November 2021

NI-RADS™ MRI Category Descriptors, Imaging Findings, and Management

<table>
<tr><th rowspan="2">Category</th><th rowspan="2">Primary Site</th><th rowspan="2">Neck</th><th colspan="2">MR Imaging Findings</th><th rowspan="2">Management</th></tr>
<tr><th>Primary Site</th><th>Neck</th></tr>
<tr><td>Incomplete</td><td>0</td><td>0</td><td colspan="2">• New baseline study without any prior imaging available AND knowledge that prior imaging exists and will become available as comparison</td><td>Assign score in addendum after prior imaging examinations become available</td></tr>
<tr><td rowspan="3">No Evidence of Recurrence</td><td rowspan="2">1</td><td rowspan="3">1</td><td colspan="2">• Expected posttreatment changes
• Diffuse thin linear mucosal enhancement or submucosal edema
• Low T1 and T2 signal intensity suggesting scar/fibrosis
• Non-mass-like distortion of soft tissues with T2-hyperintense (not T2-intermediate) signal, suggesting edema / inflammation
Note: Be familiar with appearance of flaps (which often have different enhancement and signal characteristics than the original tumor)</td><td rowspan="3">Routine surveillance</td></tr>
<tr><td>Comparison with prior post-treatment studies available:
• No new focal nodular or mass-like soft tissue
• Unchanged or decreased effacement of fat planes on pre-contrast T1WI and/or unchanged or decreased enhancement at skull base foramina and in perineural locations</td><td rowspan="2">• Residual nodal tissue† that is hypoenhancing in the region of original node, and no FDG uptake if PET is available</td></tr>
<tr><td>1f</td><td>First post-treatment baseline study*:
• Resolution of tumor seen on pre-treatment study; no focal nodular or mass-like soft tissue
• Decreased soft tissue and/or enhancement in skull base foramina and perineural regions, decreased effacement of fat planes on pre-contrast T1WI</td></tr>
<tr><td rowspan="3">Low Suspicion</td><td>2a</td><td rowspan="3">2</td><td>• Focal non-mass-like mucosal enhancement‡ or focal reduced diffusion</td><td rowspan="3">• Residual nodal tissue with persistent areas of heterogeneous enhancement or mild/moderate FDG uptake if PET is available
• New or enlarging lymph node†† without definitive abnormal morphologic features
• Any discordance between PET and MRI if PET or PET/MR is available: enlarging lymph node or discrete neck mass but little to no FDG uptake, or focal uptake with no MRI correlate‡‡</td><td>Primary 2a: Direct visual inspection</td></tr>
<tr><td>2b</td><td>• Deep, ill-defined non-nodular soft tissue
• Soft tissue in which MRI features are different from the original tumor: different DWI, enhancement, or T1 and T2 signal characteristics (and therefore considered 2b rather than 3)§
• Soft tissue with intermediate rather than hyperintense T2 signal and intermediate rather than intense enhancement (and therefore considered 2b rather than 1)**</td><td>Primary 2b or 2f, or Neck 2: Short interval follow-up MRI or PET to assess deep submucosal abnormality or questionable nodes.

Note: PET is not as helpful for evaluation of perineural disease at the skull base. As such, for a Primary 2b or 2f related to perineural soft tissue, short interval follow-up MRI would be preferable over PET.</td></tr>
<tr><td>2f</td><td>First post-treatment baseline study:
• Partial resolution of tumor when compared to pre-treatment study
• No change in soft tissue in skull base foramina and perineural regions which is of same signal and enhancement characteristics when compared to pre-treatment study
• New thin smooth enhancement in skull base foramina and perineural regions within radiation field</td></tr>
<tr><td>High Suspicion</td><td>3</td><td>3</td><td>• Discrete nodule or mass at the primary site especially if new/enlarging AND signal characteristics and enhancement match original tumor
• Intense focal FDG uptake if PET is available
• Increased soft tissue and/or enhancement in skull base foramina and perineural regions, increased effacement of fat planes and skull base foramina on pre-contrast T1WI, and/or increased enhancement and nodular soft tissue along major nerves supplying the site of primary disease</td><td>• Residual nodal tissue with intense FDG uptake OR definite enlargement/ increased enhancement
• New or enlarging lymph node†† with necrosis or irregular borders, or focal intense FDG uptake if PET is available</td><td>Image-guided or clinical biopsy if clinically indicated</td></tr>
<tr><td>Definitive Recurrence</td><td>4</td><td>4</td><td colspan="2">• Pathologically proven or definite radiologic and clinical progression</td><td>Clinical management</td></tr>
</table>

Primary Sites (1f)

* The first post-treatment MRI serves as a new baseline study for future comparison. On the first post-treatment MRI, skull base foramina and perineural findings are indeterminate (in the absence of features suspicious for residual or progressive tumor described under NI-RADS 2 and 3) and can be presumed to be post- treatment related and assigned NI-RADS 1, until further assessment on the next MRI.

Neck (1, 1f)

† "Residual nodal tissue" – tissue at a site where an abnormal node was present and identified on pre-treatment scan. In these cases, hypoenhancement and irregular borders are not unexpected and are likely a sign of treatment response, especially if there is no FDG uptake.

Primary Sites (2a)

‡ Focal mucosal abnormalities have a reasonable likelihood of being treatment-related, especially on the initial post-treatment study, such that, in most cases, it is prudent to assign NI-RADS 2a and recommend correlation with direct visual inspection. If a more mass-like or nodular mucosal abnormality develops later in the time course of surveillance, the assignment of NI-RADS 3 may be warranted.

Primary Sites (2b)

§ If there is persistent enlargement or growth of discrete mass-like soft tissue that differs in signal characteristics from the original tumor, this should be designated NI-RADS 3 despite the mismatch in signal characteristics.

** Tumor tends to exhibit intermediate T2 signal and enhancement, while hyperintense T2 signal and intense enhancement are more often seen with reactive/inflammatory changes.

Neck (2, 3)

†† New or enlarging node" – node that newly develops or grows during the course of surveillance (node not present or smaller on pre-treatment scan). In these nodes, irregular borders or new necrosis are definitively abnormal features. Irregular borders with new gross extra nodal extension (ENE) as evidenced by invasion of adjacent structures is another abnormal feature. This is in contradistinction to irregular borders or necrosis in nodes unchanged or decreasing in size following radiation treatment, which are considered expected post-treatment findings in radiated nodes.

Neck (2)

‡‡ This guideline for PET and MRI discordance only applies if the original tumor was FDG avid.

- If the primary tumor is unknown, then the authors suggest designating "P-unknown primary"; if the primary cannot be assessed (dental artifact, motion, other technical reasons, or outside FOV), then the authors suggest "P-x"
- Head and neck cancer surveillance MR examinations are often tailored to a specific area of concern (e.g. skull base for perineural tumor spread), in which case the entire neck may not be imaged. If the neck cannot be assessed, then the authors suggest "N-x."
- NI-RADS categories are designed for use after definitive/curative treatment for H&N cancer, and are not to be used during treatment

January 2021

NI-RADS™ PET/CT Category Descriptors, Imaging Findings, and Management

Category	Primary Site	Neck	Imaging Findings		Management
			Primary Site	Neck	
Incomplete	**0**	**0**	• New baseline study without any prior imaging available ***AND*** knowledge that prior imaging exists and will become available as comparison		Assign score in addendum after prior imaging examinations become available
No evidence of recurrence	**1**	**1**	• Expected post treatment changes • Non-mass-like distortion of soft tissues • Low-density post-treatment mucosal edema • Diffuse linear mucosal enhancement or FDG • If residual nodal tissue, no FDG uptake or enhancement		Routine surveillance
Low suspicion	**2a**	**2**	• Focal mucosal enhancement or FDG uptake on initial post treatment scan*	• Mild/ mod FDG in residual nodal tissue or persistent areas of heterogenous enhancement • Enlarging or new lymph node without definitive abnormal morphologic features * • Any discordance between PET & CECT: enlarging lymph node but little to no FDG uptake **	2a: Direct visual inspection
	2b		• Deep, ill-defined soft tissue, with only mild/ mod FDG if PET available • Any discordance between PET & CECT: discrete CECT abnormality but little to no FDG uptake or focal FDG uptake but no CT correlate**		2b or neck 2: Short interval follow-up (3 months) or PET if scoring on CECT alone
High suspicion	**3**	**3**	• Discrete nodule or mass at the primary site with intense focal FDG uptake if PET available • Residual nodal tissue with intense FDG • New enlarged lymph node or enlarging lymph node with abnormal morphologic features*** on CECT only or focal intense FDG uptake if PET available		Image guided or clinical biopsy if clinically indicated
Definitive recurrence	**4**	**4**	• Pathologically proven or definite radiologic and clinical progression		Clinical management

*Focal mucosal abnormalities have a high likelihood of being treatment related, especially on the initial post-treatment PET/CECT, so that in most cases, it is prudent to assign a "2a" and let surgeons or oncologists directly inspect. If a more mass-like or nodular mucosal abnormality develops later in the time course of surveillance, it may warrant a "3".

**This guideline for PET and CECT discordance only applies if the original tumor was FDG avid

**Morphologically abnormal features which are definitive= new necrosis or gross extra nodal extension (ENE) as evidenced by invasion of adjacent structures

- "Residual nodal tissue" = node that was abnormal and identified on pre-treatment scan. In these cases, hypo enhancement and irregular borders are not unexpected and are likely a sign of treatment response, especially if there is no FDG uptake.
- "New or enlarging node" = node that develops DURING surveillance (not on pre-treatment scan). In these nodes, irregular borders or necrosis are definitively abnormal features.

+ If Primary tumor is unknown, then authors suggest designating "P-unknown primary", if the primary cannot be assessed (dental artifact, motion or other technical reasons or outside FOV), then authors suggest P-x

+ NI-RADS categories designed for use after definitive/ curative treatment for H&N cancer, and therefore not designed to be used during treatment