Imaging of the head and neck neoplasms

Guidelines: last update 01 June 2002
Imaging H&N neoplasms: sections

**Foreword:** specific definition of the evidence levels applied to the imaging work-up

- **T staging.** The primitive tumors of:
  - the nasopharynx
  - the oral cavity - oropharynx
  - the hypopharynx-larynx
  - the sinonasal cavities
  - the salivary glands
- **N staging.** The metastatic lymph nodes
- **M staging.** The distant metastases
- **The unknown primary tumor**
- **The second primitive tumor**
- **The loco-regional tumor recurrence**

**Appendix:** references
Foreword:

Levels of evidence

as described in the introduction of the present work are not suited for the evaluation of imaging modalities (see Valk PE*) since randomized controlled trials are not appropriate in the purpose. Most studies consist in direct comparisons of modalities with the patient being its own control.

To establish the present guidelines, we used a “litterature-based consensus” and defined three levels of application: “standard” for techniques to be routinely used in all patients “individual” for techniques useful in a selected subset of patients presenting with a peculiar clinical problem to be solved “investigational” for techniques of which benefit still remains unsupported by sufficient scientific evidence but needing a clinical trial to be evaluated

**T Staging: 1. The nasopharynx**

**Spiral CT scan**

CT has lower performance than MRI in imaging soft tissue but remains a valuable alternative technique (**contra-indications to MRI/uncooperative patients**)

CT best depicts the status of bone structures

**Technique:**

Profile scout view

100 cc contrast medium

Biphasic injection (50 cc, 1 cc/sec-delay 150 s; 60 cc, 1.5 cc/s)

120 kV-300 mAs

Acquisition starting 35 s after the 2nd inj. 4 x 2.5 mm - Matrix: 512x512

**Post processing and options:**

Soft tissue display + bone window setting

MPR if necessary

4 X 1 mm unenhanced CT to assess the skull base
MRI Standard

MRI has two major advantages on CT: better soft tissue depiction and better accuracy in assessing endocranial involvement. It therefore appears as the best suited imaging modality.

**Standardized examination protocol**

1. Sagittal FSE T2-weighted sequence (scout view)
2. Coronal SE T1-weighted sequence / 15 slices 4 mm with a large FOV (30 cms) focussed on both the primitive and the nodal areas

*If lesion located posteriorly on 1.*

3. Sagittal T1-weighted 15 slices 3mm0.3
4. Transverse T1-weighted 15 slices 4mm0.4 (both focussed on the primitive lesion)

*If lesion located cranially on 1.*

3. Sagittal SE-T1-weighted 15 slices 3mm0.3
4. Coronal SE T1-weighted sequence 15 slices 4mm0.4 (both focussed on the primitive lesion)

**Paramagnetic contrast agent perfusion**

- Transverse or coronal FSE T2-weighted sequence with FS option 15 slices 4mm0.4 (transverse if posterior lesion; coronal if cranial lesion)

5. Similar as 3, but with FS option
6. Similar as 4, but with FS option

**Optional additional sequences**

8. standard Transverse SE T1-weighted sequence covering the whole brain with 24 slices 5mm/0.5 *if cerebral meningeal involvement is suspected*
Ultrasound: Ø

Bone scanning: individual
(locally advanced tumor with suspicion of involvement of the skull base)

FDG-PET scan: investigational
**T Staging: 2. The oral cavity - oropharynx**

**Spiral CT**

CT has lower performance than MRI in soft tissue depiction but may be a valuable alternative technique *(dental artifacts!!)*

CT best performs in depicting bone structures but could be less sensitive than MR in the purpose.

**Technique:**

- 100 cc contrast medium
- Biphasic injection (50 cc, 1 cc/s-delay 150 s; 60 cc, 1.5 cc/s)
- 120 kV-225 mAs
- 4 x 2.5 mm after a delay of 35 s - Matrix: 512 x 512

**Post-processing and options:**

- Soft tissue display + bone window setting
- MPR if necessary

*4 X 1 mm unenhanced CT images to assess the involvement of the mandible by the tumoral process*
MRI standard
primary imaging modality addressing both local tumor and nodal metastases

Standardized examination protocol

1. Sagittal FSE T2-weighted sequence (scout-view)
2. Coronal SE T1-weighted sequence with large FOV (covering primary and nodes)
3. Transverse SE T1-weighted sequence / 20 slices 4.5mm/1
4. Coronal SE-T1-weighted sequence / 20 slices 4.5mm/1

Paramagnetic contrast agent perfusion

5. Transverse FSE T2-weighted sequence with FS option / 20 slices 4.5 mm/1
6. Transverse SE T1-weighted sequence with FS option / 20 slices 4.5mm/1

Optional additional sequence

7. Thin FSE T2-weighted coronal slices on the pelvic-buccal floor if involvement of the muscles is insufficiently depicted by 4 and others.

Bone scanning: individual (locally advanced tumors, when mandibular invasion is suspected)
FDG-PET scan: investigational
Standardized examination protocol

- Sagittal FSE T2-weighted sequence (scout-view)
- Coronal SE T1-weighted sequence with large FOV (covering primary and nodes)
- Transverse SE T1-weighted sequence/ 20 slices 4.5mm/1
- Coronal SE-T1-weighted sequence/ 20 slices 4.5mm/1

*Paramagnetic contrast agent perfusion*

- Coronal FSE T2-weighted sequence with FS option/ 20 slices 4.5 mm/1
- Coronal SE T1-weighted sequence with FS option/ 20 slices 4.5mm/1
- Transverse SE T1-weighted sequence with FS option/ 20 slices 4.5mm/1

Addendum: MRI protocol dedicated to *pelvic-buccal* tumors
**T Staging: 4. The hypopharynx-larynx**

**Spiral CT Standard**
CT appears as the best imaging modality to assess the hypo-pharynx and larynx in routine.
MR seems promising in focussed purposes such as the tumoral involvement of the cartilages and of the anterior commissure, but needs further validation.

**Technique:**
- Profil scout view including skull base and shoulders
- Quiet breathing
- Iodinated contrast medium with bi-phasic injection (50 cc, 1 cc/s-delay 150 s; 60 cc, 1.5 cc/s)
- 4 x 2.5 mm, 35 sec after 2\textsuperscript{nd} injection, from skull base down to the clavicles, Pitch: 1.25 / Matrix: 512 x 512

**Post-processing and options:**
- 4x1mm on laryngeal cartilages if suspicion of cartilage invasion.
- Valsalva manoeuvre if asymmetry of the pyriform sinuses
- Phonation to assess the mobility of vocal cords
- MPR reconstructions on sagittal plane to show the pre-epiglottic space, epiglottis, …
MRI

Standardized protocol for the hypopharynx  Individual

- Sagittal FSE T2-weighted sequence (scout-view)
- Coronal SE-T1-weighted sequence with large FOV including the primitive and the nodal areas
- Transverse SE T1-weighted sequence 20 slices 4.5 mm/1

4. Coronal SE T1-weighted sequence focussed on the primitive 4.5mm/1

Paramagnetic contrast agent perfusion

5. Transverse FSE T2-weighted sequence with FS option  4.5 mm/1
6. Transverse SE T1-weighted sequence with FS option 4.5 mm/1

Experimental MR protocol for the larynx  investigational

1. Sagittal FSE T2-weighted sequence 21 slices 5mm/0.5 (scout view)
2. Transverse SE T1-weighted sequence 15 slices3 mm/0.3
3. Transverse FSE T2-weighted sequence 15 slices 3 mm/0.3
4. Coronal FSE T2-weighted sequence 15 slices 3 mm/0.3

Additional optional sequence

Paramagnetic contrast agent perfusion

5. Transverse SE T1-weighted sequence with FS option 15 slices 3 mm/0.3
   (similar slice location as 2.)
Ultrasound: Ø

Bone scanning: not performed (unless symptoms)

FDG-PET scan: investigational
T Staging: 5. The sino-nasal cavities

Spiral CT
- appropriate in the tumoral work-up with unsurpassed bone depiction
- MRI must be preferred in cases of endocranial/orbital involvement

Technique:
Patient in decubitus
120 kV; 30 mAs (some authors advocate 10 mAs!)
1.3 mm collimation
0.6 mm interval of reconstruction
Pitch: 0.75
FOV: 250 mm

Post-processing and options
IV contrast medium injection if tumor is suspected
MPR in sagittal and frontal planes
MRI
Both CT and MR are suited with similar accuracy.
CT better depicts bone destruction
MR better depicts meningeal/endo-orbital involvement

**Standardized MR examination**  **standard**
1. Sagittal FSE T2-weighted sequence 21 slices 5mm/0.5 (scout-view)
2. Coronal SE T1-weighted sequence with large FOV  *for nodal areas work-up*
3. Coronal SE T1-weighted sequence focussed on the primitive/ 20 slices 4mm/.4

*Paramagnetic contrast agent perfusion*
4. Coronal FSE T2-weighted sequence with FS option 20 slices 4 mm/0.4
5. Coronal SE T1-weighted sequence with FS option 20 slices 4 mm/0.4
6. Transverse SE T1-weighted sequence with FS options 20 slices 4 mm/0.4

**Optional additional sequences**
7. Transverse SE T1-weighted sequence covering the whole brain 24 slices 5 mm/0.5 *for meningeal involvement depiction*

**Bone scanning:**  **individual**
**FDG-PET scan:**  **not applicable**
**T Staging: 6. The salivary glands**

**Spiral CT**

CT is the first-line imaging modality in the inflammatory painful gland in which a neoplastic process seems poorly probable.

**Technique:**

Profil scout view including skull base and shoulders

Unenhanced and enhanced CT images, biphasic injection (50 cc, 1 cc/s-delay 150 s; 60 cc, 1.5 cc/s)

4 x 2.5 mm from skull base down to the clavicles, pitch: 1.25

120 kV, 150 mAs

Quiet breathing

**Post-processing and options:**

Soft tissue and bone window setting if bone contact or intra-tumoral calcifications
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**MRI**  **standard**

First line imaging modality of the indolent gland potentially harboring a neoplastic process

*Standardized examination protocol*

1. Sagittal FSE T2-weighted sequence 21 slices 5 mm/0.5 (scout)
2. Transverse SE T1-weighted sequence 24 slices 4 mm/0.4
3. Coronal SE T1-weighted sequence 24 slices 4 mm/0.4 including salivary glands and nodal areas

*Paramagnetic contrast agent perfusion*

4. Transverse FSE T2-weighted sequence 24 slices 4 mm/0.4
5. Transverse SE T1-weighted sequence with FS option 24 slices 4 mm/0.4
6. Coronal SE T1-weighted sequence with FS option 24 slices 4 mm/0.4

*Additional optional sequences*

7. MR sialography using 3D T2 FSE sequence with very long echo time (lower interest than in the benign gland)

**Ultrasound**

**Bone scanning**: not applicable (unless symptoms)

**FDG-PET scan**: investigational
**N Staging:** the lymph nodes metastases

**CT scan and MRI**

* CT and MRI have similar accuracy in depicting metastatic nodes
* both suffer significant
  - unsensitivity to micro-metastases
  - unspecificity in discriminating benign from malignant adenomegalies
* lymph node size remains the main criterion for malignancy using MSAD measurements
* central necrosis is the second significant criterion, others being ancillary
Spiral CT

The use of IV contrast medium injection is mandatory to differentiate lymph nodes from adjacent soft tissue structures and for better characterization.

**Technique:**

Profil scout view including skull base and shoulders

Quiet breathing

Iodinated contrast medium with bi-phasic injection (50 cc, 1 cc/s-delay 150 s; 60 cc, 1.5 cc/s)

4 x 2.5 mm, 35 s after 2nd injection, from skull base down to the clavicles,

**Post-processing and options:**

- Classification of lymph nodes in levels (1-6) using the international classification

- Co-registration with PET
N Staging: the lymph nodes metastases

MRI

MRI is never performed as solely node-targeted examination. Nodal areas are frequently included into the FOV of the images depicting the primary tumor, therefore yielding extra-information on the nodes. An additional large FOV T1-weighted sequence in the coronal plane before IV contrast agent perfusion is often performed to cover the major nodal areas at the initial phase of the procedure.

PET scan: investigational
Ultrasound and FNA

Ultrasound is an easy and inexpensive imaging modality to assess lymph nodes. It can be used to guide a Fine Needle Aspiration (FNA) procedure. FNA is operator-dependent and should be performed by the same trained radiologist. Colour Doppler Ultrasound improves the diagnostic performance by highlighting specific vascular patterns of the neoplastic nodes.

Technique:

High frequency probe.
Short axis registration with internal structure
(hypoechoic nodes are more suspicious)

Recommandations:

If FNA is planned, do stop aspirin 3 days before the procedure
**M Staging** The distant metastases: lungs

The lungs appear to be the first site of extra cervical dissemination.

**Patients at risk to develop lung metastases** are e.g., patients with three or more metastatic lymph nodes, and/or with residual tumor above the clavicles, and/or with recurrent tumor.

**Technique**

Spiral CT is by far the best imaging modality, surpassing the chest plain film.

- Scout view including the entire chest
- No contrast medium injection
- Deep inspiration and thereafter holding breath
- 5 mm slice thickness, pitch: 1.5
- Mediastinal and lung window setting

**Post-processing and options**

- Low dose CT (15 mAs) in cases of young patients
There is no perfect imaging modality to detect liver metastases. The first line modality should be selected regarding the local expertise, the availability of the different techniques, and the patient’s status. The risk for liver metastases seems strongly correlated to the presence of lung metastases.

If lung CT (+) for metastases → liver imaging
If lung CT (-) for metastases → stop

**Techniques**

**Ultrasound**: best contributive when performed in thin cooperative patients by an experienced radiologist

**Spiral CT**: standardized using 4 x 2.5 mm, post-contrast slices, from the upper aspect of the liver down to the iliac crests

**MR**: restricted as additional technique because of high costs
M Staging: the distant metastases

PET-scan: Investigational. Published data support the use of PET-FDG as a staging procedure for N and M evaluation but the impact of the technique on the patient’s management and outcome is not fully determined. Further studies are subsequently needed before definite validation.

A major advantage of the technique is that it covers comprehensively the whole body in a one session procedure.
The second primary

CT Scan  Investigational in pulmonary lesions

Lung cancer:
Low dose CT (15 mAs) of the lungs to detect the second primary is being evaluated.

Abdominal lesions:
In colonic and esophageal tumors, routine abdominal CT is not advocated.
CT may be helpful in characterizing abnormalities detected by other modalities (PET)

PET-scan: *investigational*. See Metastatic staging.
The unknown primary

PET-scan: standard

The recommended initial routine work-up includes:

1. chest X-ray
2. panendoscopy
3. ultrasound.

If unconcontributive: perform a FDG-PET scan.

If PET is positive, than perform additional imaging investigations (CT, MR, endoscopy) focused on the abnormal PET findings.
PET-scan: *investigational*. See Metastatic staging.
The locoregional tumor recurrence

CT scan and MRI:
have yielded disappointing results in the purpose of detecting local recurrence and failed to reach an acceptable level in accuracy in spite of technical/semiological refinements

PET-scan standard

Therefore considered as the first-line imaging procedure in the patient suspected of tumoral recurrence, mainly if the primary site is not accessible to the clinical examination (i.e. all sites except the oral cavity).

Best performed before panendoscopy so that PET information can guide biopsies.

Co-registration of CT-MR and PET information is beneficial by superimposing anatomical and metabolic information.
Limitations:
State-of-the-art PET scanners have a maximal spatial resolution of 5-mm, which means that micrometastatic lymph nodes/primitives may be overlooked by PET. High uptake of FDG can be seen in benign inflammatory lymph nodes. Usual recommendations for diabetic patients are: optimized glycemic control at the time of PET, early in the morning procedure scheduling, and adequate information of the NM physician.

Technique:
Patient must be fasting for at least 6 hours (12 hours is better). Premedication with diazepam 10 mg orally is systematic 30 minutes before the injection of FDG. Injected dose is 10 mCi/70 kg. Imaging cannot be started less than 60 minutes after tracer injection. Acquisition centered on the ENT region is performed using the 3-D mode (increased sensitivity) and longer scanning time in order to increase the image quality. This MUST be followed by a whole-body acquisition to detect distant metastases or synchronous tumors. Reconstruction of the data is performed using the iterative algorithm. The interpretation is based on the intensity and the symmetry of the uptake. PET should be performed BEFORE any surgical or (deep) sampling procedure to avoid local reactive changes and thus local artificial increase in FDG uptake.
Appendix: references

T staging – nasopharynx

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T staging – Oral cavity/Oropharynx

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**T staging – Hypopharynx-larynx (a)**

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**T staging – Hypopharynx-larynx (b)**

N Staging

**M Staging**

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The second primary

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