

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 [☆]



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

^a Cancer Center and Department of Radiation Oncology, Clinical and Experimental Research Institute, Université Catholique de Louvain, Cliniques Universitaires St-Luc, Brussels, Belgium; ^b Department of Radiation Oncology, The University of Texas MD Anderson Cancer Center, Houston, USA; ^c Department of Radiation Oncology, University Hospital Düsseldorf, Germany; ^d Department of Oncology, Aarhus University Hospital, Denmark; ^e Cancer Center and Department of Otorhinolaryngology, Head and Neck Surgery, Institut de Recherche Experimentale et Clinique, Université Catholique de Louvain, Cliniques Universitaires St-Luc, Brussels, Belgium; ^f Department of Radiation Oncology, University Medical Center Groningen, University of Groningen, The Netherlands; ^g Department of Clinical Oncology, The University of Hong Kong (Shenzhen) Hospital, China; ^h Department of Radiation Oncology, Stanford University School of Medicine, Stanford Cancer Center, Stanford; ⁱ Radiation Therapy Oncology Group (RTOG), USA; ^j Department of Radiation Oncology, Centre Georges-François Leclerc, Dijon, France; ^k Department of Radiation Oncology, Royal Marsden Hospital and Institute of Cancer Research, London, UK; ^l Department of Radiation Oncology, Princess Margaret Hospital, University of Toronto, Canada; ^m Cancer Services, Princess Alexandra Hospital, Brisbane, Australia; ⁿ Cancer Center and Department of Human Anatomy and Plastic & Reconstructive Surgery, Institut de Recherche Experimentale et Clinique, Université Catholique de Louvain, Cliniques Universitaires St-Luc, Brussels, Belgium

ARTICLE INFO

Article history:

Received 2 September 2013
Received in revised form 21 September 2013
Accepted 13 October 2013
Available online 31 October 2013

Keywords:

IMRT
Head and neck tumors
Lymph node levels
Neck nodes
Worldwide consensus

ABSTRACT

In 2003, a panel of experts published a set of consensus guidelines for the delineation of the neck node levels in node negative patients (Radiother Oncol, 69: 227–36, 2003). In 2006, these guidelines were extended to include the characteristics of the node positive and the post-operative neck (Radiother Oncol, 79: 15–20, 2006). These guidelines did not fully address all nodal regions and some of the anatomic descriptions were ambiguous, thereby limiting consistent use of the recommendations.

In this framework, a task force comprising opinion leaders in the field of head and neck radiation oncology from European, Asian, Australia/New Zealand and North American clinical research organizations was formed to review and update the previously published guidelines on nodal level delineation.

Based on the nomenclature proposed by the American Head and Neck Society and the American Academy of Otolaryngology-Head and Neck Surgery, and in alignment with the TNM atlas for lymph nodes in the neck, 10 node groups (some being divided into several levels) were defined with a concise description of their main anatomic boundaries, the normal structures juxtaposed to these nodes, and the main tumor sites at risk for harboring metastases in those levels. Emphasis was placed on those levels not adequately considered previously (or not addressed at all); these included the lower neck (e.g. supraclavicular nodes), the scalp (e.g. retroauricular and occipital nodes), and the face (e.g. buccal and parotid nodes). Lastly, peculiarities pertaining to the node-positive and the post-operative clinical scenarios were also discussed.

In conclusion, implementation of these guidelines in the daily practice of radiation oncology should contribute to the reduction of treatment variations from clinician to clinician and facilitate the conduct of multi-institutional clinical trials.

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[☆] The work of the Radiation Therapy Oncology Group (RTOG) is supported by grants from the National Cancer Institute (NCI). This manuscript's contents are solely the responsibility of the authors and do not necessarily represent the official views of the NCI.

* Corresponding author. Address: Radiation Oncology Dept., Cliniques Universitaires St-Luc, Avenue Hippocrate, 10, 1200 Brussels, Belgium.

E-mail address: vincent.gregoire@uclouvain.be (V. Grégoire).

In head and neck (H&N) IMRT, it has been shown that heterogeneity in target volume selection and delineation is an important source of variations among radiation oncologists [1]. Such variations could easily jeopardize the gain of IMRT by increasing either the risk of geographical miss, thereby resulting in tumor recurrence, or enhancing the volume of non-target tissues irradiated, resulting in a higher probability of normal tissue complications.

Within this framework, an initial set of recommendations for selection and delineation of the neck node target volumes was published in 2000 [2]. Three years later, a consensus was established among major stakeholders in H&N clinical research for the delineation of node levels in the node-negative neck [3]. These recommendations were subsequently expanded for the post-operative situation and the node-positive neck [4]. Although it appears that these recommendations are well accepted and used among the radiation oncology community, they are also associated with some shortcomings. Firstly, not all the neck node areas described in the TNM atlas were included [5]. In particular, the nodal areas in the lower and posterior neck typically involved in nasopharyngeal carcinoma were not properly discussed; also the lymph node regions draining the face, the scalp, and those nodal regions close to the base of skull received inadequate attention. Secondly, it appears that the description of the anatomic boundaries of some of these levels (e.g. in the lower neck) was not sufficiently accurate and thus required some interpretation from the users. Thirdly, in the guidelines for the node-positive neck, the proposed extension around positive nodes into normal structures to generate the Clinical Target Volume (CTV) was both arbitrary and potentially imprecise. New data on tumor extra-capsular extension in lymph nodes have emerged permitting specific recommendations to be proposed [6,7]. Lastly, in the original publication, the illustrations of the nodal levels were not available in DICOM or DICOM-RT format, consequently limiting the easy use of the atlas, and preventing its direct importation into treatment planning systems.

In this context, in a continuing effort to standardize and simplify the H&N IMRT process for safe and effective global advancement of clinical practice, it was decided to update the previously published guidelines on target delineation in the neck. A task force assembling opinion leaders in the field of H&N radiation oncology from various clinical research organizations and from various geographic regions was formed to review and update the previously published guidelines on nodal level delineation.

Methodology used to reach consensus guidelines for the delineation of the neck node levels

A multidisciplinary working party, including European individuals who already participated in the creation of the previous guidelines was created to update the previous recommendations for neck level delineation. The working party was enlarged to include representatives of North American, Australia/New Zealand and Asian cooperative groups. All physicians who contributed to the creation of these guidelines are listed as co-authors of this manuscript. The general principles guiding the activities of the working group were (1) to integrate as accurately as possible anatomic knowledge and previously defined surgical and radiological guidelines into a set of recommendations based on axial CT sections useful to radiation oncologists, (2) to minimize differences in interpretation of the guidelines by refining the description of the boundaries of the various levels, and (3) to extend the previously published guidelines to cover all the head and neck lymph node areas, especially in the lower neck (e.g. supraclavicular nodes), the scalp (e.g. retroauricular and occipital nodes), and the face (e.g. buccal nodes, parotid nodes).

Practically, with the help of an anatomist (BL) and a head and neck surgeon (MH), all the individual lymph node groups identified in the TNM atlas for lymph nodes of the neck [5] were reviewed and considered in the context of the anatomic description of Rouvière [8] and with the classification proposed by the American Head and Neck Society and the American Academy of Otolaryngology-Head and Neck Surgery [9,10]. Finally, they were depicted specifically on axial CT slices. When the existing classifications

were considered insufficiently detailed, the working party proposed subdivisions of certain groups into several clearly identified levels; for example the caudal jugular nodes in the TNM atlas (group #5) were subdivided into the lower jugular group (level IVa in the current proposal) and the medial supraclavicular group (level IVb in the current proposal) to better reflect the difference in the risk of nodal infiltration in these 2 levels according to primary tumor location and nodal stage; another example is that of the retropharyngeal nodes in the TNM atlas (group #9), which the working party proposed to subdivide into the retropharyngeal nodes and the retro-styloid nodes, two distinct node levels according to Rouvière. Lastly, in the publications of Robbins from the American Head and Neck Society and the American Academy of Otolaryngology-Head and Neck Surgery, only 6 node levels were described [9,10]. In the present consensus we propose to extend the levels to 10 (some being divided into sub-levels) to correspond more completely with the TNM atlas.

The consensus guidelines for the delineation of the node levels in the neck

Fig. 1 presents lateral views of the superficial and the deep node groups of the head and neck region [11]. For all these groups, Table 1 compares the terminology of the TNM atlas and the proposed terminology of the lymph node levels modified from Robbins. In the following sections, each of these levels will be briefly reviewed with a short description of their main anatomic boundaries, the normal structures juxtaposed to these nodes, and the main tumor sites at risk for harboring metastases in those levels [11]. The boundaries refer to a patient lying supine with his/her head in a “neutral” position. The terms “cranial” and “caudal” refer to structures closer to the cephalic and pedal ends, respectively. The terms “anterior” and “posterior” were chosen to be less confusing than the terms “ventral” and “dorsal”, respectively. A set of 6 transverse CT sections with the various delineated levels is presented in Fig. 2.

Level Ia

Level Ia (Table 2) is a median region located between the anterior belly of the digastric muscles, which contains the submental nodes. The medial limit of level Ia is virtual, as the region is continuous with the contralateral level Ia.

Nodes in level Ia drain the skin of the chin, the mid-lower lip, the tip of the tongue, and the anterior floor of the mouth. Level Ia is at greatest risk of harboring metastases from cancer arising from the floor of the mouth, the anterior oral tongue, the anterior mandibular alveolar ridge, and the lower lip.

Level Ib

Level Ib (Table 2) contains the submandibular nodes located in the space between the inner side of the mandible laterally and the digastric muscle medially, from the symphysis menti anteriorly to the submandibular gland posteriorly.

Level Ib nodes receive efferent lymphatics from the submental lymph nodes (level Ia), the lower nasal cavity, the hard and soft palate, the maxillary and mandibular alveolar ridges, the cheek, the upper and lower lips, and most of the anterior tongue. Nodes in level Ib are at risk of developing metastases from cancers of the oral cavity, anterior nasal cavity, soft tissue structures of the mid-face and the submandibular gland.

Level II

Level II (Table 3) contains the upper jugular nodes located around the upper one-third of the internal jugular vein (IJV) and

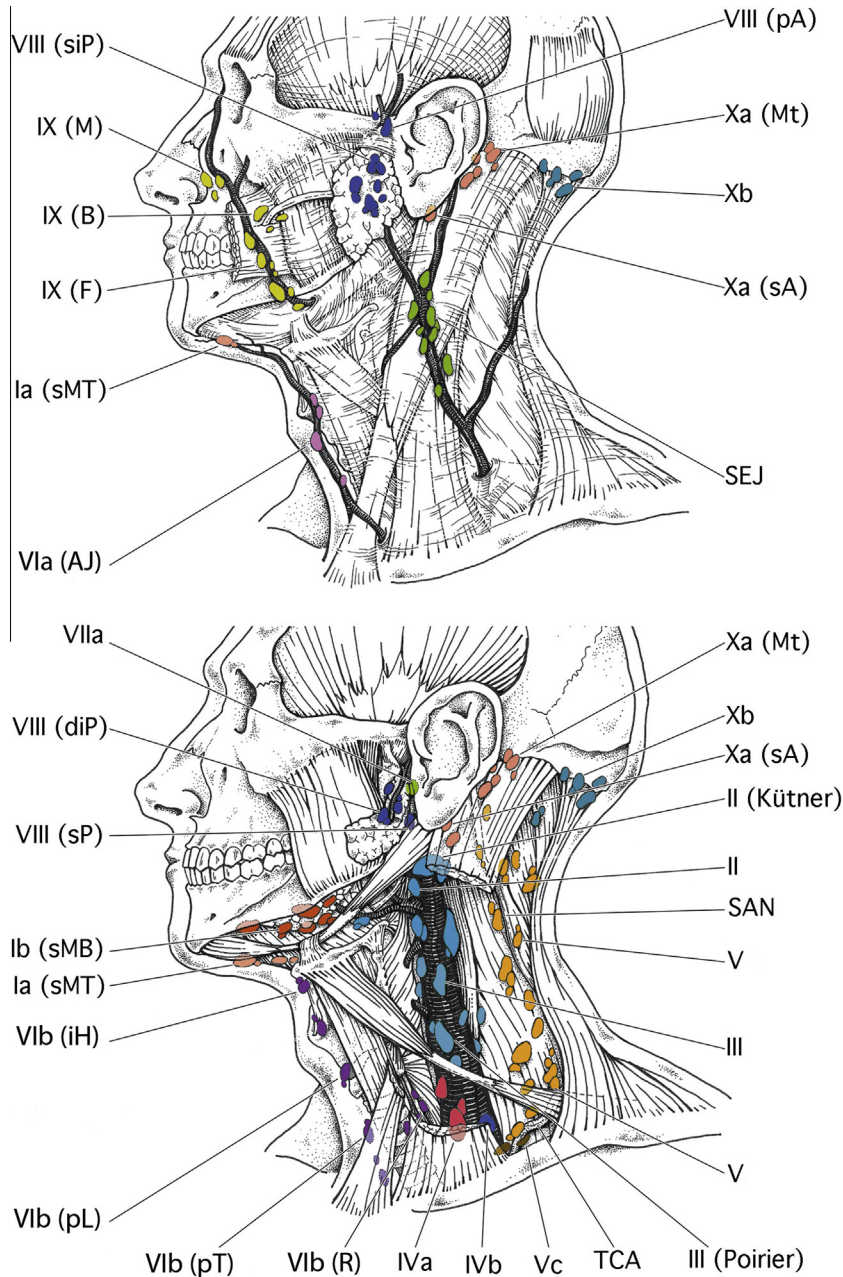


Fig. 1. Superficial (top) and deep (bottom) lymphatic node groups of the head and neck. These groups are named according to the node levels modified from Robbins classification (see [Table 1](#)) [modified from Lengelé [\[11\]](#)]. AJ: anterior jugular; B: buccal; diP: deep intraparotid; F: facial; iH: infrahyoid; M: malar; Mt: mastoid; pA: preauricular; pL: prelaryngeal; pT: pretracheal; R: recurrent or paratracheal; sA: subauricular; SAN: spinal accessory nerve; SEJ: superficial external jugular; siP: superficial intraparotid; sMB: submandibular; sMT: submental; sP: subparotid; TCA: transverse cervical artery.

the upper spinal accessory nerve (SAN). The nodes lie in the space between the deep (medial) surface of the sternocleidomastoid muscle laterally, and the medial edge of the internal carotid artery and the scalenius muscle medially; this space extends from the posterior edge of the submandibular gland anteriorly to the posterior edge of the sternocleidomastoid muscle posteriorly, and from the lateral process of the first cranial vertebra to the caudal edge of the hyoid bone. Level II can be further subdivided into level IIa and IIb by the posterior edge of the internal jugular vein. The usefulness of the distinction between these 2 sub-levels is a matter of discussion in the radiotherapy community.

Level II receives efferent lymphatics from the face, the parotid gland, and the submandibular, submental and retropharyngeal nodes. Level II also directly receives the collecting lymphatics from

the nasal cavity, the pharynx, the larynx, the external auditory canal, the middle ear, and the sublingual and submandibular glands. The nodes in level II are therefore at greatest risk of harboring metastases from cancers of the nasal cavity, oral cavity, nasopharynx, oropharynx, hypopharynx, larynx, and the major salivary glands. Level IIb is more likely associated with primary tumors of the oropharynx or nasopharynx, and less frequently with tumors of the oral cavity, larynx or hypopharynx.

Level III

Level III ([Table 3](#)) contains the middle jugular nodes located around the middle third of the IJV. It is the caudal extension of level II. It extends from the caudal edge of the body of the hyoid bone to

Table 1

Comparison between the TNM atlas for lymph nodes in the neck [5] and the guidelines of the lymph node levels modified from Robbins [9].

TNM atlas for lymph nodes of the neck		Node levels modified from Robbins	
Group number	Terminology	Level	Terminology
1	Submental nodes	Ia	Submental group
2	Submandibular nodes	Ib	Submandibular group
3	Cranial jugular nodes	II	Upper jugular group
4	Middle jugular nodes	III	Middle jugular group
5	Caudal jugular nodes	IVa	Lower jugular group
6	Dorsal cervical nodes along the spinal accessory nerve	IVb	Medial supraclavicular group
		V	Posterior triangle group
		Va	- Upper posterior triangle nodes
7	Supraclavicular nodes	Vb	- Lower posterior triangle nodes
		Vc	Lateral supraclavicular group
8	Prelymphatic and paratracheal nodes	VI	Anterior compartment group:
		VIa	- Anterior jugular nodes
		VIb	- Prelymphatic, pretracheal, & paratracheal nodes
9	Retropharyngeal nodes	VII	Prevertebral compartment group:
		VIIa	- Retropharyngeal nodes
		VIIb	- Retro-styloid nodes
10	Parotid nodes	VIII	Parotid group
11	Buccal nodes	IX	Bucco-facial group
12	Retroauricular and occipital nodes	X	Posterior skull group:
		Xa	- Retroauricular & subauricular nodes
		Xb	- Occipital nodes

the caudal edge of the cricoid cartilage. The anterior limit is the anterior edge of the sternocleidomastoid muscle or the posterior third of the thyro-hyoid muscle, and the posterior limit is the posterior edge of the sternocleidomastoid muscle. Laterally, level III is limited by the deep surface of the sternocleidomastoid muscle and medially by the medial edge of the common carotid artery and the scalenius muscles.

Level III receives efferent lymphatics from levels II and V, and some efferent lymphatics from the retropharyngeal, pretracheal and recurrent laryngeal nodes. It collects the lymphatics from the base of the tongue, tonsils, larynx, hypopharynx and thyroid gland. Nodes in level III are at greatest risk of harboring metastases from cancers of the oral cavity, nasopharynx, oropharynx, hypopharynx and larynx.

Level IVa

Level IVa (Table 3) contains the lower jugular lymph nodes located around the inferior third of the IJV from the caudal limit of level III to a limit set arbitrarily 2 cm cranial to the sternoclavicular joint, caudally. This caudal limit was set after a critical examination of level IVa neck node dissection, which typically does not go all the way down to the clavicle and definitely never reaches the medial portion of the clavicle at the level of the sternoclavicular joint. The anterior limit is the anterior edge of the sternocleidomastoid muscle cranially and the body of the sternocleidomastoid muscle caudally; the posterior limit is the posterior edge of the sternocleidomastoid muscle cranially and the scalenius muscles caudally. Laterally, level IVa is limited by the deep (medial) surface of the sternocleidomastoid muscle cranially and the lateral edge of that muscle caudally; the medial limit of level IVa is the medial edge of the common carotid artery, the medial edge of the thyroid gland and the scalenius muscle cranially, and the medial edge of the sternocleidomastoid muscle caudally.

Level IVa receives efferent lymphatics primarily from levels III and V, some efferent lymphatics from the retropharyngeal, pretracheal, and recurrent laryngeal nodes, and collecting lymphatics from the hypopharynx, larynx, and thyroid gland. Level IVa nodes are at high risk for harboring metastases from cancers of the hypopharynx, larynx, thyroid and cervical esophagus. Rarely metastases

from the anterior oral cavity may manifest in this location with minimal or no proximal nodal disease.

Level IVb

Level IVb (Table 3) contains the medial supraclavicular lymph nodes located in the continuation of level IVa down to the cranial edge of the sternal manubrium. The anterior limit is the deep surface of the sternocleidomastoid muscle; the posterior limit is the anterior edge of the scalenius muscle cranially, and the apex of the lung, the brachiocephalic vein, the brachiocephalic artery (right side) and the common carotid artery and subclavian artery on the left side, caudally; the lateral limit is the lateral edge of the scalenius muscle, while the medial limit about level VI and the medial edge of the common carotid artery.

Level IVb receives efferent lymphatics primarily from levels IVa and Vc, some efferent lymphatics from the pretracheal, and recurrent laryngeal nodes, and collecting lymphatics from the hypopharynx, esophagus, larynx, trachea and thyroid gland. Level IVb nodes are at high risk for harboring metastases from cancers of the hypopharynx, sub-glottic larynx, trachea, thyroid and cervical esophagus.

Level V (Va and Vb)

Level Va and Vb (Table 4) contains the nodes of the posterior triangle group located posteriorly to the sternocleidomastoid muscle around the lower part of the spinal accessory nerve and the transverse cervical vessels. It extends from a plane crossing the cranial edge of the body of the hyoid bone to a plane crossing the cervical transverse vessels caudally. Originally, the cranial limit of level V was defined by the convergence of the sternocleidomastoid and the trapezius muscles [9,10]. From an anatomic point of view, the uppermost part of level V includes lymph nodes belonging to the occipital region (see level Xb) [12]. Thus, it was proposed to use the hyoid bone as a radiological landmark to define the cranial limit of level V. Laterally, level V is limited by the platysma muscle and the skin and medially by the levator scapulae (cranially) and the posterior scalenius (caudally) muscles. Posteriorly level V nodes extend to a limit set at the anterior border of the trapezius muscles. From a surgical point of view, level V is currently subdivided

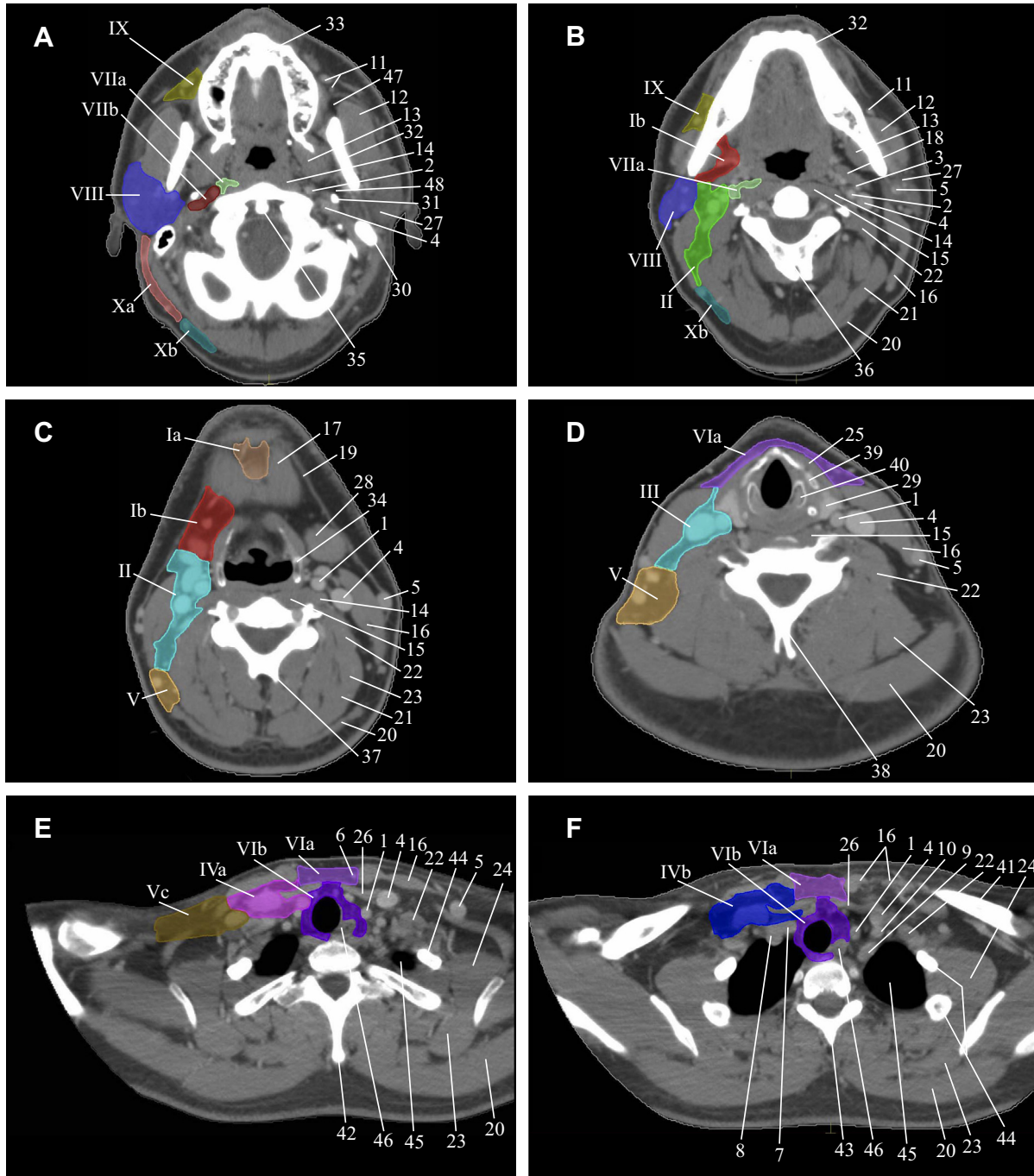


Fig. 2. Head and neck CT sections performed on a 32 year-old volunteer immobilized with a head-neck-shoulder thermoplastic mask. The head was set in a “neutral” position. Sixty ml of iodinated contrast medium (Omnipaque 350, HealthCare, Diegem, BE) was injected intravenously at a rate of 1 ml/s, then after a 3-min gap, another 50 ml were injected at a rate of 1.5 ml/s. The examination was performed on a Toshiba (Toshiba Aquilon LB, Toshiba Medical System corporation, Japan) heliocidal CT (300 mAs and 120 keV) using a slice thickness of 2.0 mm, an interval reconstruction of 2.0 mm and a heliocidal pitch of 11. CT sections were reconstructed using a 512 × 512 matrix. Sections were taken at the level of the top edge of C1 (panel A), the bottom edge of C2 (panel B), mid C4 (panel C), the bottom edge of C6 (panel D), mid Th1 (panel E), and top edge of Th2 (panel F). Neck node levels were drawn on each CT slice using the radiological boundaries detailed in Table 1. Each node level corresponds to node groups, and thus does not include any security margin for organ motion or set-up inaccuracy. 1: common carotid artery; 2: internal carotid artery; 3: external carotid artery; 4: internal jugular vein; 5: external jugular vein; 6: anterior jugular vein; 7: right brachiocephalic trunc; 8: right brachiocephalic vein; 9: left susclavian artery; 10: left susclavian vein; 11: facial vessels; 12: masseter m.; 13: pterygoid m.; 14: longus capitis m.; 15: longus colli m.; 16: sternocleidomastoid m.; 17: digastric (ant. belly) m.; 18: digastric (post. belly) m.; 19: platysma m.; 20: trapezius m.; 21: splenius capitis m.; 22: scalenius m.; 23: levator scapulae m.; 24: serratus anterior m.; 25: thyro-hyoid m.; 26: sterno-hyoid m.; 27: parotid gland; 28: sub-mandibular gland; 29: thyroid gland; 30: mastoid; 31: styloid process; 32: mandible; 33: maxilla; 34: hyoid bone; 35: odontoid process; 36: 2nd cervical vertebra; 37: 4th cervical vertebra; 38: 6th cervical vertebra; 39: thyroid cartilage; 40: cricoid cartilage; 41: clavicle; 42: 1st thoracic vertebra; 43: 2nd thoracic vertebra; 44: rib; 45: lung apex; 46: esophagus; 47: Bichat’s fat pad; 48: pre-styloid para-pharyngeal space.

vided into levels Va and Vb using the caudal edge of the cricoid cartilage as an anatomic landmark.

Level V receives efferent lymphatics from the occipital and retroauricular nodes as well as those from the occipital and parietal

Table 2
Node levels Ia and Ib.

Boundaries	Level Ia (submental group)	Level Ib (submandibular group)
Cranial	Mylo-hyoid m.	Cranial edge of submandibular gland; anteriorly, mylo-hyoid m.
Caudal	Platysma m. (caudal edge of the anterior belly of digastric mm)	Plane through caudal edge of hyoid bone and caudal edge of mandible; alternatively caudal edge of submandibular gland (whichever is more caudal)/platysma m.
Anterior	Symphysis menti	Symphysis menti
Posterior	Body of hyoid bone/mylo-hyoid m.	Posterior edge of submandibular gland (caudally)/posterior belly of digastric m. (cranially)
Lateral	Medial edge of ant. belly of digastric m.	Medial aspect (innerside) of mandible down to caudal edge/platysma m. (caudal)/medial pterygoid m. (posteriorly)
Medial	n.a.	Lateral edge of ant. belly of digastric m. (caudally)/posterior belly of digastric m. (cranially)

Table 3
Node levels II, III, IVa and IVb.

Level	Boundaries					
	Cranial	Caudal	Anterior	Posterior	Lateral	Medial
II (upper jugular group) [#]	Caudal edge of the lateral process of C1	Caudal edge of the body of the hyoid bone	Posterior edge of the submandibular gland/posterior edge of posterior belly of digastric m.	Posterior edge of sternocleidomastoid m.	Deep (medial) surface of sternocleidomastoid m./platysma m./parotid gland/posterior belly of digastric m.	Medial edge of internal carotid artery/scalenius m.
III (middle jugular group)	Caudal edge of the body of the hyoid bone	Caudal edge of cricoid cartilage	Anterior edge of sternocleidomastoid m./posterior third of thyro-hyoid m.	Posterior edge of sternocleidomastoid m.	Deep (medial) surface of sternocleidomastoid m.	Medial edge of common carotid artery/scalenius mm.
IVa (lower jugular group)	Caudal edge of cricoid cartilage	2 cm cranial to sternal manubrium	Anterior edge of sternocleidomastoid m. (cranially)/body of sternocleidomastoid m. (caudally)	Posterior edge of sternocleidomastoid m. (cranially)/scalenius mm. (caudally)	Deep (medial) surface of sternocleidomastoid m. (cranially)/lateral edge of sternocleidomastoid m. (caudally)	Medial edge of common carotid artery/lateral edge of thyroid gland/scalenius mm. (cranially)/medial edge of sternocleidomastoid m. (caudally)
IVb (medial supraclavicular group)	Caudal border of level IVa (2 cm cranial to sternal manubrium)	Cranial edge of sternal manubrium	Deep surface of sternocleidomastoid m./deep aspect of clavicle	Anterior edge of scalenus mm. (cranially)/apex of lung, the brachiocephalic vein, the brachiocephalic trunc (right side) and the common carotid artery and subclavian artery on the left side (caudally)	Lateral edge of scalenus m.	Lateral border of level VI (pre-tracheal component)/medial edge of common carotid artery

[#] Level II can be divided into level IIa and level IIb by drawing an artificial line at the posterior edge of the internal jugular vein.

Table 4
Levels V (Va and Vb) and Vc.

Boundaries	Level V (posterior triangle group) ^a	Level Vc (lateral supraclavicular group)
Cranial	Cranial edge of the body of hyoid bone	Plane just below transverse cervical vessels (caudal border of level V)
Caudal	Plane just below transverse cervical vessels	2 cm cranial to sternal manubrium, i.e. caudal border of level IVa
Anterior	Posterior edge of sternocleidomastoid m.	Skin
Posterior	Anterior border of trapezius m.	Anterior border of trapezius m. (cranially)/±1 cm anterior to serratus anterior m. (caudally)
Lateral	Platysma m./skin	Trapezius m (cranially)/clavicle (caudally)
Medial	Levator scapulae m./scalenius m. (caudally)	Scalenius m./lateral edge of sternocleidomastoid m, lateral edge of level IVa

^a Surgically, level V is subdivided in two groups of upper (Va) and lower (Vb) nodes according to their respective relationships with the cricoid cartilage.

scalp, the skin of the lateral and posterior neck and shoulder, the nasopharynx, the oropharynx and the thyroid gland. Level V lymph nodes are at high risk for harboring metastases from cancers of the nasopharynx, oropharynx and thyroid gland. Nodes in level V are most often associated with primary cancers of the nasopharynx, the oropharynx, the cutaneous structures of the posterior scalp, and the thyroid gland (level Vb).

Level Vc

Level Vc (Table 4) contains the lateral supraclavicular nodes located in the continuation of the posterior triangle nodes (level Va

and Vb) from the cervical transverse vessels down to a limit set arbitrarily 2 cm cranial to the sternal manubrium, i.e. a similar limit than the caudal border of level IVa. It corresponds partly to the area known as the “the supraclavicular fossa” also called the triangle of Ho, which was clinically defined in the mid-seventies before the era of CT for the neck staging of nasopharyngeal carcinoma [13]. Originally, this fossa also included the caudal portions of level IV and V. Instead of proposing new boundaries of its own, we elected to subsume this fossa into other lower neck nodal levels. The anterior limit of level Vc is the skin. Its posterior limit is the anterior border of the trapezius muscles (cranially) or ±1 cm from the anterior surface of the serratus anterior muscle (caudally).

Table 5
level VIa and VIb.

Boundaries	Level VIa (anterior jugular nodes)	Level VIb (pre-laryngeal, pre-tracheal, para-tracheal-recurrent laryngeal nerve nodes)
Cranial	Caudal edge of the hyoid bone or caudal edge of the sub-mandibular gland, whichever is more caudal	Caudal edge of the thyroid cartilage ^a
Caudal	Cranial edge of the sternal manubrium	Cranial edge of the sternal manubrium
Anterior	Skin/platysma m.	Posterior aspect of infrahyoid (strap) mm.
Posterior	Anterior aspect of the infrahyoid (strap) mm.	Anterior aspect of larynx, thyroid gland and trachea (pre-laryngeal and pre-tracheal nodes)/pre-vertebral m. (right side)/esophagus (left side)
Lateral	Anterior edges of both sternocleidomastoid mm.	Common carotid artery on both sides
Medial	n.a.	Lateral aspect of trachea & esophagus (caudally)

^a For tumors located on the anterior floor of mouth, tip of the tongue and lower lip, caudal edge of the body of the hyoid bone.

Medially level Vc abuts level IVa; laterally it is limited by the trapezius muscle (cranially) and the clavicle (caudally).

Level Vc receives efferent lymphatics from the posterior triangle nodes (level Va and Vb) and is more commonly associated with nasopharyngeal tumors.

Level VIa and VIb

Level VI (Table 5) contains the anterior compartment nodes including superficially, the anterior jugular nodes (level VIa), and in the deep previsceral space, the pre-laryngeal, pre-tracheal and para-tracheal (recurrent laryngeal nerve) nodes (level VIb). Level VIa is contained between the anterior edges of the sternocleidomastoid muscles. It is limited cranially by the caudal limit of level Ib (i.e. the caudal edge of the hyoid bone or the caudal edge of the sub-mandibular gland, whichever is more caudal), caudally by the cranial edge of the sternal manubrium, anteriorly by the platysma, and posteriorly by the anterior surface of the infrahyoid muscles. These nodes mostly drain the integuments of the lower face and anterior neck. Consequently, their treatment should only be addressed in lower lip tumors and in advanced gingivo-mandibular carcinomas invading the soft tissues of the chin. Level VIb is contained between the 2 common carotid arteries. Its most cranial part comprises 2–3 inconstant infrahyoid nodes, which rest on the thyro-hyoid membrane and drain the anterior floor of mouth, tip of the tongue and lower lip. Consequently, for all other primary tumor locations, it is proposed to set the cranial limit of level VIb at the caudal edge of the body of the thyroid cartilage. Level VIb is limited caudally by the cranial edge of the sternal manubrium and anteriorly by the posterior aspect of the infrahyoid (strap) muscles. For the pre-laryngeal and pre-tracheal nodes, the posterior limit is delineated by the anterior aspect of the respiratory tract, i.e. from cranial to caudal, the anterior wall of the larynx, in front of the cricoid cartilage (pre-laryngeal nodes), the anterior surface of the thyroid gland (thyroid nodes) and the anterior aspect of the trachea (pre-tracheal nodes). For the para-tracheal nodes also known as the recurrent laryngeal nerve nodes, the pre-vertebral muscles and the esophagus delineate the posterior limit on the right and left sides, respectively.

Level VIb receives efferent lymphatics from the anterior floor of mouth, the tip of the tongue, the lower lip, the thyroid gland, the glottic and subglottic larynx, the hypopharynx, and the cervical

esophagus. These nodes are at high risk for harboring metastases from cancers of the lower lip, the oral cavity (floor of mouth and tip of the tongue), the thyroid gland, the glottic and subglottic larynx, the apex of the piriform sinus, and the cervical esophagus.

Level VIIa

Level VIIa (Table 6) contains the retropharyngeal nodes, which lie within the retropharyngeal space, extending cranially from the upper edge of the first cervical vertebrae to the cranial edge of the body of the hyoid bone caudally. This space is bounded anteriorly by the pharyngeal constrictor muscles, and posteriorly by the longus capitis and longus colli muscles. Laterally, the retropharyngeal nodes are limited by the medial edge of the internal carotid artery. Typically, retropharyngeal nodes are divided into a medial and a lateral group. The lateral group lies medial to the internal carotid artery and lateral to a line parallel to the lateral edge of the longus capiti muscle. The medial group is an inconsistent group of 1–2 lymph nodes intercalated in or near the midline. In this proposal, only the lateral retropharyngeal nodes are considered.

Retropharyngeal node receives efferent lymphatics from the mucosa of the nasopharynx, the Eustachian tube and the soft palate. These nodes are at risk of harboring metastases from cancers of the nasopharynx, the posterior pharyngeal wall and the oropharynx (mainly the tonsillar fossa and the soft palate).

Level VIIb

Level VIIb (Table 6) contains the retro-styloid nodes, which are the cranial continuation of the level II nodes. They are located in the fatty space around the jugulo-carotid vessels up to the base of skull (jugular foramen). The retro-styloid space is delineated by the internal carotid artery medially, by the styloid process and the deep parotid lobe laterally, by the vertebral body of C1 and the base of skull posteriorly, and by the pre-styloid para-pharyngeal space anteriorly.

Retro-styloid nodes receive efferent lymphatics from the nasopharyngeal mucosa, and are at risk of harboring metastases from cancers of the nasopharynx, and from any other head and neck primary with massive infiltration of upper level II nodes through retrograde lymph flow.

Table 6
Level VIIa and VIIb.

Boundaries	Level VIIa (retropharyngeal nodes)	Level VIIb (retro-styloid nodes)
Cranial	Upper edge of body of c1/hard palate	Base of skull (jugular foramen)
Caudal	Cranial edge of the body of the hyoid bone	Caudal edge of the lateral process of C1 (upper limit of level II)
Anterior	Posterior edge of the superior or middle pharyngeal constrictor m.	Posterior edge of prestyloid para-pharyngeal space
Posterior	Longus capitis m. and longus colli m.	Vertebral body of C1, base of skull
Lateral	Medial edge of the internal carotid artery	Styloid process/deep parotid lobe
Medial	A line parallel to the lateral edge of the longus capiti muscle	Medial edge of the internal carotid artery

Table 7
Level VIII.

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

Table 8
Level IX.

Boundaries	Level IX (bucco-facial group)
Cranial	Caudal edge of the orbit
Caudal	Caudal edge of the mandible
Anterior	SMAS layer in sub-cutaneous tissue
Posterior	Anterior edge of masseter m. & corpus adiposum buccae (bichat's fat pad)
Lateral	SMAS layer in sub-cutaneous tissue
Medial	Buccinator m.

Level VIII

Level VIII (Table 7) contains the parotid node group, which includes the subcutaneous pre-auricular nodes, the superficial and deep intraparotid nodes and the subparotid nodes. These nodes extend from the zygomatic arch and the external auditory canal down to the mandible. They extend from the subcutaneous tissue laterally to the styloid process medially, and from the posterior edge of the masseter and the pterygoid muscles anteriorly to the anterior edge of the sternocleidomastoid muscle and the posterior belly of the digastric muscle posteriorly.

The parotid group nodes receive efferent lymphatic from the frontal and temporal skin, the eyelids, the conjunctiva, the auricle, the external acoustic meatus, the tympanum, the nasal cavities, the root of the nose, the nasopharynx, and the Eustachian tube. They are at risk of harboring metastasis from cancers of these regions but especially from tumors of the frontal and temporal skin, the orbit, the external auditory canal, the nasal cavities, and the parotid gland.

Level IX

Level IX (Table 8) contains the malar and bucco-facial node group, which includes inconsistent superficial lymph nodes around the facial vessels on the external surface of the buccinator muscle. These nodes extend from the caudal edge of the orbit (cranially) down to the caudal edge of the mandible (caudally) where they reached level Ib. They lay on the buccinators muscle (medially) in the sub-cutaneous tissue, from the anterior edge of the masseter muscle and the Bichat's fat pad (posteriorly) to the anterior sub-cutaneous tissue of the face.

Table 9
Level Xa and Xb.

Boundaries	Level Xa (retroauricular nodes)	Level Xb (occipital nodes)
Cranial	Cranial edge of external auditory canal	External occipital protuberance
Caudal	Tip of the mastoid	Cranial border of level V
Anterior	Anterior edge of the mastoid (caudally)/posterior edge of the external auditory canal (cranially)	Posterior edge of sternocleidomastoid m.
Posterior	Anterior border of occipital nodes – posterior edge of sternocleidomastoid m.	Anterior (lateral) edge of trapezius m.
Lateral	Sub-cutaneous tissue	Sub-cutaneous tissue
Medial	Splenius capitis m. (caudally)/temporal bone (cranially)	Splenius capitis m.

The bucco-facial nodes receive efferent vessels from the nose, the eyelids, and the cheek. They are at risk of harboring metastases from cancers of the skin of the face, the nose, the maxillary sinus (infiltrating the soft tissue of the cheek) and the buccal mucosa.

Level Xa

Level Xa (Table 9) contains the retroauricular (also called mastoid) and subauricular nodes, which includes superficial nodes lying on the mastoid process from the cranial edge of the external auditory canal cranially to the tip of the mastoid caudally. These nodes extend from the parotid gland (caudally) and the auditory canal (cranially) anteriorly, to the occipital nodes posteriorly.

The retroauricular nodes receive efferent vessels from the posterior surface of the auricle, the external auditory canal and the adjacent scalp. They are at risk of harboring metastases mainly from skin cancers of the retro-auricular area.

Level Xb

Level Xb (Table 9) contains the occipital lymph nodes, which are the cranial and superficial continuation of the level Va nodes up to the cranial protuberance. They lie from the posterior edge of the sternocleidomastoid muscle to the anterior (lateral) edge of the trapezius muscle.

Level Xb nodes receive efferent vessels from the posterior part of the hair-bearing scalp and are at risk of metastases from skin cancers of the occipital area.

Discussion: From nodal levels to the creation of clinical target volumes

The proposed classification and delineation guideline of the node groups of the head and neck region reflect in-depth discussions of a panel of European, Asian, Australian/New Zealander and North American experts from various disciplines, i.e. radiation oncologists, a head and neck surgeon and an anatomist, representing the major relevant cooperative groups in radiation oncology (DAHANCA, EORTC, HKNPCSG, NCIC CTG, NCRI, RTOG, TROG). Their objective was to create a set of common recommendations for radiation oncologists to use in their daily practice for the delineation of the various neck node levels on axial CT sections. A set of 6 transverse CT sections with the various delineated levels is presented in Fig. 2. A set of 110 transverse CT sections in DICOM-RT format has been posted on the websites of the cooperative groups to be downloaded and to be used as a set of education material. Interested readers are invited to contact the chair of their affiliated group to get access to this material. All the anatomic landmarks described in Tables 2–9 and illustrated in Fig. 2 are valid for a patient resting in a “neutral” position, which is the most natural and comfortable position. In some clinical situations however, e.g. a patient with neck skin folds, it may be useful to slightly hyperextend the neck to smooth them out to try to reduce moist desquamation. In such situation, the relationship between levels (e.g. level Ib

and level II) may be slightly modified, and some of the anatomic landmarks may have to be adapted, especially near the base of skull. For example in such situation, the use of the upper edge of the body of C1 will probably better depict the cranial limit of the retropharyngeal nodes instead of the level of the hard palate. These are peculiarities where common sense and good knowledge of anatomy will be required.

The objective of these guidelines is not to generate recommendations on how (e.g. selection of the node levels, dose levels, unilateral and/or bilateral irradiation, etc.) to treat a neck with radiotherapy for any specific primary tumor site, or T and N category. During the working party meetings, although it was agreed that reaching a consensus on these matters would also be valuable for the medical community, it was felt that another working group should deal with these issues, as the foreseen variations among institutions and radiation oncologists were expected to be quite large. Furthermore some recommendations on these aspects have already been published [2,14–17].

The proposal for the node level delineation is valid irrespective of the nodal status of the patient, i.e. node-negative or node-positive. However the translation from the node levels to CTV delineation may need some adjustments as a function of the nodal status setting. In the node-negative patients and in patients with a single small lymph node or with several small lymph nodes not abutting one of the surrounding structures (e.g. muscle, salivary gland), the CTV will be defined by the association of one or several of the node levels as discussed above.

For larger lymph nodes abutting or infiltrating one of the surrounding structures, CTV delineation may need to take account of macroscopic and microscopic tumor infiltration outside of the node. It has been reported that the risk of microscopic extracapsular extension (ECE) was (weakly) proportional to the size of lymph node, typically being 20–40% for nodes smaller than 1 cm in diameter, and above 75% for bulky nodes more than 3 cm in diameter. However, a recent analysis of the Surveillance, Epidemiology, and End Results (SEER) registry did not confirm these data (see review in [15,18]). Two studies examined the magnitude of microscopic infiltration in the surrounding tissues in the case of extra-capsular rupture. In the study of Apisarnthanarax et al., it was found that for lymph nodes less than 3 cm in their largest dimension, the microscopic infiltration into the surrounding fatty tissue was within 5 mm of the node capsule in 96% of the cases, and always within less than 10 mm [6]. In the study of Ghadjar, which included 168 nodes with ECE from 74 patients (including 10 patients with N3 nodes) who underwent radical, modified radical or selective neck dissection procedures, the infiltration was always within an 8 mm range [7]. Thus in the case of larger lymph nodes abutting or infiltrating adjacent structures such as the sternocleidomastoid muscle, the para-spinal muscles or the parotid gland, an expansion of the nodal level into but limited to these structures is recommended. Based on experts' opinion, an isotropic expansion by 10–20 mm into these structures from the visible edge of the node (i.e. the nodal GTV) appears reasonable [Grau, DAHANCA, personal communication] (Fig. 3). This is a modification of the previous recommendations, which arbitrarily proposed to include the full muscle in the corresponding infiltrated levels [4]. These recommendations are valid irrespective of the HPV-status of the patient. In particular, there are no data to suggest that extra-capsular extension should be managed differently in HPV-positive patients, e.g. to reduce the muscular extension of the CTV into the sternocleidomastoid muscle.

The proposal for the node level delineation is also valid irrespective of the dose prescription range. Typically, for the node-negative neck, the entire selection of node levels (i.e. the nodal CTV) receives a prophylactic dose of 50 Gy in 25 fractions of 2 Gy over 5 weeks. Other equivalent dose levels (e.g. 56 Gy in 35 daily fractions of 1.6 Gy over 7 weeks in a simultaneous integrated boost

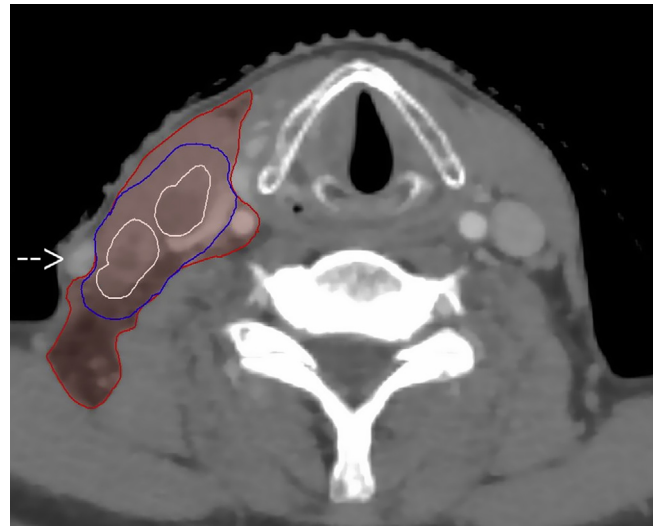


Fig. 3. Axial CT section of the neck of a patient with a T3-N2b-M0 squamous cell carcinoma of the right pyriform sinus. On the right side of the neck, due to the presence of two necrotic nodes (white) abutting the sternocleidomastoid muscle within level III, the so-called prophylactic dose CTV (red) is enlarged. An isotropic expansion of 10–20 mm in the sternocleidomastoid muscle (but limited to the muscle) is used. The external jugular vein (arrow) is not included as it is outside of the sternocleidomastoid muscle. For the so-called therapeutic dose CTV (blue), a margin of 5 mm around the GTV is used.

(SIB) approach) are also acceptable. For the node-positive neck, after a prophylactic irradiation of the selected levels, a boost dose is delivered to smaller volumes. Several approaches are being utilized for the delineation of these boost volumes, typically adding margin(s) around the GTV to delineate the so-called therapeutic dose CTV(s), to which additional doses are delivered. It is beyond the scope of this manuscript to review the different dose-level regimens in use, and which reflect different institutional policies.

The proposal for the node level delineation still holds for the post-operative situation, at least from a conceptual point of view. Issues such as delineation of part of a level based on a detailed pathologic report and an accurate registration between the pre-operative and the post-operative images is an unresolved issue and is definitely beyond the scope of this manuscript. In the post-operative situation, delineation of the node levels may be more difficult due to the inflamed and edematous nature of the post-operative tissues in the neck, and anatomical modifications resulting from structure ablation during the neck dissection procedure, that may include the fatty tissues constituting the levels, the internal jugular vein and the sternocleidomastoid muscle. It should be emphasized that in the post-operative situation, unambiguous information about the surgical procedure performed, and a comprehensive report of the pathological analysis of the surgical specimen should be provided to the radiation oncologist to avoid inadequate delineation of the target volumes, which may lead to unacceptably high rates of loco-regional recurrence.

Lastly, it should be clearly stated that the authors of the present guidelines are not responsible for any misuse of this material by third parties. It should also be understood that these guidelines represent levels for nodal CTV delineation (typically for elective CTV) and that margins for set-up inaccuracy and organ motion (if applicable) must be added to generate the respective PTVs to be used for IMRT dose optimization.

Conclusion

Proper delivery of radiotherapy for the treatment of head and neck cancers requires appropriate selection and accurate delineation.

tion of nodal target volumes in node-negative, node-positive and in post-operative situations. These consensus recommendations endorsed by the major European, Asian, Australasian and North American cooperative groups represent the state-of-the-art in three-dimensional delineation of the various nodal levels in the neck. Their implementation in daily practice of radiation oncology should contribute to reduce treatment variations from patient to patient and facilitate the conduct of multi-institutional clinical trials. However, when applying guidelines, oncologic knowledge, clinical experience and judgment should always prevail.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.radonc.2013.10.010>.

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