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

- PET + CECT neck
- CECT neck + chest
- CECT neck
- CECT neck + chest

If negative
- 6 months
- 6 months
- 8-12 mos
NIRADS Recommendations

<table>
<thead>
<tr>
<th>Category</th>
<th>Linked Recommendation</th>
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<tbody>
<tr>
<td>NIRADS 1</td>
<td>Routine f/u (6 mo)</td>
</tr>
<tr>
<td>NIRADS 2</td>
<td>Short f/u (3 mo), PET, or direct inspection</td>
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<tr>
<td>NIRADS 3</td>
<td>Biopsy</td>
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<tr>
<td>NIRADS 4</td>
<td>Clinical care of recurrence</td>
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</table>
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.]
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
<table>
<thead>
<tr>
<th>Non-mass like soft tissue</th>
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<tbody>
<tr>
<td>• Hypo-enhancing distortion of soft tissue and fat planes (1)</td>
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<table>
<thead>
<tr>
<th>Masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Morphology: Ill-defined (2) versus discrete (3)</td>
</tr>
<tr>
<td>• Enhancement: Mild (2) versus robust (3)</td>
</tr>
<tr>
<td>• FDG uptake relative to background: Mild (2) versus intense (3)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Mucosal abnormality</th>
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<tbody>
<tr>
<td>• Mucoid density (1)</td>
</tr>
<tr>
<td>• Diffuse linear enhancement (benign radiation mucositis) (1)</td>
</tr>
<tr>
<td>• Focal mucosal enhancement of FDG uptake (2a)</td>
</tr>
</tbody>
</table>
Lymph nodes

• Residual nodal tissue with:
  • No FDG uptake relative to background (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

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

Primary: 1  Neck: 1

Routine surveillance, 6 mo CECT
NIRADS 2a Primary

Staging scan
T4a BOT SCCA

3 mo post CRT

Primary: 2a

Direct inspection: radiation injury, f/u PET neg
NIRADS 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)

3 mo post CRT
- No abnl soft tissue enhancement
- Moderate FDG uptake

Primary: 2a
Primary: 2a

- No abnl soft tissue enhancement
- Moderate FDG uptake

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

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

Primary: 2a

Direct inspection & endoscopic biopsy: SCCA
NIRADS 2 Neck imaging findings:

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

NIRADS 2 Neck

- Enlarged right level IIA lymph node
- Central necrosis

2 mo post treatment

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

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

4 mo post resection and CRT

• Focal abnormal soft tissue with bony erosion
• Intense focal FDG uptake
NIRADS 3 Primary

Primary: 3

• Focal abnormal soft tissue enhancement
• Intense focal FDG uptake

Endoscopic biopsy: recurrent SCCA

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

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
Revision neck dissection positive for recurrence

9 mo post resection, ND and CRT

NIRADS 3 neck imaging findings:
- New or definite enlarging lymph nodes
- Intense focal FDG uptake

NIRADS 3 Neck

Enlarging abnl LN
- Intense focal FDG uptake
NIRADS 4

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

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
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

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

Staging scan
L nasal cavity alveolar rhabdomyosarcoma

Long term f/u after multiple rounds of chemotherapy

CT guided biopsy positive for recurrent disease

Neck: 3
- New mass
- Intense focal FDG uptake

Recommend tissue sampling

NIRADS 1  NIRADS 2  NIRADS 3  NIRADS 4
Unknown Case 4

Staging scan
T1N2c L BOT SCC

6 mo after CRT

Primary: 1
- No abnormal mucosal enhancement
- No abnormal FDG uptake

Neck: 1

Continue routine surveillance

NIRADS 1
NIRADS 2
NIRADS 3
NIRADS 4
**Unknown Case 5**

**NIRADS 1**
- Discrete masslike soft tissue with differential enhancement
- Intense focal FDG uptake

**NIRADS 2**
- Patient lost to f/u
- Biopsy not performed
- Returns 4 mo after resection

**NIRADS 3**
- Definite progression on imaging:
  - Increased size
  - Increased FDG uptake

**NIRADS 4**
- CT guided biopsy
- Positive for recurrent disease

**rypT4bN0 L soft palate SCC**

S/p extensive resection and reconstruction

Recommend tissue sampling

Neck: 3

Neck: 4
**Unknown Case 6**

**Staging scan**

pT1N2aN0 L tonsil SCC

**4 mo s/p TORS and ND, completed CRT**

**Now 7 mo post tx**

Neck: 2

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

Recommend short interval follow up

**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 I b node

Note: Primary 2a
Unknown Case 7

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

Neck: 3
Intense focal FDG uptake
Recommend tissue sampling

PET/CT done 1 wk later

CT guided biopsy positive for SCC

NIRADS 1  NIRADS 2  NIRADS 3  NIRADS 4
Unknown Case 8

NIRADS 1  NIRADS 2  NIRADS 3  NIRADS 4

T4N0M0 myoepithelial cancer R maxillary sinus s/p composite resection

Primary: 3

- Discrete soft tissue abnormality
- Focal FDG uptake

Recommend tissue sampling

CT guided biopsy

No malignant cells in multiple passes in three different areas

What now?

Primary: 2a

Short term f/u 4 mo after biopsy

Interval improvement in that area Changes were likely post treatment related
Unknown Case 9

Staging scan
Supraglottic SCC with transglottic spread

4 mo after TL

Primary: 3

- Discrete lesion with differential enhancement
- Intense focal FDG uptake

Recommend tissue sampling

Patient went on to clinical biopsy and proven recurrence
Unknown Case 10

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

Staging scan
R oropharyngeal SCC

Primary: 2a
- Focal mucosal enhancement
- Mild focal mucosal FDG uptake

Recommend direct inspection
If no abnormality, short interval follow up

3 mo after CRT

Primary: 3
- Definitely enlarging mass
- Intense focal FDG uptake

Recommend tissue sampling

Clinical biopsy positive for recurrence
Unknown Case 12

Staging scan
HPV + Tonsil SCC w B metastatic LNs

3 mo after CRT
- NIRADS 3
- 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

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

Primary: 1
No abnl FDG uptake
Continue routine surveillance

NIRADS 1
NIRADS 2
NIRADS 3
NIRADS 4

6 mos p XRT
Unknown Case 14

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

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

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