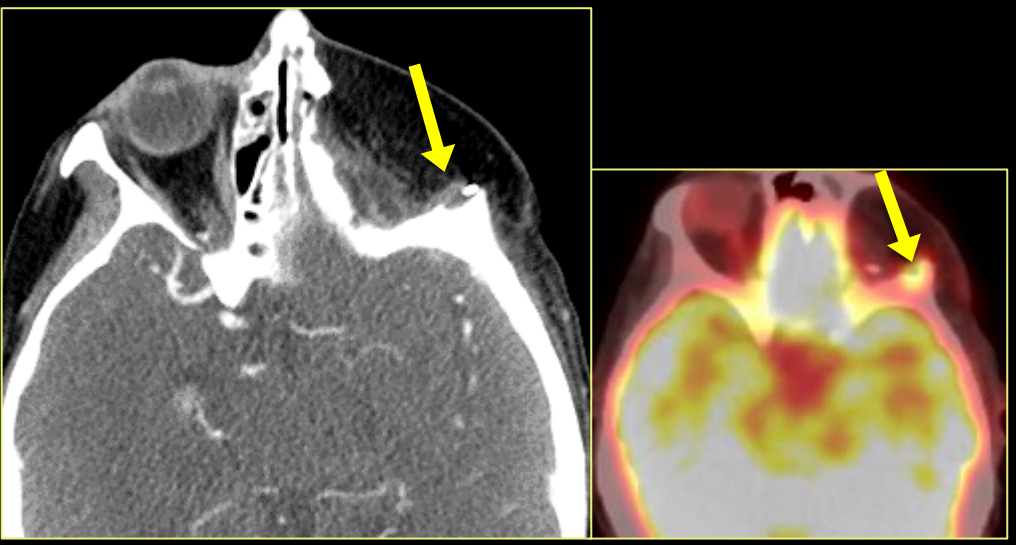
4 mo post resection and CRT

Primary: 3

CT biopsy: persistent SCCA



NIRADS 3 Primary



4 mo post resection and CRT

- Focal abnormal soft tissue with bony erosion
- Intense focal FDG uptake

NIRADS 3 imaging findings:

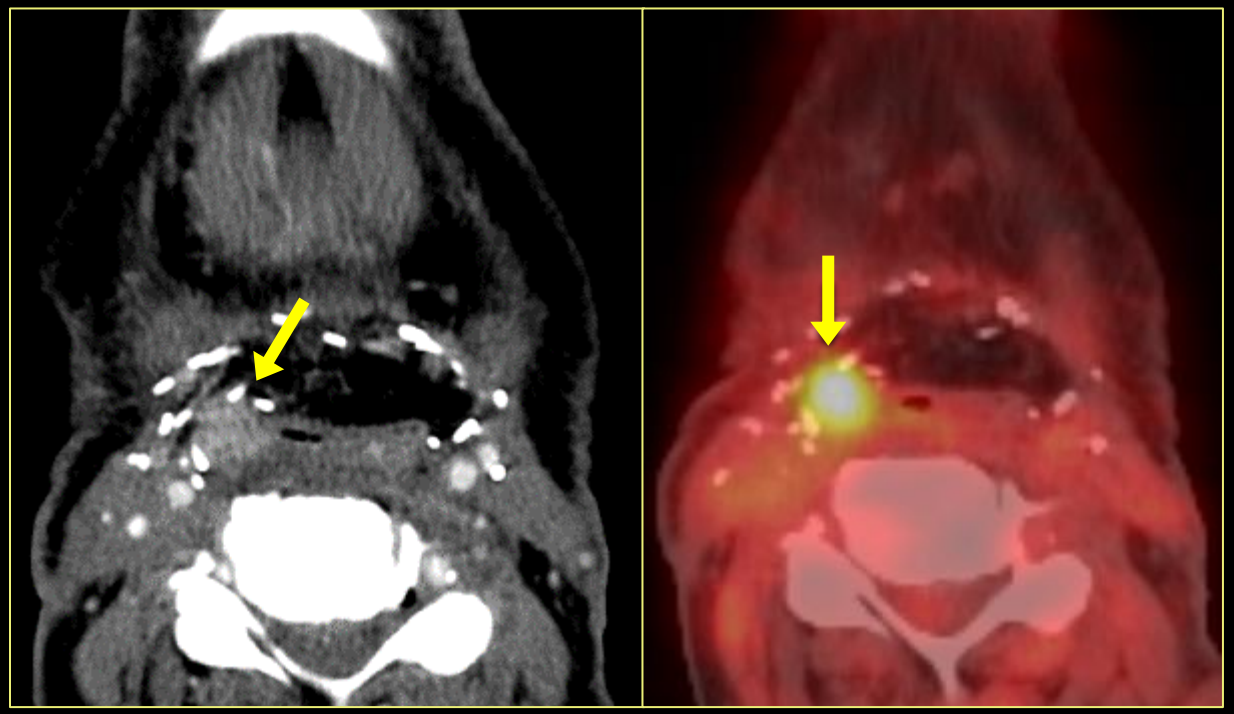
- New or definitely enlarging mass
- Discrete nodule/mass with robust enhancement
- Intense focal FDG uptake

Primary: 3

Recommend biopsy (image guided or clinical)

Approximately 59% are positive for disease

NIRADS 3 Primary



T4aN0 laryngeal SCC s/p TL, B ND, and CRT

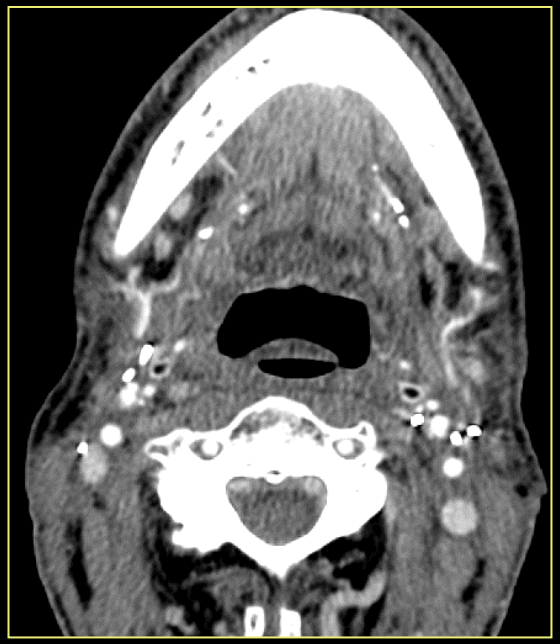
Primary: 3

- Focal abnormal soft tissue enhancement
- Intense focal FDG uptake

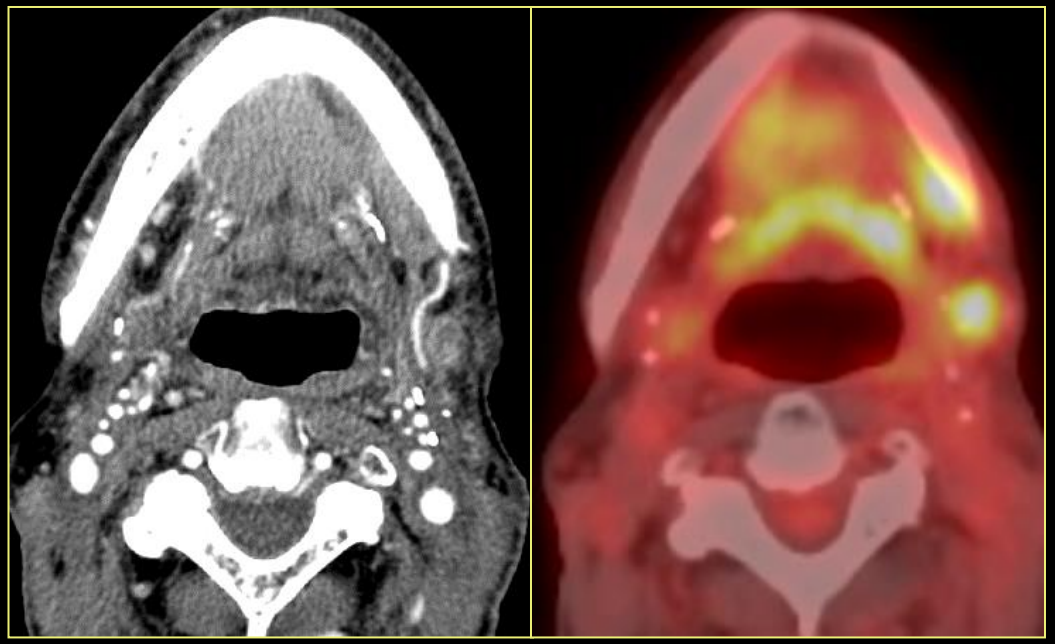
Endoscopic biopsy: recurrent SCCA

To differentiate NIRADS 2 from 3: work backwards!
Do you want to biopsy this lesion?
Is there a discrete target?
If no, NIRADS 2

NIRADS 3 Neck



3 mo post tx
T2N2b oral tongue SCCA

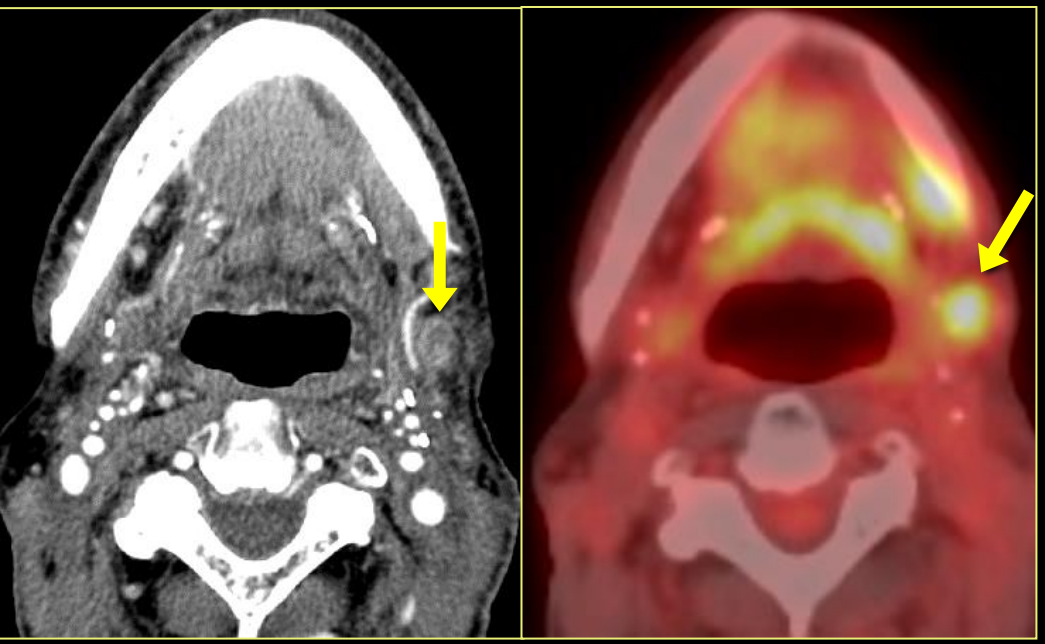


9 mo post resection,
ND and CRT

Neck: 3

Revision neck dissection positive for recurrence

NIRADS 3 Neck



9 mo post resection, ND and CRT

- Enlarging abnl LN
- Intense focal FDG uptake

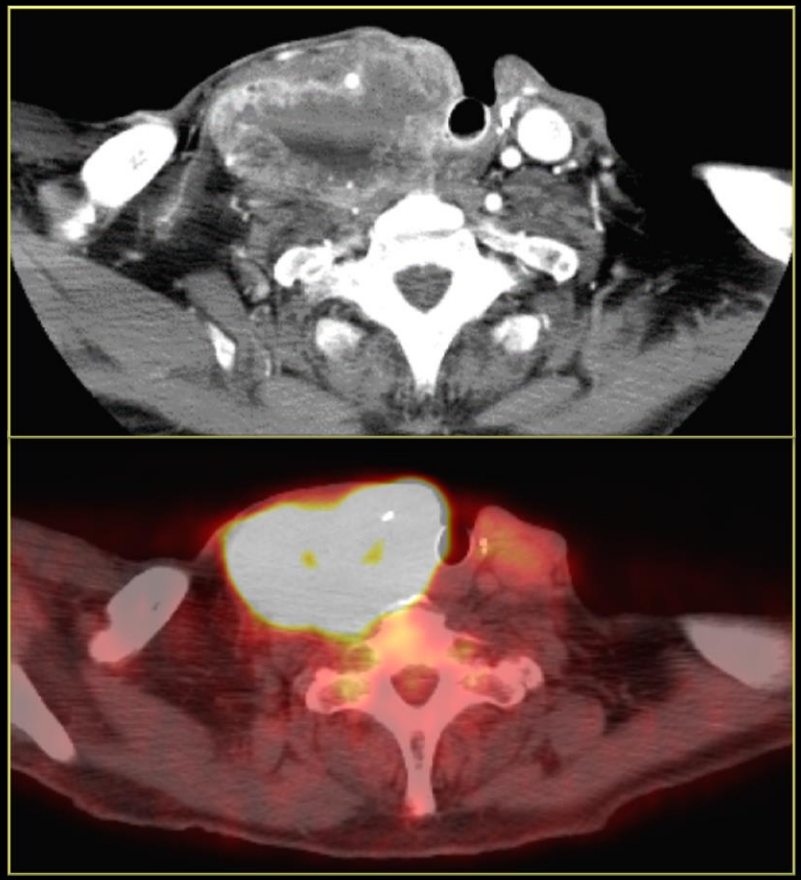
NIRADS 3 neck imaging findings:

- New or definite enlarging lymph nodes
- Intense focal FDG uptake

Neck: 3

Revision neck dissection positive for recurrence

NIRADS 4



pT4aN2cM0 laryngeal cancer s/p TL and bilateral ND
Exam concerning for recurrence at R neck/stoma

Neck: 4

NIRADS 4 imaging findings:

- Pathologically proven recurrence
- Definite radiologic or clinical progression
- Definitive recurrence on a single study

To differentiate NIRADS 3 from 4: work backwards!
Does this lesion *need* a biopsy? Is there anything else it could be? If no, NIRADS 4

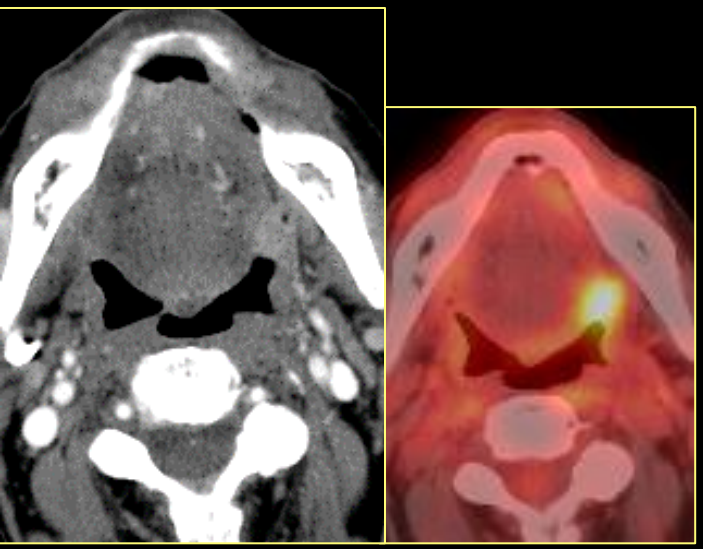
Unknown Cases

Test your skills!

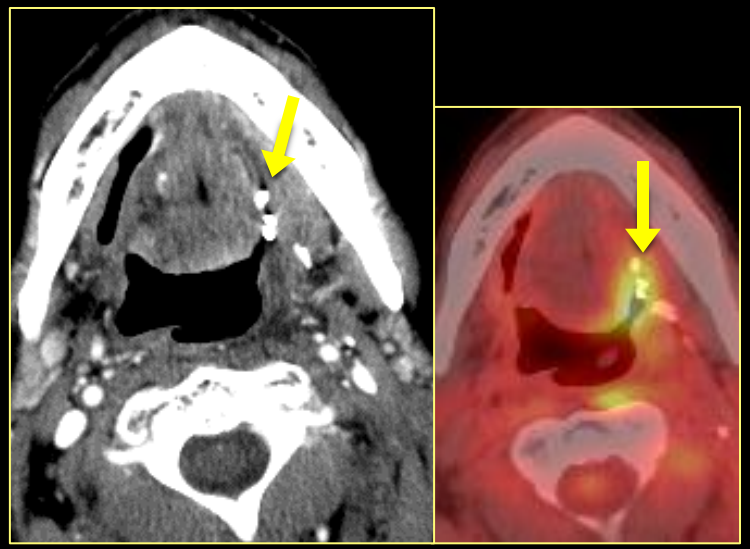
Review the following cases
Assign NI-RADS level

Unknown Case 1

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
pT1N2cM0 SCC L GTS



5 mo post TORS and L ND

Primary: 2a

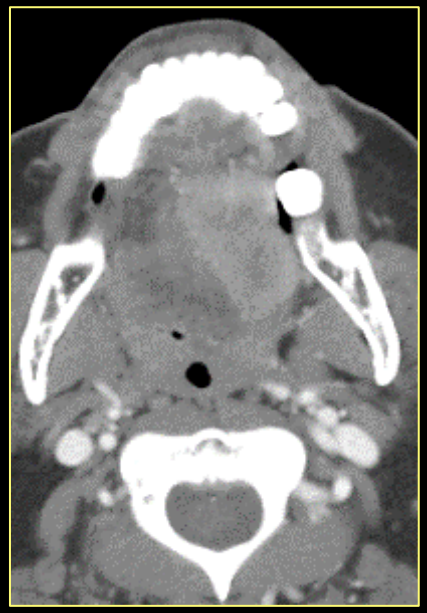
- Ulceration
- Focal mucosal FDG uptake
- DISCORDANT!

Recommend direct inspection

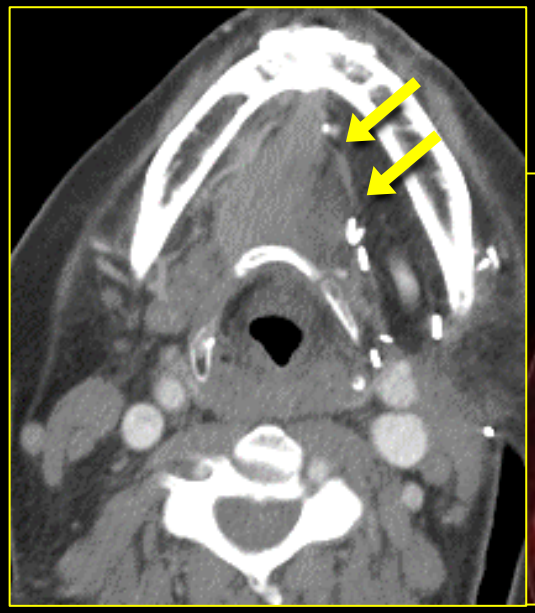
Clinicians noted ulceration without evidence of recurrence

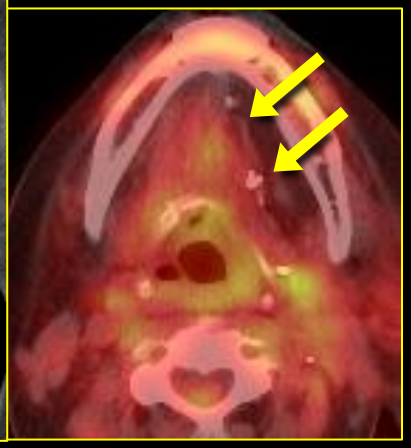
Unknown Case 2

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
T4aN2bM0 L lat oral tongue SCC





4 mo post resection

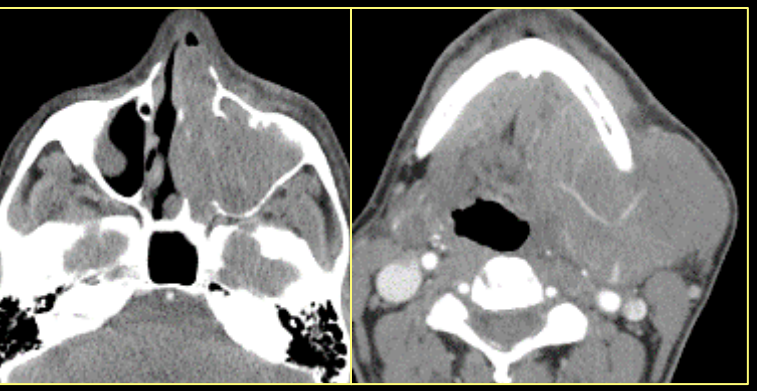
Primary: 1

- No abnormal enhancement or nodularity along the flap
- No abnormal FDG uptake

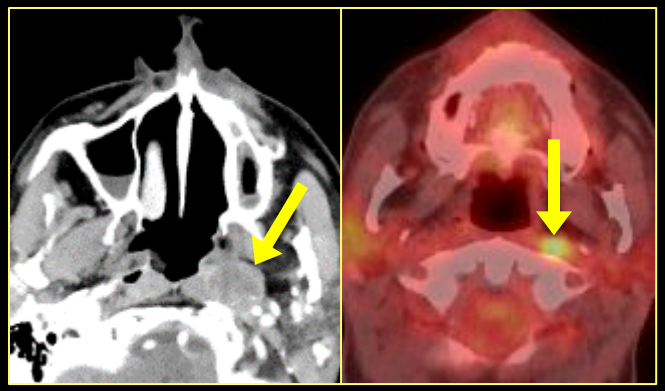
Continue routine surveillance

Unknown Case 3

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
L nasal cavity alveolar rhabdomyosarcoma

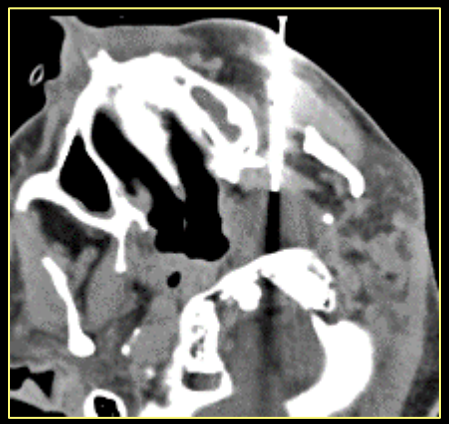


Long term f/u after multiple rounds of chemotherapy

Neck: 3

- New mass
- Intense focal FDG uptake

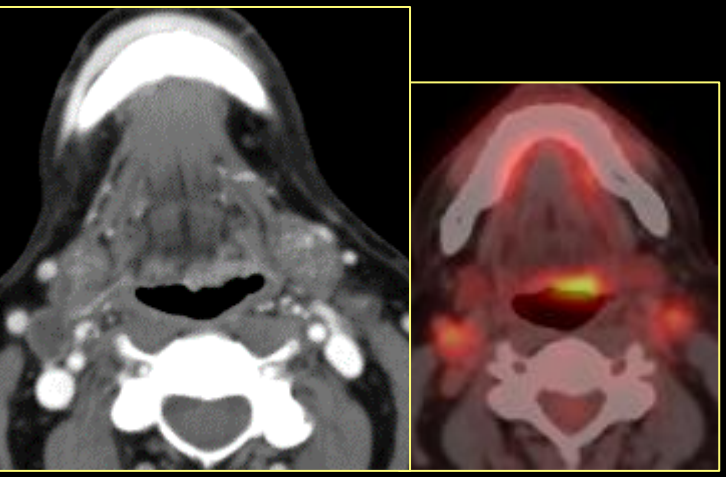
Recommend tissue sampling



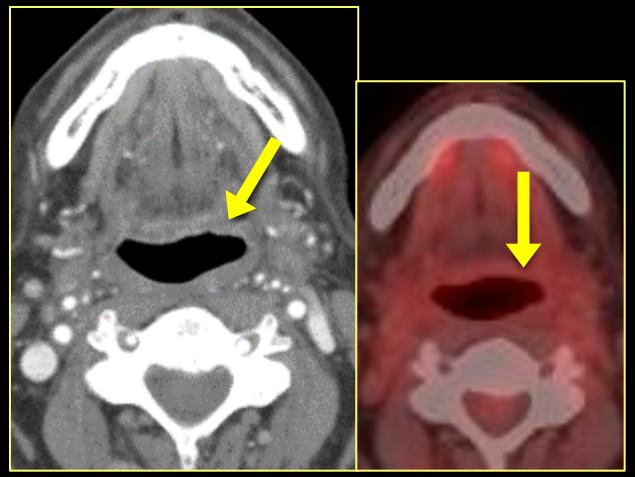
CT guided biopsy positive for recurrent disease

Unknown Case 4

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
T1N2c L BOT SCC



6 mo after CRT

Primary: 1

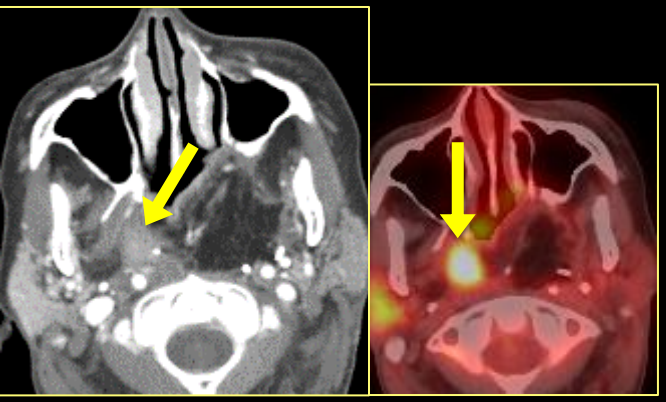
Neck: 1

- No abnormal mucosal enhancement
- No abnormal FDG uptake

Continue routine surveillance

Unknown Case 5

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4

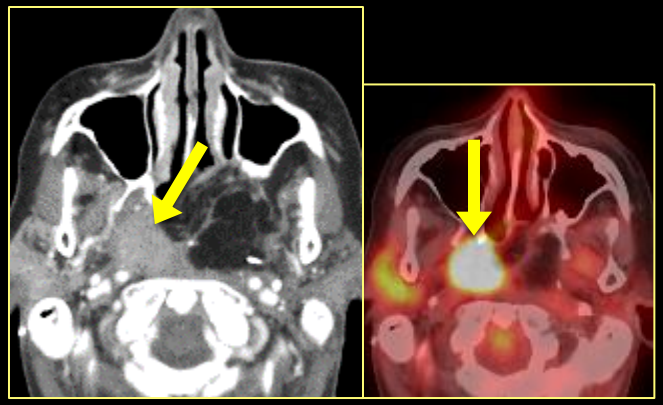


rypT4bN0 L soft palate SCC
S/p extensive resection and reconstruction

- Discrete masslike soft tissue with differential enhancement
- Intense focal FDG uptake

Neck: 3

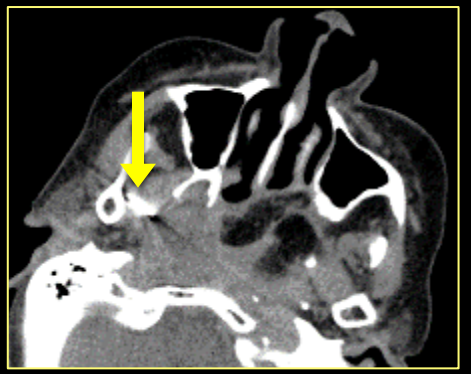
Recommend tissue sampling



Patient lost to f/u
Biopsy not performed
Returns 4 mo after resection

Definite progression on imaging:
- Increased size
- Increased FDG uptake

Neck: 4

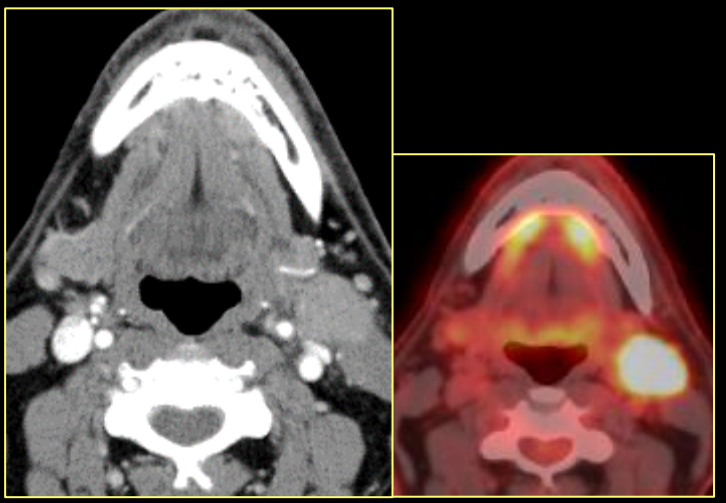


CT guided biopsy

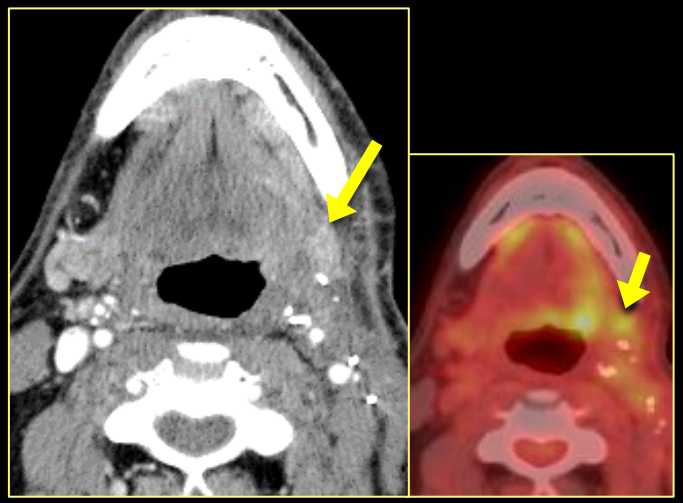
Positive for recurrent disease

Unknown Case 6

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
pT1N2aM0 L tonsil SCC



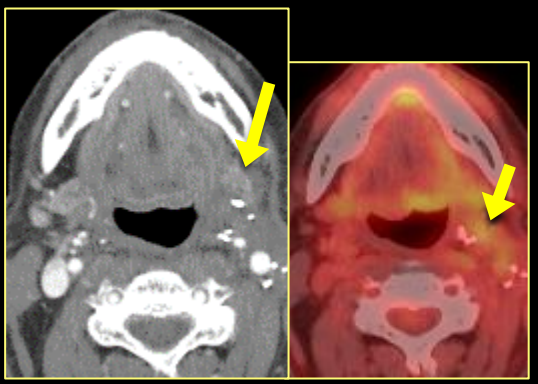
4 mo s/p TORS and
ND, completed CRT

Neck: 2

- Nodular ill-defined enhancement adjacent to surgical clips in L submandibular region
- Mild associated FDG uptake

Recommend short interval follow up

Note: Primary 2a



Now 7 mo post tx

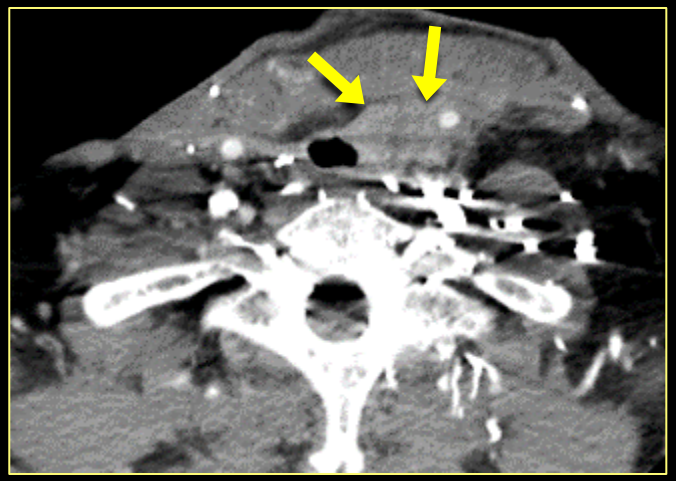
Neck: 1

No change in size, decr'd FDG activity
Likely residual submandibular gland

During TORS, surgeons may leave a portion of the SMG
Additionally, would be rare for an oropharyngeal H&N ca to go to a level Ib node

Unknown Case 7

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4

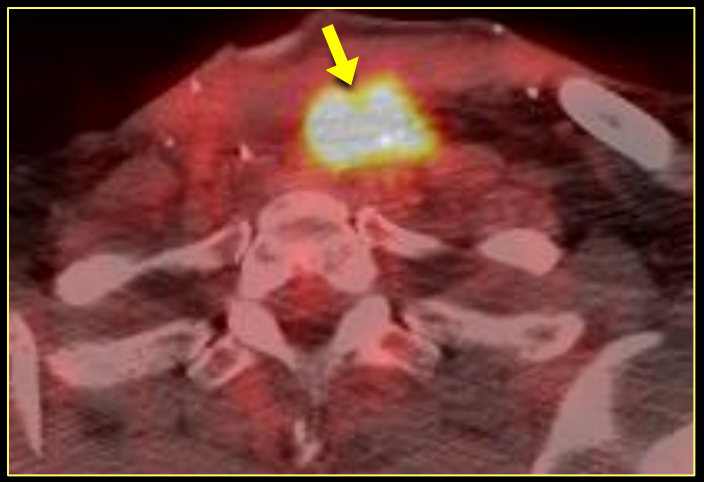


Recurrent L BOT SCC s/p TL w pec flap and R ND

Neck: 2

Abnormal soft tissue in the region of a left level IV LN adjacent to L CCA

Recommend PET

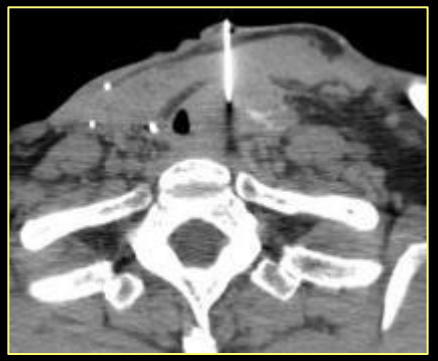


PET/CT done 1 wk later

Neck: 3

Intense focal FDG uptake

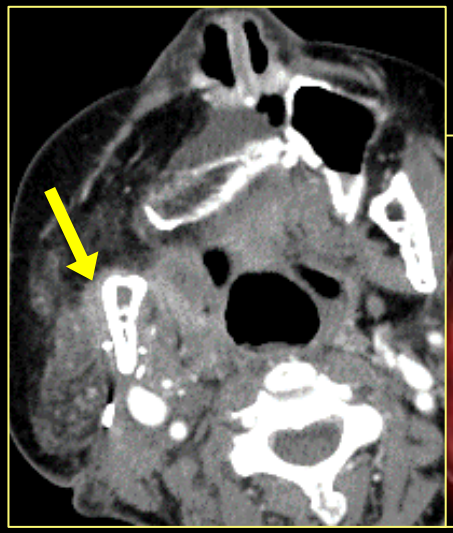
Recommend tissue sampling

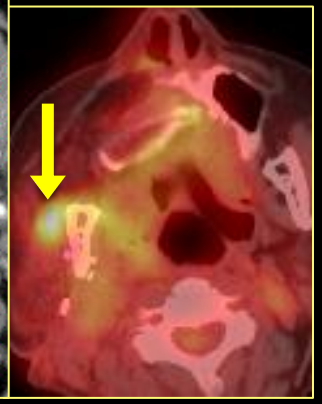


CT guided biopsy positive for SCC

Unknown Case 8

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



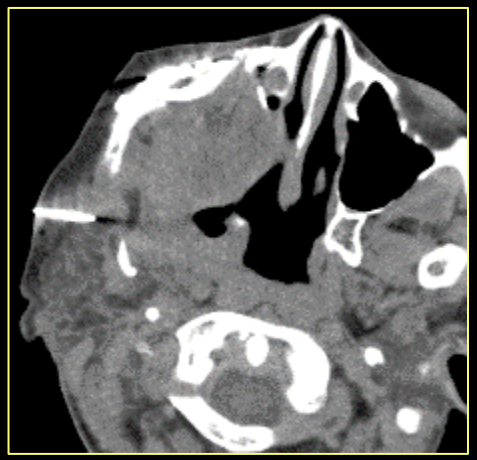


T4N0M0 myoepithelial cancer R maxillary sinus s/p composite resection

Primary: 3

Recommend tissue sampling

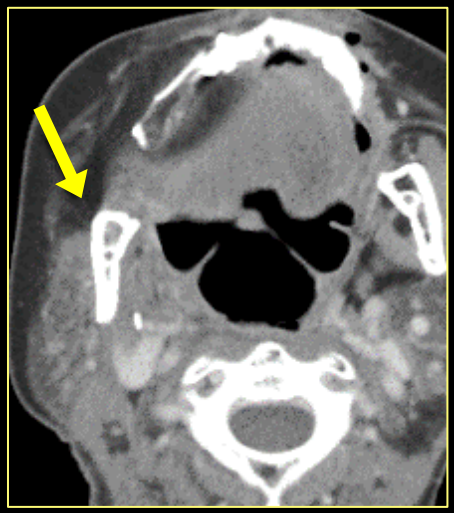
- Discrete soft tissue abnormality
- Focal FDG uptake



CT guided biopsy

No malignant cells in multiple passes in three different areas

What now?



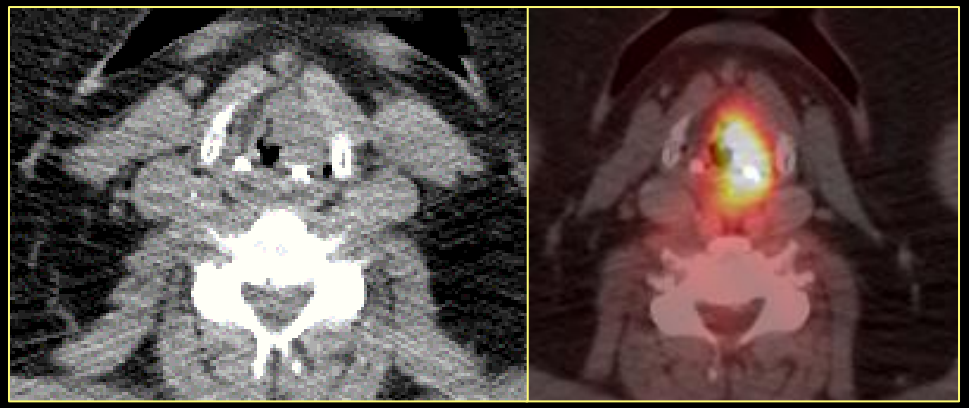
Short term f/u 4 mo after biopsy

Primary: 2a

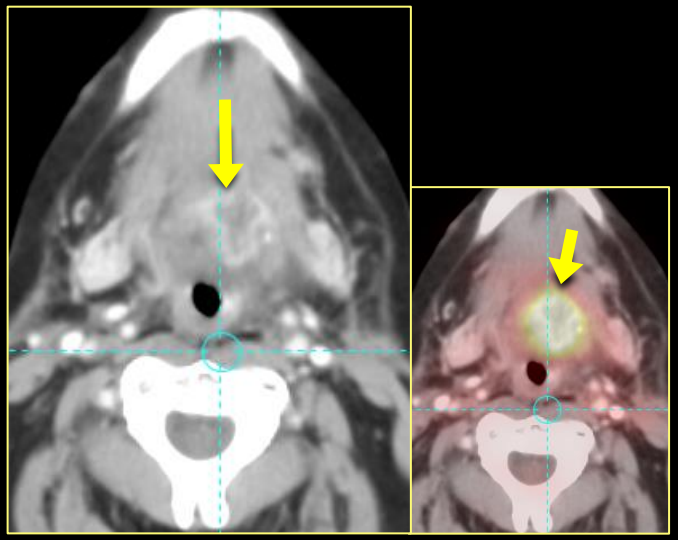
Interval improvement in that area
Changes were likely post treatment related

Unknown Case 9

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
Supraglottic SCC with transglottic spread



4 mo after TL

Primary: 3

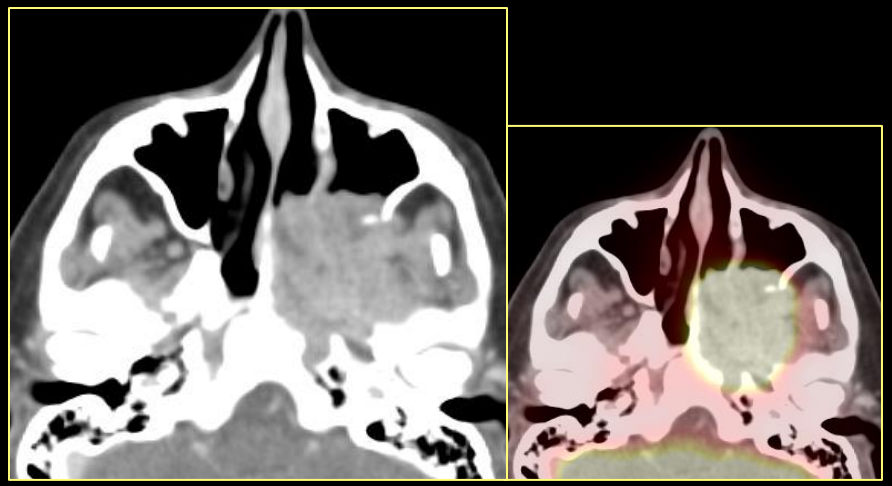
Recommend tissue sampling

- Discrete lesion with differential enhancement
- Intense focal FDG uptake

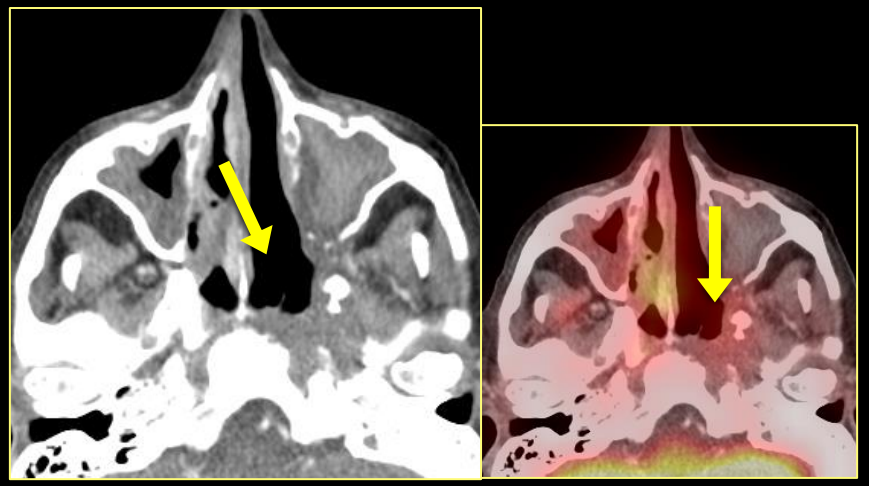
Patient went on to clinical biopsy and proven recurrence

Unknown Case 10

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
Nasopharyngeal cancer



4 mo after CRT

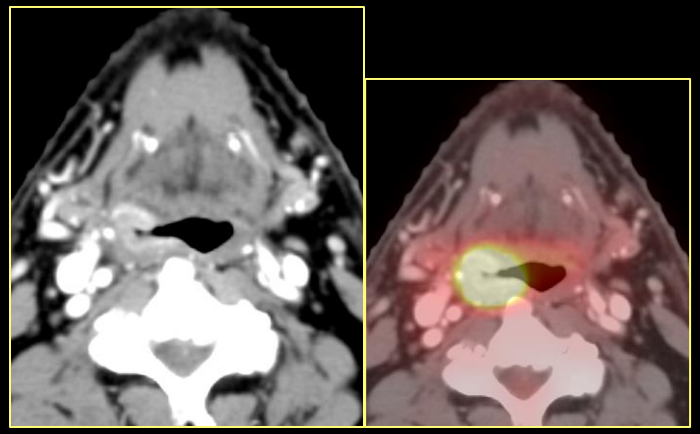
Primary: 1

- Non-mass like distortion of soft tissues
- No abnl FDG uptake

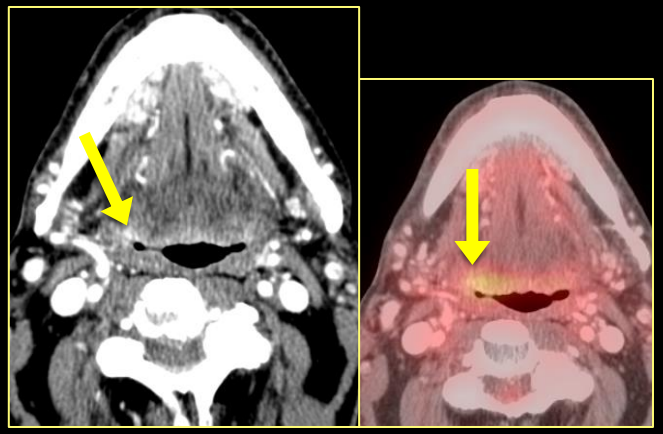
Continue routine surveillance

Unknown Case 11

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
R oropharyngeal SCC

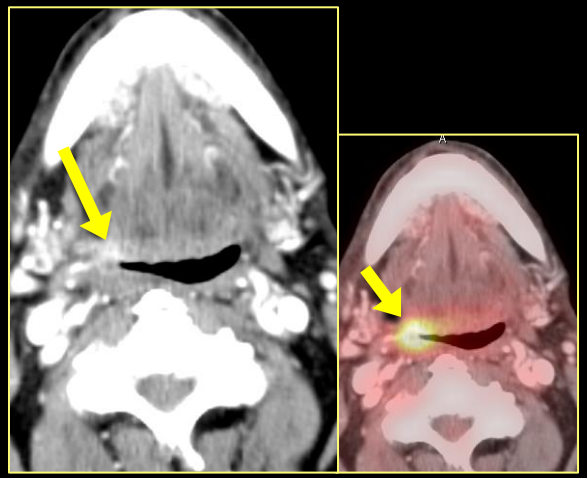


3 mo after CRT

Primary: 2a

- Focal mucosal enhancement
- Mild focal mucosal FDG uptake

Recommend direct inspection
If no abnormality, short interval follow up



6 mo after CRT

Primary: 3

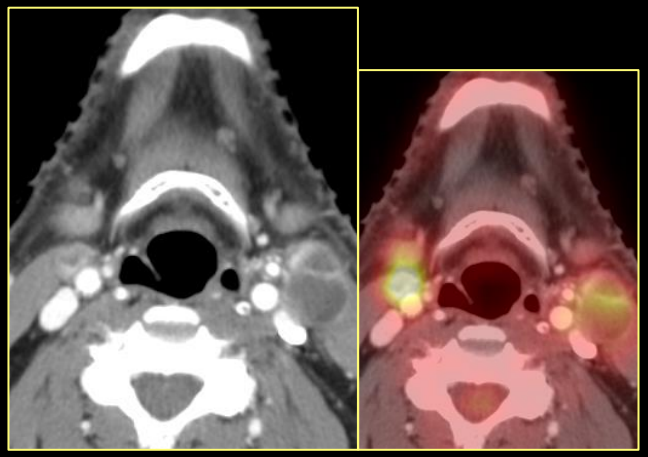
- Definitely enlarging mass
- Intense focal FDG uptake

Recommend tissue sampling

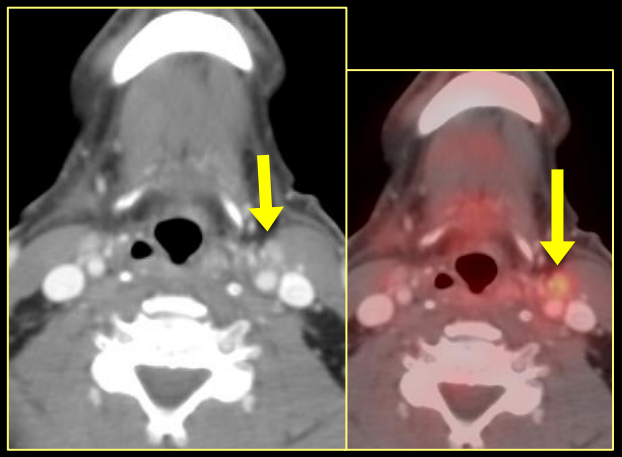
Clinical biopsy positive for recurrence

Unknown Case 12

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
HPV + Tonsil SCC w
B metastatic LNs

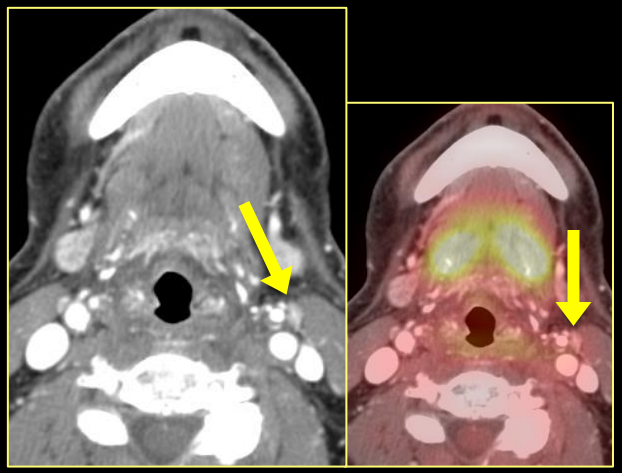


3 mo after CRT

Neck: 2

- Abnormal enhancing nodular soft tissue
- Mild FDG uptake

Recommend short interval follow up



6 mo after CRT

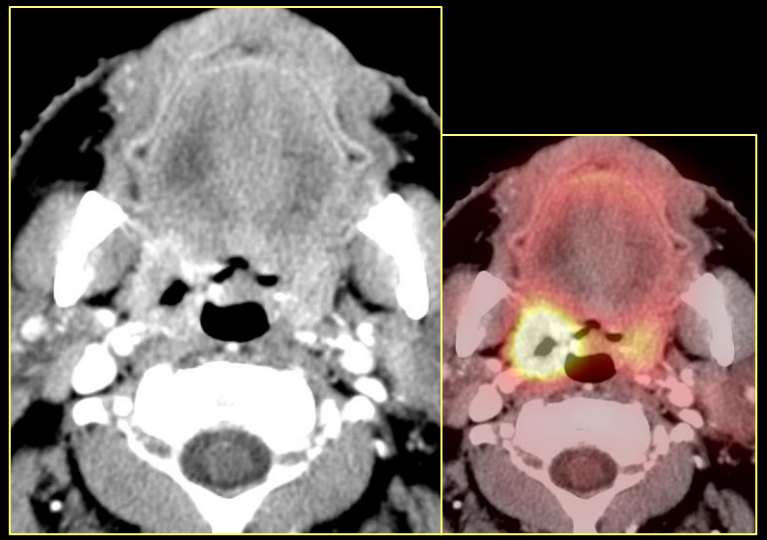
Neck: 1

No abnl FDG uptake

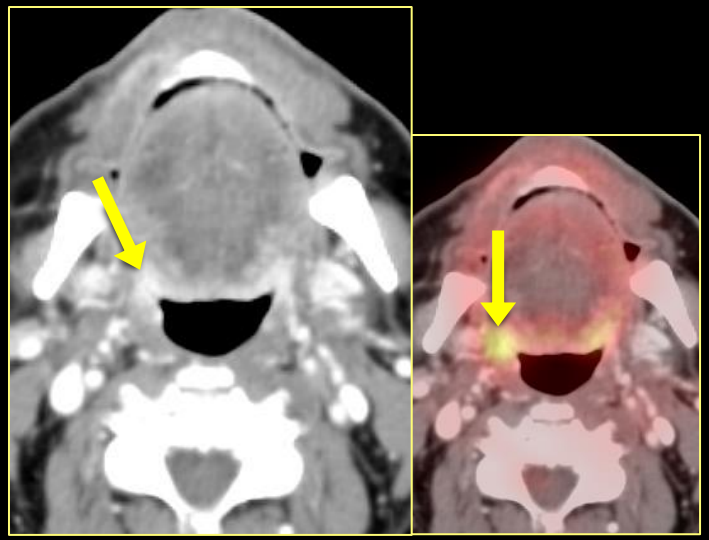
Continue routine surveillance

Unknown Case 13

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
R tonsil SCC

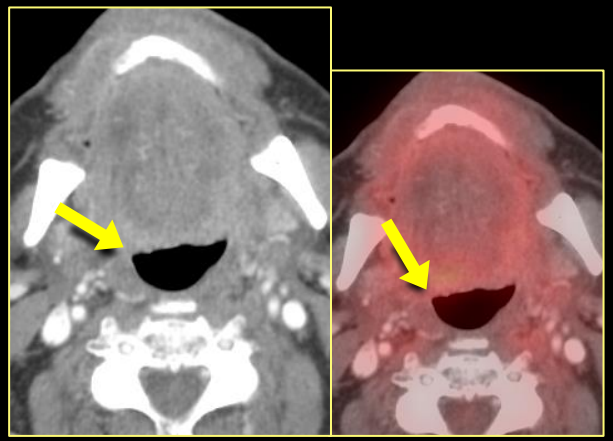


3 mo after CRT

Primary: 2a

- Focal mucosal enhancement
- Mild focal FDG uptake

Recommend direct inspection
If no abnormality, short interval follow up



6 mos p XRT

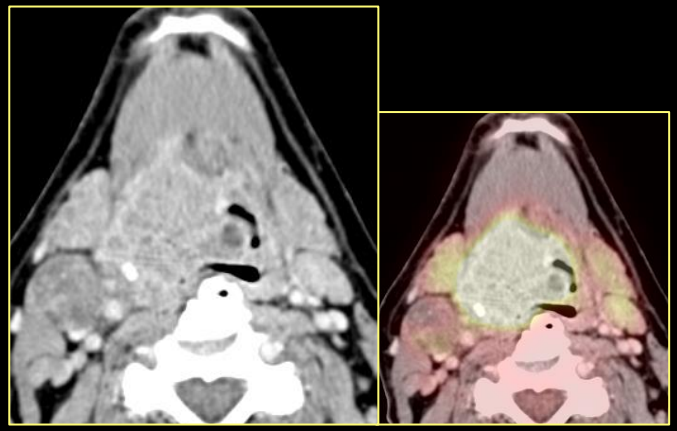
Primary: 1

No abnl FDG uptake

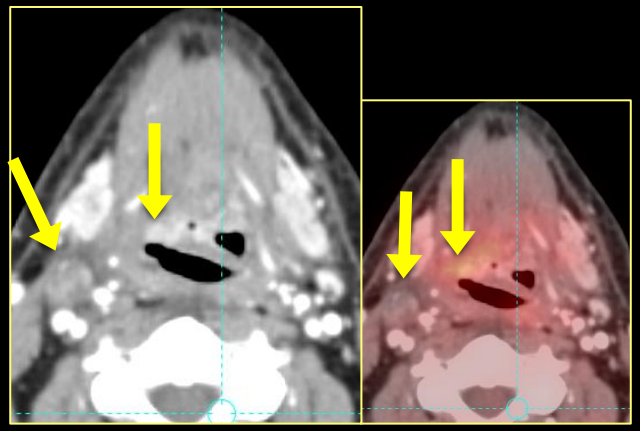
Continue routine surveillance

Unknown Case 14

NIRADS 1 | NIRADS 2 | NIRADS 3 | NIRADS 4



Staging scan
R BOT SCC with B metastatic nodes



3 mo after CRT

Primary: 2a

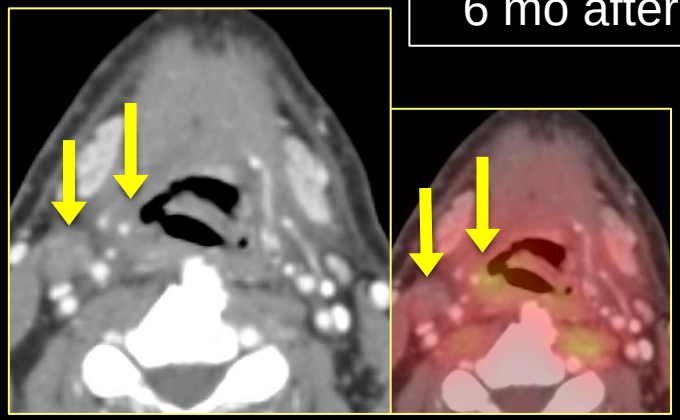
- Focal mucosal enhancement
- Mild focal mucosal FDG uptake

Neck: 2

- Persistent enlarged node
- No focal FDG uptake

Recommend direct inspection for pirmary and short interval follow up for the neck

6 mo after CRT



Primary: 1

Neck: 2

Pt underwent TL 8 mo post CRT for nonfxning larynx and salvage R ND: residual SCC in 2 LNs

Conclusions

- NIRADS was developed to assist in evaluating and reporting on patients with treated H&N cancer
- Allows for succinct, efficient reports which effectively communicate results with linked recommendations to guide care
- Several specific ways to influence patient care, including recommendations for routine surveillance, direct inspection, shorter interval follow up or additional modality, or biopsy

References

- Aiken, AH, Farley, A, Baugnon, KL, et al. Implementation of a Novel Surveillance Template for Head and Neck Cancer: Neck Imaging Reporting and Data System (NI-RADS). JACR. 2016; 13: 743-746.

- Krieger, DA, Hudgins, PA, Nayak, GK, et al. Initial Performance of NI-RADS Template to Predict Recurrence of Head and Neck Squamous Cell Carcinoma. Presented at ASNR 2016, accepted for publication in AJNR 2017.