Delineation of Nodal Volume in HNC (N0 & N+)
Management of Neck

Not all the neck nodes are involved in all sites.

Fixed and Predictable Pattern of regional spread to Nodes.

Treating whole neck in all patients make no sense.

Selective neck irradiation similar to selective neck dissection

Location of the nodes and Pattern of spread
Location of Neck Nodes

- Robbins Classification: Surgeons
- Brussels system: Radiation Oncologists
- Rotterdam system: Oncologists
- RTOG Consensus Guidelines

Due to discrepancies in different systems, a consensus guidelines was derived.
Changes in Robbins classification

• Based on surgical boundaries like muscles, nerves and vessels.
• But these structures may not be identifiable on CT.
• Cranial limit for level II was defined by surgeons at insertion of post belly of digastric muscle at mastoid.
• But this point may not be identifiable on CT.
• So cranial limit was modified to bony land mark like cervical vertebrae.
Changes in Robbins classification

• Similarly, Robbins defined the caudal limit of level III as the point at which the omohyoid muscle crossed the internal jugular vein (IJV); again not clearly identifiable on CT.

• So easily identifiable landmark is chosen like lower border of cricoid cartilage.
Changes in Robbins classification

- Robbins used the spinal accessory nerve (SAN) to sub-divide level II into IIa (anterior to a vertical plane defined by the nerve) and IIb (posterior to that plane).
- SAN cannot be identified on CT scans,
- So, posterior edge of the IJV for the subdivision between levels IIa and IIb
Boundaries

Cranial

Caudal

Upper

Lower
CT-based delineation of lymph node levels and related CTVs in the node-negative neck: DAHANCA, EORTC, GORTEC, NCIC, RTOG consensus guidelines

Vincent Grégoire\textsuperscript{a,\#}, Peter Levendag\textsuperscript{b,\#}, Kian K. Ang\textsuperscript{c}, Jacques Bernier\textsuperscript{d}, Marijel Braaksma\textsuperscript{b}, Volker Budach\textsuperscript{e}, Cliff Chao\textsuperscript{f}, Emmanuel Coche\textsuperscript{g}, Jay S. Cooper\textsuperscript{c}, Guy Cosnard\textsuperscript{f}, Avraham Eisbruch\textsuperscript{c}, Samy El-Sayed\textsuperscript{h}, Bahman Emami\textsuperscript{c}, Cai Grau\textsuperscript{b}, Marc Hamoir\textsuperscript{i}, Nancy Lee\textsuperscript{c}, Philippe Maingon\textsuperscript{j}, Karin Muller\textsuperscript{b}, Hervé Reychler\textsuperscript{k}

Guidelines

Delineation of the neck node levels for head and neck tumors: A 2013 update. DAHANCA, EORTC, HKNPCSG, NCIC CTG, NCRI, RTOG, TROG consensus guidelines \textsuperscript{\#}

Vincent Grégoire\textsuperscript{a,\#}, Kian Ang\textsuperscript{b}, Wilfried Budach\textsuperscript{c}, Cai Grau\textsuperscript{d}, Marc Hamoir\textsuperscript{e}, Johannes A. Langendijk\textsuperscript{f}, Anne Lee\textsuperscript{g}, Quynh-Thu Le\textsuperscript{h,i}, Philippe Maingon\textsuperscript{j}, Chris Nutting\textsuperscript{k}, Brian O'Sullivan\textsuperscript{l}, Sandro V. Porceddu\textsuperscript{m}, Benoit Lengele\textsuperscript{n}
N+ve Neck

Radiotherapy and Oncology 79 (2006) 15-20
www.thegreenjournal.com

Target volume delineation

Proposal for the delineation of the nodal CTV in the node-positive and the post-operative neck

Vincent Grégoirea,*, Avraham Eisbruchb, Marc Hamoirc, Peter Levendagd
Classification of the Neck Nodes

Level I to Level VI
• **Level Ia (Sub-mental)**

• **Sub-mental triangle:**
  - Bounded by two anterior belly of digastric

![Diagram](image)
Primary for la

- Floor of the mouth.
- Anterior oral tongue.
- Anterior mandibular alveolar ridge.
- Lower lip.
Cranial-> Geniohyoid muscle or a plane tangent to the basilar edge of the mandible.

Level Ia
Caudal -> hyoid bone

Level Ia
Anterior-> Platysma muscle and the symphysis menti,

Lateral-> Medial edge of ant belly of two digastric muscles

Level Ia
Posterior -> body of the hyoid bone,

Medial -> region continues into the contralateral level Ia

Level Ia
Contouring
**Level Ib (Sub-mandibular)**

**Sub-mandibular Triangle** Formed by the Digastric Muscle

- Anterior belly
- Body of the mandible
- Posterior belly
Primary for Ib

- cancers of the oral cavity,
- anterior nasal cavity,
- soft tissue structures of the mid-face and
- submandibular gland.
Anteriorly -> Platysma muscle

Level Ib
Posterior edge of the submandibular gland

Level Ib
Medial-> lateral edge of the ant belly of digastric muscle

Level Ib
Lateral-> Inner side of the mandible, Platysma and skin.

Level Ib
Cranial-> Mylohyoid muscle and cranial edge of the submandibular gland.

Level Ib
Caudal-> Plane crossing the central part of Hyoid bone

Level Ib
Contouring

Level Ib
Jugular nodes (Level II-IV)

- Most of the jugular nodes (lev. II-IV) present ant., post., and lateral to the IJV.
- No nodes on medial to IJV
- So medial boundary is medial edge of the vessel bundle.
Level II

Cranial Boundary

- Cranial limit for level II was defined by surgeons at insertion of post belly of digastric muscle at mastoid.
- But this point may not be identifiable on CT.
- Surgeons were asked to put the clips at the upper level of dissection for level II nodes in node negative neck.
How consensus was made for cranial border for level II Nodes?

• Clips cluster around caudal border of transverse process of vertebra C1.

• So cranial border of level II is taken at caudal edge of transverse process of C1.

Parotid projection so if cranial limit is taken at base of skull then more parotid will be irradiated.
Usually the cranial limit of level II is caudal border of transverse process of C1 vertebrae.

But few nodes also present superior to this up to base of skull.

This region cranial to cranial limit of Level II is called Retro Styloid region.
When to treat Retro Styloid Region

- Ca Nasopharynx.

  **Bilateral**

- In +ve level II node

  **Ipsilateral**
Caudal-> Carotid Bifurcation (Surgical Boundry) caudal edge of body of the hyoid bone.

Level II
Level II
Anterior Relation

- the anterior edge of the carotid artery
- posterior edge of the submandibular gland,
- the posterior belly of the digastric muscle,
Anterior-> Anterior edge of the carotid artery

Level II
Anterior->Posterior edge of the submandibular gland,

Level II
Anterior-> posterior belly of the digastric muscle,
Posterio-> Posterior edge of the sternocleidomastoid (SCM) muscle,

Level II
Medial-> Medial edge of the carotid artery and the paraspinal muscles (levator scapulæ and splenius capitis)
Lateral-> Medial edge of the SCM

Level II
Contouring

Level II
Primary for II

- Nasal cavity.
- Oral cavity.
- Pharynx
  - Oropharynx.
  - Hypopharynx.
  - Nasopharynx,
- Larynx.
- Major salivary glands.
Sub division of Level II

- Level II is further subdivided into two compartments.
  - IIa
  - IIb
- Surgeons demarcate between the two by spinal accessory nerve (SAN).
- From a radiological point of view, the posterior edge of the IJV is taken as the boundary between levels IIa and IIb.
More frequently
- Oropharynx
- Naso pharynx

Less frequently
- Oral cavity
- Larynx
- Hypopharynx
Level III

- contains the middle jugular lymph nodes located around the middle third of the IJV.
- It is the caudal extension of level II
- Primary.

  Oral cavity.
  Oropharynx.
  Hypopharynx.
  Nasopharynx,
  Larynx.
Cranial-> caudal edge of body of the hyoid bone.

Level III
Caudal→ Caudal edge of the cricoid cartilage.

Level III
Anterior-> Posterolateral edge of the sternohyoid muscle and the anterior edge of the SCM muscle,
Posterior edge of the SCM muscle

Level III
Lateral-> Medial edge of the SCM muscle

Level III
Medial-> Medial edge of the internal carotid artery and the paraspinal muscles (scaleni).
Level IV

- includes the lower jugular lymph nodes located around the inferior third of the IJV.
- According to Robbins, it extends from the caudal limit of level III to the clavicle.
- But since surgeons never dissect up to clavicle so consensus is that the caudal limit is 2cm cranial to the cranial edge of sterno-clavicular joint.
Cranial→ Caudal edge of the cricoid cartilage.

Level IV
Anterior, Posterior, Lateral.

Anterior edge, posterior edge, and medial edge of the SCM muscle, respectively.
Medial-> Medial edge of the internal carotid artery and the paraspinal muscles (scaleni)
Level IV

IVa

IVb

Medial Supra Clavicular

Continuation of level IVa

Cranial extent up to cranial edge of sternal manubrium

2013 Guidelines
Primary for level IVa

- Hypopharynx.
- Larynx
- Oropharynx.
- Skip metastasis from ant tongue.
- Cervical esophagus
- Thyroid

Level IVb
Sub Glottic Larynx and with positive level IV a nodes
Level V

Nodes in the posterior triangle

- SCM
- Trapezius
- Clavicle
The uppermost part of level V contains superficial occipital lymph node(s), which are not involved in head and neck ca except skin cancer.

So cranial limit is a horizontal plane crossing the cranial edge of the body of the hyoid bone.
Cranial -> Horizontal plane crossing the cranial edge of the body of the hyoid bone
Level V
Caudal

• For the caudal limit of level V, it appears from critical examination of neck dissection procedure, that surgeons never dissect up to clavicle but go only up to the transverse cervical vessels.

• Hence, caudal limit of level V is kept at CT slices encompassing the cervical transverse vessels
Caudal -> CT slices at the level of transverse Cervical vessels
Lateral-> Platysma muscle and the skin,

Level V
Medial -> Paraspinal muscles (splenius capitis, levator scapulae and scaleni (posterior, medial and anterior) muscles)
Anterior-> Posterior edge of the SCM muscle

Level V
Posterior -> Antero-lateral border of the trapezius muscles

Practically, a virtual line joining the antero-lateral border of both trapezius muscles can be used to set the posterior limit of level V.
Contouring

Level V
Primary for Level V

• Nasopharynx.
• Oropharynx.
• Thyroid gland.
Level V is divided into Va and Vb by omohyoid muscle where it crosses the internal jugular vein.

But this crossing point cannot be appreciated on CT film.
Level V

- For practical purpose, use of the plane between levels III and IV extended posteriorly is recommended,

- which means lower border of cricoid can be taken as dividing line between Va and Vb
Continuation of Level V down

Lateral Supraclavicular

- Nasopharyngeal Ca
- Gross level V nodes

2 cm from M Sterni
Level Vc

Ant border of Trapezius

Medially abut IVa

Skin

IVa

Vc
Level VI

- Located in anterior neck compartment

Vla
- Anterior Jugular Nodes

Vlb
- Pre Laryngeal
- Pre-tracheal
- Para-tracheal (recurrent laryngeal nerve nodes)
Level VIa

Cranial

Caudal edge of the hyoid bone
or caudal edge of the sub mandibular gland
whichever is more caudal

- Ca Lower Lip
- Advanced lower alveolus ca with invasion to chin

Caudal

Cranial edge of the sternal Manubrium
Level VIa

Between two Sterno cleidomastoid Muscle

Platysma

Anterior Aspect of Infrahyoid Muscle
Contouring
Level VIb

Cranial -> Caudal edge of the body of the thyroid cartilage,
Level VIb

Caudal -> Cranial edge of the sternum manubrium
Level VIb  Posterior Aspect of Infra hyoid Muscle
Level VIb

Anterior aspect of the respiratory tract

Cricoid

Pre laryngeal

Tracheal rings

Pre tracheal
Contouring Pre tracheal Level VIb
Contouring Para tracheal Level VIb

Posterior border is by esophagous and Pre vertebral muscles
Contouring
Primary for Level VI

Cervical esophagus
Apex of pyriform sinus
Thyroid ca
Transglottic extension
Subglottic extension
Typically, retropharyngeal nodes are divided into
- Medial Group
- Lateral Group.

The medial group is an inconsistent group which consists of one to two lymph nodes.
The lateral group lies medial to the carotid artery.
The most superior lymph node of this group is also called the lymph node of Rouvie`re.
Level VIIa RP nodes

**Caudal** -> Cranial edge of the body of the hyoid bone
Level VIIa RP nodes

Cranial-> upper edge of the body of first cervical vertebra
Anterior-> Levator Veli palatini muscle.

RP nodes
Posterior-> Pre-vertebral Muscles. .

RP nodes
Lateral-> Medial edge of the carotid vessel.

RP nodes
Contouring

RP nodes
Primary for Level VIIa

• Nasopharynx
• Tonsillar fossa
• Soft Palate
• Post Pharyngeal wall
### Level VIII.

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Level VIII (parotid node group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial</td>
<td>Zygomatic arch, external auditory canal</td>
</tr>
<tr>
<td>Caudal</td>
<td>Angle of the mandible</td>
</tr>
<tr>
<td>Anterior</td>
<td>Posterior edge of mandibular ramus &amp; posterior edge of masseter m. (laterally) medial pterygoid muscle (medially)</td>
</tr>
<tr>
<td>Posterior</td>
<td>Anterior edge of sternocleidomastoid m. (laterally), posterior belly of digastric m. (medially)</td>
</tr>
<tr>
<td>Lateral</td>
<td>SMAS layer in sub-cutaneous tissue</td>
</tr>
<tr>
<td>Medial</td>
<td>Styloid process and styloid m.</td>
</tr>
</tbody>
</table>

### Level Xb (occipital nodes)

- External occipital protuberance
- Cranial border of level V
- Posterior edge of sternocleidomastoid m.
- Anterior (lateral) edge of trapezius m.
- Sub-cutaneous tissue
- Splenius capitis m.

### Level IX.

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Level IX (bucco-facial group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial</td>
<td>Caudal edge of the orbit</td>
</tr>
<tr>
<td>Caudal</td>
<td>Caudal edge of the mandible</td>
</tr>
<tr>
<td>Anterior</td>
<td>SMAS layer in sub-cutaneous tissue</td>
</tr>
<tr>
<td>Posterior</td>
<td>Anterior edge of masseter m. &amp; corpus adiposum buccae (bichat’s fat pad)</td>
</tr>
<tr>
<td>Lateral</td>
<td>SMAS layer in sub-cutaneous tissue</td>
</tr>
<tr>
<td>Medial</td>
<td>Buccinator m.</td>
</tr>
</tbody>
</table>

### Level Xa (retroauricular nodes)

<table>
<thead>
<tr>
<th>Boundaries</th>
<th>Level Xa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial</td>
<td>Cranial edge of external auditory canal</td>
</tr>
<tr>
<td>Caudal</td>
<td>Tip of the mastoid</td>
</tr>
<tr>
<td>Anterior</td>
<td>Anterior edge of the mastoid (caudally)/posterior edge of the external auditory canal (cranially)</td>
</tr>
<tr>
<td>Posterior</td>
<td>Anterior border of occipital nodes – posterior edge of sternocleidomastoid m.</td>
</tr>
<tr>
<td>Lateral</td>
<td>Sub-cutaneous tissue</td>
</tr>
<tr>
<td>Medial</td>
<td>Splenius capitis m. (caudally)/temporal bone (cranially)</td>
</tr>
</tbody>
</table>
N +ve Neck
What is positive neck node?

**SIZE**
- Smallest Transverse diameter
  - Level I, II: >12-15mm
  - Level III to VI: >10mm
  - Level VII: >5-8mm

**HETEROGENEITY**
- Central Region hypodense,
  - T1-Weighted hypointensity
  - T2-Weighted hyperintensity

**NECROSIS → METASTASIS**

**CLUSTERS**
- Three or more contiguous ill defined nodes with 6-8mm size present together

**SHAPE**
- Normal------Bean or Elliptical.
- Abnormal--------Round

Consensus at 43rd meeting of ASTRO, San Francisco, 2001
Changes in contouring for +ve Neck

• Extent of contouring to be increased
• Extra Capsular Extension to be taken into account.
• Node infiltrating the muscle.
• CTV margin
• Junction Nodes
Extent of contouring to be increased

Level II is Enlarged

• Extend level II cranially up to jugular foramina i.e. Retrostyloid region is included on the side of involvement
Extent of contouring to be increased

Level IVa or V is Enlarged

- Go down to contour up to manubrium sterni i.e. Include level IVb & Vc as well, i.e. Supra Clavicular region
Extra Capsular Extension (ECE)

- **Clinical Criteria**
  - Skin Infiltration
  - Fixed or restricted mobility
  - Clinical Sign of Nerve damage

- **Imaging Criteria**
  - Irregular Capsular Enhancement.
  - Ill defined nodal margins
  - Obliterated Fat Plane
  - Edema or thickening of adjacent soft tissue
Extra Capsular Extension (ECE)

The majority of the ECE extend <5mm from the capsule of node (97% of the cases).
A CTV margin of 5mm will cover most of the ECE.

Node Infiltrating the muscle

Include whole muscle in CTV at the level of infiltration and 1 cm cranio-caudally
Junction Nodes

If N1 node is located at the boundary with another level which was not intended to be part of CTV, then extend the CTV to include that level.

Ca Oro pharynx with N1 node at junction with Level Ib
Pattern of Spread

• Prophylactic neck node irradiation is required if the incidence of occult metastasis is $> 10$-15%.
Pattern of Spread

• Typically, nasopharyngeal and hypopharyngeal tumors have the highest propensity of nodal involvement which occurs in 80 and 70%, respectively.

• Interestingly, the node distribution follows the same pattern in the contra-lateral neck as in the ipsi-lateral neck.

• Contra lateral level V is usually not involved
## Micro Metastasis in Levels I-V for clinically N0 neck

<table>
<thead>
<tr>
<th>Tumor site</th>
<th>Levels involved(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>20</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>2</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>0</td>
</tr>
<tr>
<td>Larynx</td>
<td>5</td>
</tr>
</tbody>
</table>

- In non-nasopharyngeal cancers of head and neck, level V is not included in N0 neck as incidence of involvement is <5%.
- Similarly, in oro-pharynx, hypo-pharynx and larynx, level I is not included as again incidence of occult metastasis is <5%.
Non Nasopharyngeal N0 Neck

- Oral Cavity Ca → Level I, II, III and in ca tongue level IV
- Oro pharynx
- Hypo pharynx
- larynx → Level II, II, IV
Incidence and distribution of regional metastasis for Levels I–V for clinically N+ve neck

<table>
<thead>
<tr>
<th>Tumor site</th>
<th>Levels involved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>48</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>15</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>10</td>
</tr>
<tr>
<td>Larynx</td>
<td>5</td>
</tr>
</tbody>
</table>

In non-nasopharyngeal cancers of head and neck, level V is included in N+ve neck except in ca oral cavity where incidence is <5%.

Similarly level I should be included in neck positive disease except in +/-larynx.
N +ve neck

One adjacent extra nodal level is also at high risk of occult metastasis and should be treated.

- **Oral Cavity**: Level I, II & III + Level IV
- **Pharynx**: Level II, III & IV + Level I & V
- **Larynx**: Level II, II & IV + Level I & V
When to Treat RP Nodes?

<table>
<thead>
<tr>
<th>Site</th>
<th>N0 neck</th>
<th>N+ neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oropharynx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pharyngeal wall (n=93)</td>
<td>16%</td>
<td>21%</td>
</tr>
<tr>
<td>soft palate (n=53)</td>
<td>5%</td>
<td>19%</td>
</tr>
<tr>
<td>tonsillar fossa (n=176)</td>
<td>4%</td>
<td>12%</td>
</tr>
<tr>
<td>base of tongue (n=121)</td>
<td>0%</td>
<td>6%</td>
</tr>
<tr>
<td>Hypopharynx (n=136)</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Supraglottic larynx (n=196)</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Nasopharynx (n=474)</td>
<td>17%</td>
<td>47%</td>
</tr>
</tbody>
</table>

Incidence of retropharyngeal lymph nodes in head and neck squamous cell carcinomas

From McLaughlin, Chua, Chong

N0 Neck → Nasopharynx and Pharyngeal Wall

N+ Neck → All sites except larynx
RP nodes

• Always treated bilaterally.

• Most of the patients with non nasopharyngeal tumors have risk of metastasis only in lateral RP nodes.

• So only lateral should be included. This can save superior constrictor muscle, thus better swallowing after RT
Oral Cavity Tips

• Bilateral Neck to be treated except T1 and T2,N0, Buccal mucosa and RM trigone where same side of neck to be treated.

• Level I-III nodes are to be treated in N0 except in oral tongue ca where I-IV are treated.

• Level IIb may be omitted in N0.

• With multiple nodes include level V also(Level I-V).
Pharynx Tips

• Oro and hypo Pharynx

• *Treat bilateral neck except N0, T1 and T2 tonsil.*

• N0 → Level II-IV,
  • IIb may be omitted
  • Post Pharyngeal wall include RP nodes as well

• With single node <6cm, also include level V and RP nodes (Level II-V with RP)

• With multiple nodes or >6cm size also include level I also(I-V with RP)

• With Pyifrom sinus apex and esophageal extension also include level VI.
Larynx Tips

- Treat bilaterally
- With N0, level II-IV.
  - **IIb may be omitted**
- With single node <6cm size, also include level V (II-V)
- With multiple nodes or >6cm size also include level I also (I-V).
- With trans glottic and sub glottic ext also include level VI
Nasopharynx Tips

- Delineate Levels II – V and retropharyngeal nodes in No patients.
- Include Level I B in N+ patients.
- Delineate Level II till the base of skull in all patients.
- Delineate the entire Ho’s triangle when marking Level V
Thanks

Greetings From Rishikesh