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Overview

The head and neck region has a rich lymphatic network which is divided into sublevels in order to define the regions for surgical neck dissection and radiotherapy. Head and neck cancers have specific routes for lymphatic spread according to their locations. More than 30 % of head and neck tumors are clinically lymph node positive at the time of diagnosis [1], and more than 30 % of patients who are clinically negative have pathologically involved lymph nodes.

Tumors of certain locations do not require elective nodal treatment, as the risk for lymphatic metastasis is less than 5 % (i.e., small tumors of the lip, T1–T2 tumors of the glottic larynx). For the salivary gland, tonsil, paranasal sinus, and middle ear tumors, small tumors of the buccal mucosa and retromolar trigone, and oral tongue tumors not exceeding midline, ipsilateral neck treatment is adequate, whereas for tumors such as the nasopharynx, supraglottic and infraglottic larynx, hypopharynx, soft palate, and base of tongue, bilateral neck treatment is indicated. In case of ipsilateral positive lymph nodes, contralateral neck is also at risk as the metastatic nodes obstruct the lymphatic trunks.

The risk of lateral retropharyngeal lymph node involvement is related to the primary site and neck stage [2]; the medial retropharyngeal nodes are almost never the site of metastatic disease.

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1 Introduction

Once the tumor spreads into a lymph node, it expands the node, and the spherical node becomes rounded. Then, the capsule is invaded, leading to extension to adjacent tissues which is called “extracapsular extension”. Extracapsular extension impacts prognosis and survival of patients with head and neck cancers significantly.

Nodal areas in the neck are divided into superficial and deep chains. Retropharyngeal and parapharyngeal nodes constitute the latter. The sternocleidomastoid (SCM) muscle divides the neck into two large triangles. The external jugular vein and the platysma muscle are located superficially, where the internal jugular vein, the carotid artery, and some of the cranial nerves are located deeply to the SCM muscle. There are seven lymph node levels proposed by the American Joint Committee on Cancer (AJCC) for head and neck cancers and are shown by Roman numerals (levels I–VII) [3]. These levels are not recommended to be used for lymphomas. Beside these lymph nodes, supraclavicular, retrostyloid space, retropharyngeal, preauricular, intraparotid, buccal, retroauricular, suboccipital, facial, and mastoid lymph nodes, which are not routinely dissected, may also be involved in head and neck cancers. Retropharyngeal nodes are divided into two as medial and lateral. They extend through the internal carotid arteries medially and finally drain into level II lymph nodes. Certain lymphatics have special names: Virchow’s node is used for supraclavicular, Delphian’s node is used for the precricoid node, and Rouviere’s node is the most superior node in the retropharyngeal region (alongside the jugular foramen, and clinically inaccessible).

Different types of neck dissection are performed for particular sites. In radical neck dissection, levels I–V lymph nodes along with superficial and deep cervical fascia they are located in are removed together with the SCM muscle, omohyoid muscle, submandibular gland, internal and external jugular veins, and cranial nerve (CN) XI (spinal accessory nerve). In modified radical dissection, same levels are removed with both fascia, but internal jugular vein, CN XI, or one or more leaves of SCM muscle are not removed. These two techniques require at least ten nodes to be removed. If other lymphatic groups (such as retropharyngeal, levels VI and VII) or non-lymphatic structures (such as the carotid artery, the skin, or the parotid gland) are also removed, it is called an “extended radical dissection”. Selective neck dissection is the technique where one or more levels of lymph nodes are not removed, but at least six nodes should be sent for pathologic evaluation. In supraomohyoid dissection (for small oral cavity tumors) levels I–III, in lateral neck dissection (for larynx, oropharynx, and hypopharynx cancers) levels II–IV, in posterolateral neck dissection levels II–V, and in anterior compartment neck dissection level VI are removed. In superselective neck dissection, only the lymph nodes with the highest potential for spread are removed. Following neck dissection, shunts of lymphatic flow develop towards the opposite neck. Also, a previously irradiated neck may have atypical lymphatic drainage [1].

Risks of clinical and pathological bilateral lymph node metastasis of certain head and neck tumors are shown in Table 3.1 [1, 4–9].

Table 3.1 Risks of clinical and pathological bilateral lymph node metastasis of certain head and tumors

Location	Clinically N+ (%)	Clinically N–, pathologically N+ (%)
Glottic larynx	–	15
Supraglottic larynx	39	26
Piriform sinus	49	59
Pharyngeal wall	50	37
Oral tongue	12	33
Floor of the mouth	27	21
Base of tongue	37	55
Tonsil	16	–

N lymph node

2 Evidence-Based Treatment Approaches

Neck irradiation may be performed in negative necks electively (adjuvant or definitive), and in positive necks either preoperatively or postoperatively [10, 11]. Elective neck radiotherapy (RT) has local control (LC) rates similar to elective neck dissection, and neither has an effect on survival [12, 13]. However, Piedbois et al. showed a survival advantage of elective neck dissection over RT in 233 patients with early-stage oral cavity cancers [14]. The decision between RT and dissection is given according to the treatment method for the primary disease. Indications for an elective neck treatment depend on the stage and the grade of the primary lesion. Radiotherapy (RT) (45–50 Gy) is justified in patients with a 20 % or higher risk of occult lymphatic metastasis. Thus, early lesions of the paranasal sinuses, nasal vestibule and nasal cavity, lip, and glottic larynx do not require elective neck RT [15, 16]. The University of Florida published their results for elective neck RT [17, 18]. They observed neck failure in 5 and 21 % of patients who did and did not receive elective neck RT, respectively.

Neck dissection is indicated following RT in patients with multiple, large, and fixated lymph nodes. If positive lymph nodes regress completely after RT, subsequent neck dissection is not necessary [19–22]. The University of Florida recommends following the patients with CT performed after 4 weeks of the last day of RT, and withholding neck dissection if the risk of residual disease is under 5 % [23].

There are two trials showing the efficacy of neck irradiation with a concomitant boost scheme. Peters et al. treated 100 patients with oropharyngeal cancer who had cervical lymph node metastases [24]. Among 62 patients who had complete response to RT, 7 recurred in the neck. Neck control rate was 86 % at 2 years. Subcutaneous fibrosis rate was not different from a group of patients who received RT and neck dissection. Johnson et al. reported complete response in 72 % of 81 patients with lymph node metastases [25]. Among these, 5 % had recurrence in the neck. 3-year neck control was 94 %, and 86 % for <3-cm and >3-cm lymph nodes,

respectively. In Mayo Clinic's study, 5-year neck recurrence-free survivals in patients treated with neck dissection only were 76 % for N1, 60 % for N2, and 69 % overall [26].

If neck dissection is "planned" after RT, doses of 50–70 Gy are delivered according to the size and the mobility of the lymph nodes [27]. If the nodes are fixed and/or the primary disease is treated with RT, the neck should be treated with RT followed by neck dissection. With a planned dissection following a decreased dose of RT, LC is increased, and complications such as fibrosis and cranial nerve palsy are decreased compared to high-dose RT alone.

If RT is to follow surgery, it is generally performed within 4–6 weeks; however, waiting for 10 weeks at most did not affect LC of the neck negatively [27, 28]. In dissected necks with negative margins, 60–65 Gy are prescribed, whereas higher doses are needed for positive margins or residual disease [28–30].

Chao et al. reported the results of 126 patients with head and neck cancer who were treated with IMRT [31]. They observed that most of neck failures were seen within the high-risk region, which was described as CTV1.

As different doses are prescribed for the primary region and the neck according to the presence of residual disease, lymph node metastasis, or extracapsular extension (ECE), Mohan et al. developed "simultaneous integrated boost" in order to be able to prescribe different doses to different regions without decreasing fraction size [32]. Butler et al. defined "simultaneous modulated accelerated radiation therapy" (SMART) where they prescribed 2.4 Gy to high-risk disease in order to minimize the overall treatment time [33]. In RTOG 00–22 study, patients with early-stage oropharyngeal cancer, who had no chemotherapy, received 66 Gy with daily fraction sizes of 2.2 Gy to primary tumor and metastatic nodes, where subclinical disease received 54–60 Gy with daily fraction sizes of 1.8–2 Gy [34]. They found 2-year local failure (LF) rate of 9 % with grade 2 or higher xerostomia rates of 16 % and other toxicities even less. In the study of Ozyigit et al., 2 and 1.2 Gy daily were prescribed to high-risk and low-risk diseases, respectively [35]. The patients were also receiving chemotherapy. They reported no increase in LF in areas receiving 1.2 Gy daily. However, 2-year disease-free survival (DFS) was lower compared to high-dose areas (78 % vs. 94 %).

The decision for prophylactic neck treatment depends on the probability of occult metastasis. This limit is 20 % or higher for many American centers, whereas in Europe, neck treatment is performed if the risk is 5–10 % or higher [36]. In N0 necks, retropharyngeal (RP) lymph nodes should be included in tumors infiltrating the posterior pharynx wall (e.g., nasopharyngeal, hypopharyngeal, oropharyngeal). In tumors of the subglottic or transglottic larynx, and hypopharynx with extension to the esophagus, level VI nodes should be delineated. In nasopharynx cancer, bilateral levels I–V together with RP lymph nodes should be irradiated. According to Byers, this is also the case for N1 necks without ECE [37].

In the majority of patients with N2b disease, levels I–V should be treated [1]. However, in larynx and oral cavity tumors, one may omit level I and level V lymph nodes, respectively (in case they are not metastatic). This is also the case in postoperative patients. In tumors located in the midline or have bilateral lymph node

Table 3.2 Lymph node positivity rates of specific regions (%)

Region	Level I	Level II	Level III	Level IV	Level V	RP
Nasopharynx	17	94	85	19	61	86
Glottic larynx	6	61	54	30	6	
Supraglottic larynx	6	61	54	30	6	4
Piriform sinus	2	77	57	23	22	9
Pharyngeal wall	11	84	72	40	20	21
Oral tongue	39	73	27	11	0	
Floor of mouth	72	51	29	11	5	
Alveolar ridge and retromolar trigone	38	84	25	10	4	
Base of tongue	19	89	22	10	18	6
Tonsil	8	74	31	14	12	12
Thyroid	0	87	100	100	10	

RP retropharyngeal

drainage, contralateral neck should be treated. In patients with neck dissection who have indication for neck irradiation, levels I–V should be treated with previously described exceptions [1].

Lymph node positivity rates of specific regions are shown in Table 3.2 [1, 2, 4–6, 38, 39].

3 Levels of Drainage for Certain Locations of Tumors

Each head and neck subsite have particular pattern of lymphatic drainage [40]:

- *Level Ia:* This level drains the mid-lower lip, anterior oral tongue, anterior floor of the mouth, anterior alveolar mandibular ridge, and skin of the chin.
- *Level Ib:* These nodes are sentinel to maxillary sinus and oral cavity tumors. They drain submandibular gland, anterior and lower nasal cavity, upper and lower lips, hard and soft palates, nasopharynx, anterior of oral tongue, cheeks, maxillary and mandibular alveolar ridges, medial canthus, and soft tissues of the midface.
- *Level II:* This region contains the sentinel lymph nodes for oropharyngeal, oral cavity, supraglottic laryngeal, hypopharyngeal, and thyroid gland cancers. It also drains lymphatics from the nasopharynx, nasal cavity, glottic and subglottic larynx, salivary glands, paranasal sinuses, face, middle ear, and external auditory canal. Oropharyngeal and nasopharyngeal tumors drain to level IIb lymph nodes.
- *Level III:* These lymph nodes are sentinel for subglottic laryngeal and thyroid gland tumors. They also drain nasopharynx, hypopharynx, oropharynx (tonsils, base of the tongue), supraglottic and glottic larynx, paranasal sinuses, and oral cavity tumors.

- *Level IV*: It drains the larynx, hypopharynx, nasopharynx, and cervical esophagus.
- *Level V*: It drains the nasopharynx, oropharynx (tonsils, base of the tongue), apex of piriform sinus, subglottic larynx, cervical esophagus, thyroid gland, occipital and parietal scalp, postauricular and nuchal regions, and skin of the lateral and posterior neck and shoulder.
- *Level VI*: Prelaryngeal lymph nodes are sentinel for glottic and subglottic laryngeal and thyroid gland tumors. They also drain the hypopharynx, cervical esophagus, and apex of the piriform sinus tumors.
- *Retropharyngeal Nodes*: They are sentinel for ethmoid sinus, nasal cavity, and nasopharynx cancers, but also drain the oropharynx, hypopharynx, supraglottic larynx, maxillary sinus, and soft palate.

4 Radiologic Boundaries for Lymph Node Levels of the Neck

Radiologic boundaries for level I lymph nodes are described in Table 3.3 (Fig. 3.1) [40].

Radiologic boundaries for level II lymph nodes are described in Table 3.4 (Fig. 3.2).

Radiologic boundaries for level III lymph nodes are described in Table 3.5 (Fig. 3.3).

Radiologic boundaries for level IV lymph nodes are described in Table 3.6 (Fig. 3.4).

Radiologic boundaries for level V lymph nodes are described in Table 3.7 (Fig. 3.5).

Radiologic boundaries for level VI lymph nodes are described in Table 3.8 (Fig. 3.6).

Radiologic boundaries for retrostyloid space are described in Table 3.9.

Radiologic boundaries for supraclavicular fossa lymph nodes are described in Table 3.10.

Radiologic boundaries for retropharyngeal lymph nodes are described in Table 3.11 (Fig. 3.7).

Table 3.3 Radiologic boundaries for level I lymph nodes

Levels	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
Ia	Submental	Cranial border of mandible	Body of hyoid	Platysma muscle	Body of hyoid		Anterior belly of digastric muscle
Ib	Submandibular	Cranial border of submandibular gland, mylohyoid muscle	Central hyoid bone	Platysma muscle	Posterior border of submandibular gland	Anterior belly of digastric muscle	Mandible, skin, platysma muscle

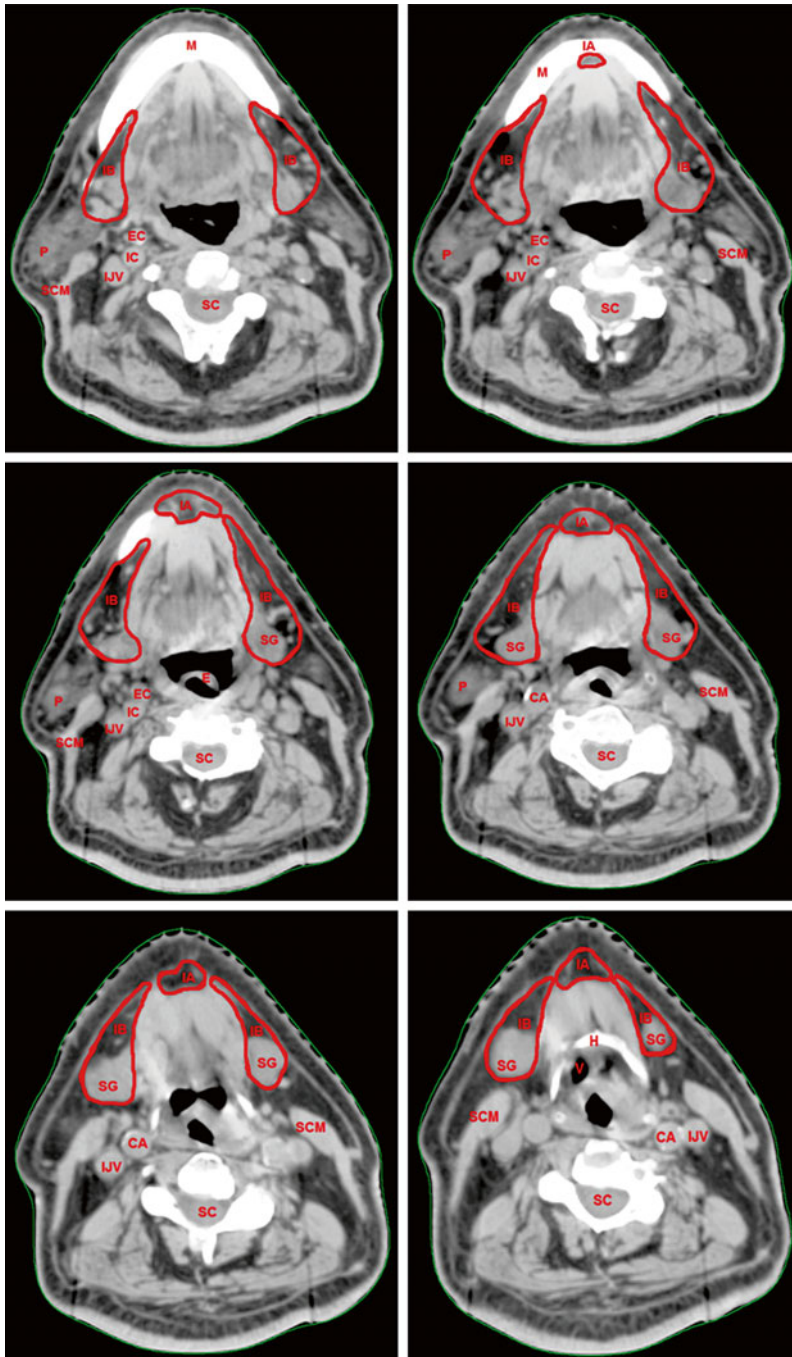


Fig. 3.1 Delineation of level I lymph nodes. Tip: find C1 transverse process to begin level II in case of N(-); otherwise, find jugular foramen (JF) in N(+) neck (see Fig. 3.6 to see JF) (*H* hyoid bone, *IB* level IB, *IA* Level 1A, *SG* submandibular gland, *P* parotid gland, *SC* spinal cord, *IJV* internal jugular vein, *IC* internal carotid artery, *EC* external carotid artery, *CA* common carotid artery, *E* epiglottis, *V* vallecula, *M* mandible, *SCM* sternocleidomastoid muscle)

5 Target Volume Determination and Delineation Guidelines

- *Gross Tumor Volume for Lymph Nodes (GTVn)*: It should include the grossly involved lymph nodes detected by clinical examination, CT, MRI, PET/CT, and intraoperative findings, if operated. In postoperative cases, GTVn is not stated as it is assumed to be grossly resected.
- *Clinical Target Volume for Lymph Nodes (CTVn)*: CTV1 for definitive IMRT is defined as GTV of the primary tumor and GTVn with specific margins. CTV2 is formed by adding high-risk regions for tumor involvement of the primary tumor and metastatic lymph nodes with a 1-cm margin to CTV1. CTV3 includes the uninvolved lymph nodes, and these nodal stations are also called “elective” or “prophylactically treated” nodal regions.
- For postoperative cases, preoperative GTV with 1–2-cm margin including the whole surgical bed and metastatic lymph nodes with ECE is defined as CTV1. CTV2 includes the uninvolved lymph nodes, which are the elective nodal regions in this case. In regions adjacent to parotid glands, deep lobes of the glands are not delineated as critical organs to prevent a decrease in LC in the parapharyngeal space.
- The presence of ECE has a significant importance in terms of LC and survival. Huang et al. reported that patients with ECE required RT in order to improve LC as they have higher risk of recurrence in the neck [41]. In patients with neck dissection and no ECE, CTVn should include wider margins than negative necks, and a 2–3 mm of skin sparing is necessary to decrease skin toxicity [1]. In patients with neck dissection who have ECE, CTVn should have wider margins (including sternocleidomastoid (SCM) and/or paraspinal muscles), and in the regions where there is ECE, the skin is more generously included in CTV. If the muscular fascia is invaded, the entire muscle should be delineated as CTV [40].
- In patients with positive neck, borders of levels differ from the borders in negative necks. If level II lymph nodes are positive, the cranial border starts from the skull base in order to include the jugular fossa. If level IV nodes are positive, the caudal border ends at the clavicular head, to include the supraclavicular region [31].
- In patients with no neck dissection, studies showed that the size of the lymph node is important on estimating the risk of ECE [42–46]. If the lymph node is smaller than 1 cm, the risk of ECE is 17–43 %. However, when it exceeds 3 cm, the risk may rise up to 95 %. As we do not have pathologic evaluation in patients without neck dissection, the size of the nodes should be taken into account, and generous margins should be added for larger ones. A study from MD Anderson Cancer Center reported that margins of 5 and 10 mm are adequate for covering 90 and 100 % of microscopic ECE, respectively [47].
- In 2014, radiation oncologists from the Danish Head and Neck Cancer Group (DAHANCA), the European Organization for Research and Treatment of Cancer (EORTC), the Hong Kong Nasopharyngeal Cancer Study Group (HKNPCSG), the National Cancer Institute of Canada Clinical Trials Group (NCIC CTG), the

Table 3.4 Radiologic boundaries for level II lymph nodes

Levels	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
IIa	Upper jugular (jugulodigastric)	Superior border of transverse process of C1 vertebra	inferior border of hyoid bone	Posterior to submandibular gland	Posterior to jugular vein	Medial border of ICA	Medial border of SCM muscle
IIb		Superior border of transverse process of C1 vertebra	Inferior border of hyoid bone	Posterior to jugular vein	Posterior border of SCM muscle	Deep cervical muscles	Medial border of SCM muscle

ICA internal carotid artery, SCM sternocleidomastoid

Radiation Therapy Oncology Group (RTOG), and the Trans Tasman Radiation Oncology Group (TROG) published a new recommendation guideline for the delineation of neck node levels with the cooperation of an anatomist and a head and neck surgeon [48].

This recent guidelines divided the neck node levels into ten subsites. There is no significant difference in the description and delineation of levels I, II, and III. However, levels IV, VI, and VII were subdivided into two, whereas level V was subdivided into three subgroups, and levels VIII, IX, and X were recently proposed.

They described level IVa lymph nodes as the previous level IV (e.g., lower jugular lymph nodes) and level IVb as the medial supraclavicular lymph nodes which lie between the anterior border of the scalenus muscle and the apex of the lung. The previously described level V was subdivided into level Va and Vb lymph nodes separated by the caudal edge of the cricoid cartilage. Level Vc was recently proposed for the lateral supraclavicular lymph nodes which lie lateral to the scalenus muscle and lateral border of level IVa. Level VI was also divided into VIa and VIb lymph nodes as anterior jugular, and prelaryngeal, pretracheal, and paratracheal lymph nodes, respectively. The previously defined retropharyngeal and retrostyloid lymph nodes were named as levels VIIa and VIIb, respectively. In level VIIb lymph nodes, lateral retropharyngeal nodes were solely included, excluding the medial nodes. The parotid lymph nodes (e.g., preauricular, intraparotid, and subparotid nodes) were defined as level VIII, whereas the malar and buccofacial nodes were defined as level IX lymph nodes. Level X was subdivided into levels Xa and Xb which contain retro- and subauricular and occipital lymph nodes, respectively.

- *Planning Target Volume (PTV)*: A margin of 3 mm is added in all directions; however, it may be minimized to 1 mm in areas adjacent to critical structures.
- *Guidelines for Clinical Target Volumes of the Neck*
Guidelines for clinical target volumes of the neck are shown in Table 3.12.
- *Recommendations for Target Volume Dose Prescriptions*
Recommendations for target volume dose prescriptions are summarized in Table 3.13.

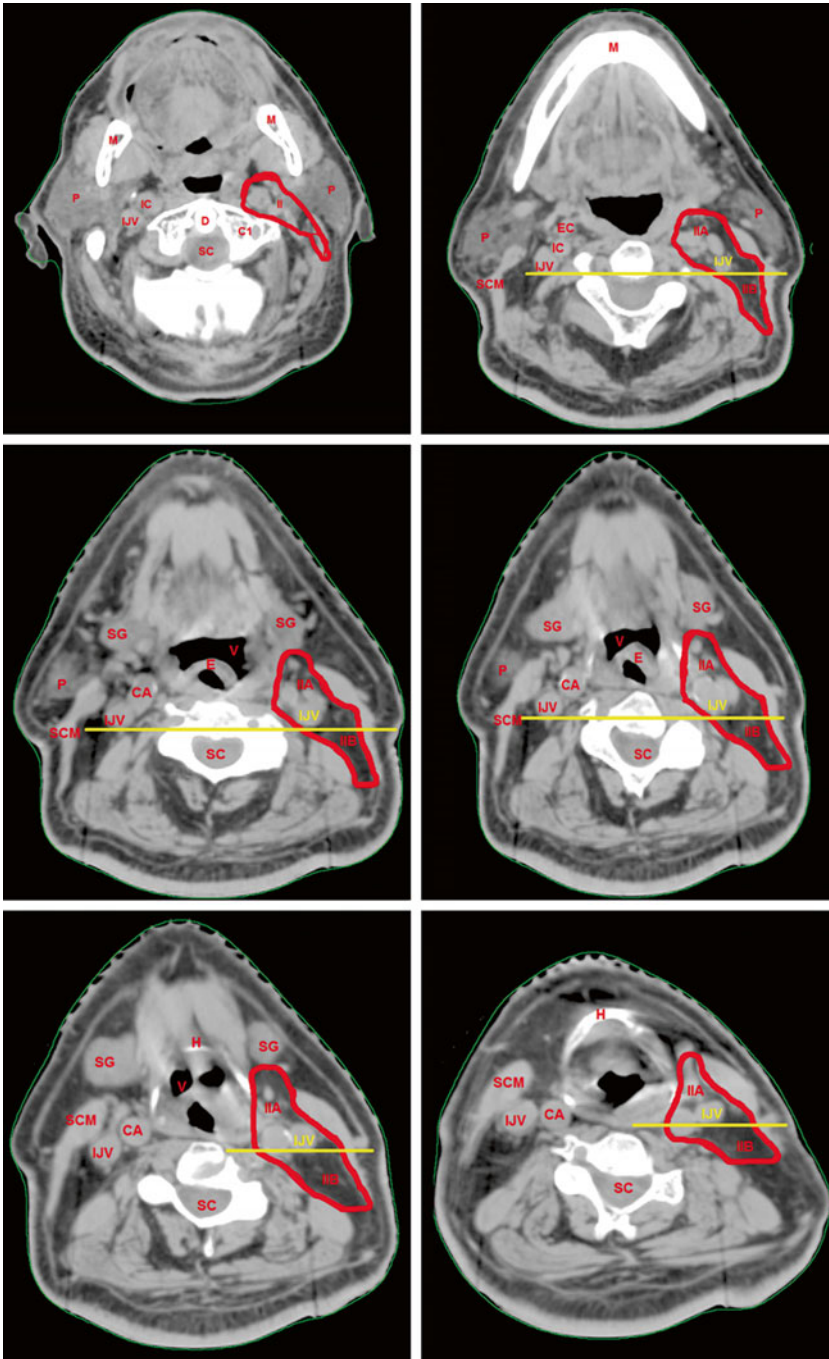


Fig. 3.2 Delineation of level II lymph nodes. Tip: *yellow line* just at the posterior edge of IJV divides level II into A and B. (SG submandibular gland, P parotid gland, SC spinal cord, IJV internal jugular vein, IC internal carotid artery, EC external carotid artery, CA common carotid artery, E epiglottis, V vallecula, M mandible, SCM sternocleidomastoid muscle, H hyoid bone, D dens of axis, CI C1 cervical vertebrae)

Table 3.5 Radiologic boundaries for level III lymph nodes

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
III	Mid-jugular (jugulo-omohyoid)	Inferior to body of hyoid	Inferior to cricoid	Anterior border of SCM muscle	Posterior border of SCM muscle	Medial border of ICA, deep cervical muscles	Lateral border of SCM muscle

ICA internal carotid artery, *SCM* sternocleidomastoid

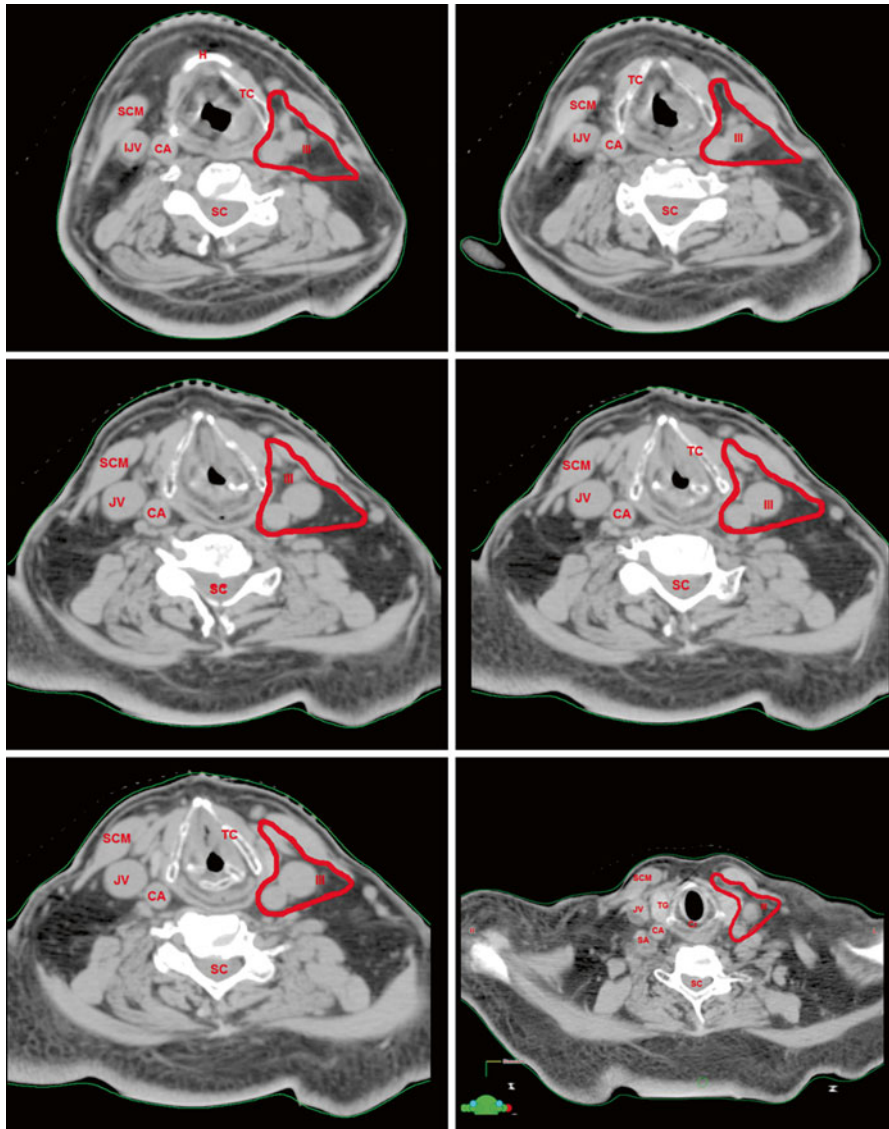


Fig. 3.3 Delineation of level III lymph nodes (*SC* spinal cord, *IJV* internal jugular vein, *CA* common carotid artery, *SCM* sternocleidomastoid muscle, *H* Hyoid bone, *TC* Thyroid cartilage, *Cr* Cricoid cartilage, *TG* Thyroid gland, *SA* Scalenus anterior muscle, *JV* Jugular vein)

Table 3.6 Radiologic boundaries for level IV lymph nodes

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
IV	Lower jugular (transverse cervical)	Inferior to cricoid	2 cm superior to sternoclavicular joint	Anteromedial border of SCM muscle	posterior border of SCM muscle	Medial border of ICA, paraspinal muscles	Medial border of SCM muscle

ICA internal carotid artery, SCM sternocleidomastoid

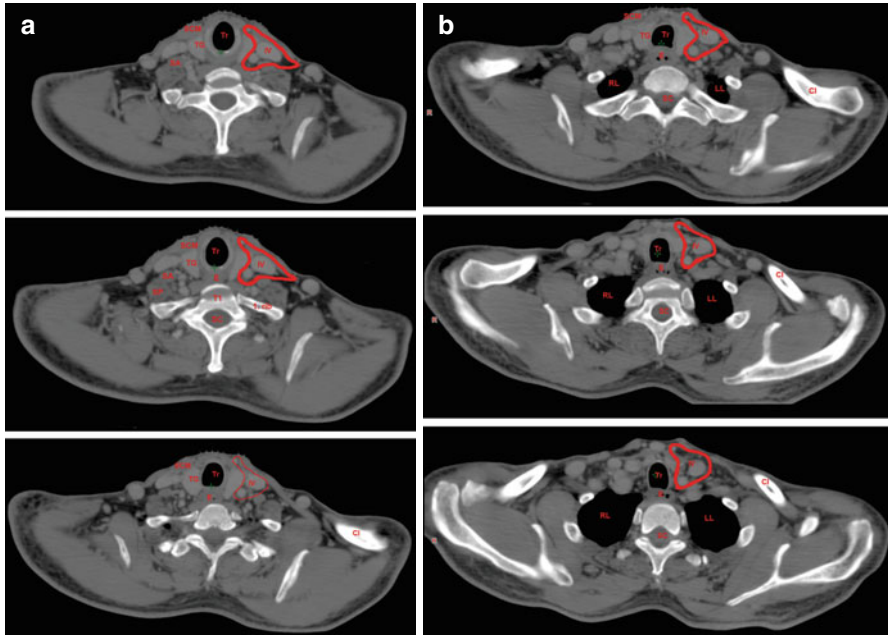


Fig. 3.4 (a, b) Delineation of level IV lymph nodes (SC spinal cord, SCM sternocleido mastoid muscle, H hyoid bone, TC thyroid cartilage, Cr cricoid cartilage, TG thyroid gland, SA scalenus anterior muscle, SP scalenus posterior muscle, Tr trachea, T1 T1 vertebrae, E esophagus, Cl clavicle, RL right lung, LL left lung)

Table 3.7 Radiologic boundaries for level V lymph nodes

Levels	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
Va		Superior to hyoid	Inferior border of cricoid	Posterior border of SCM muscle	Anterolateral border of trapezius muscle	Deep paraspinal muscles	Skin, platysma
Vb	Spinal accessory chain (posterior triangle)	Inferior border of cricoid	Transverse cervical arteries	Posterior border of SCM muscle	Anterolateral border of trapezius muscle	Deep paraspinal muscles	Skin, platysma

SCM sternocleidomastoid

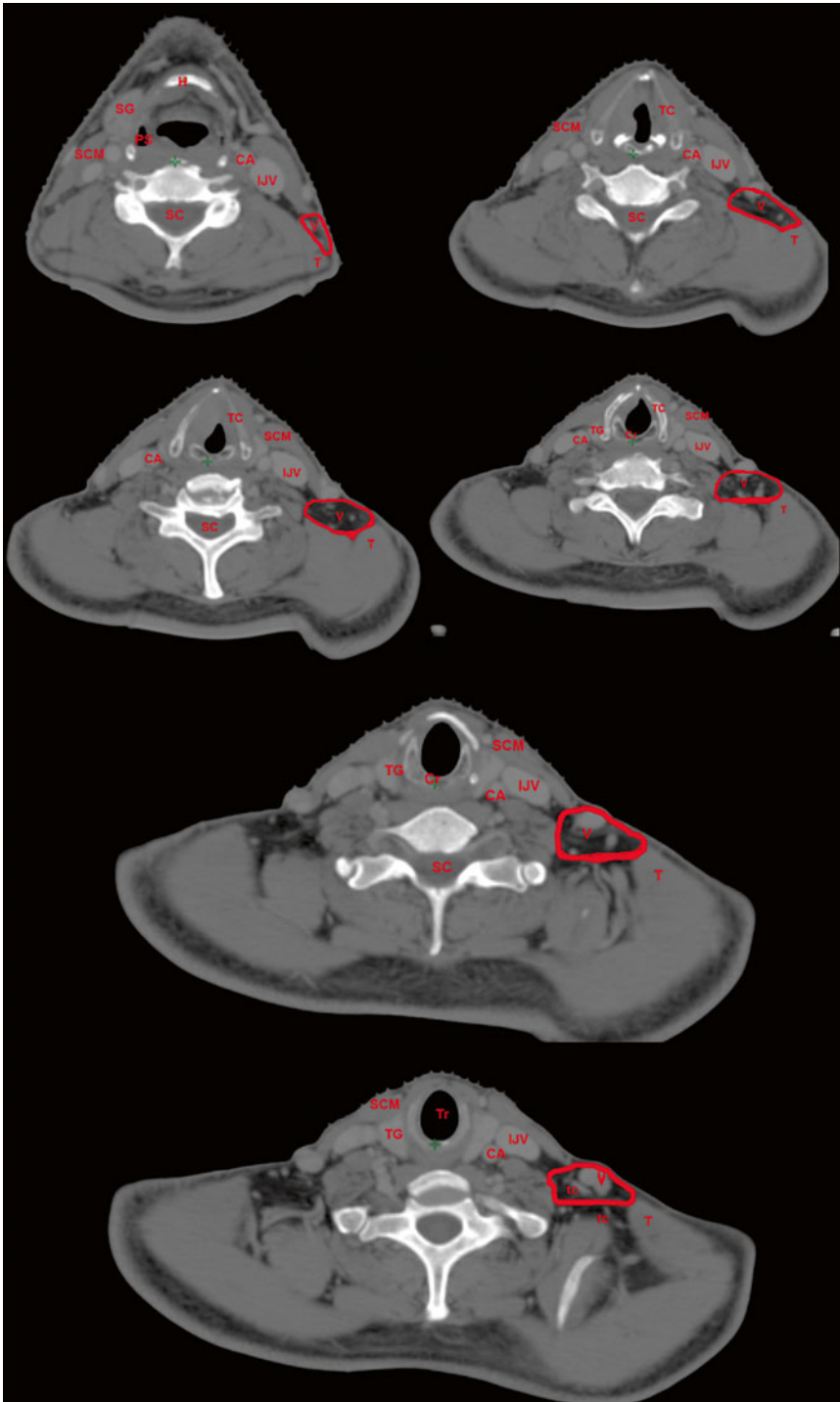


Fig. 3.5 Delineation of level V lymph nodes (*SG* submandibular gland, *SC* spinal cord, *IJV* internal jugular vein, *CA* common carotid artery, *SCM* sternocleidomastoid muscle, *PS* pyriform sinus, *T* trapezius muscle, *tc* transverse cervical vessels, *TG* thyroid gland, *TC* thyroid cartilage, *Cr* cricoid cartilage)

Table 3.8 Radiologic boundaries for level VI lymph nodes

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
VI	Anterior compartment (prelaryngeal, pretracheal, precricoid, and tracheoesophageal)	Superior to thyroid/caudal edge of cricoid cartilage (for paratracheal nodes)	Manubrium of sterni	Skin/cricoid cartilage (for pretracheal nodes)	Esophagus/trachea	Trachea	Medial border of SCM muscle, thyroid gland

SCM sternocleidomastoid muscle

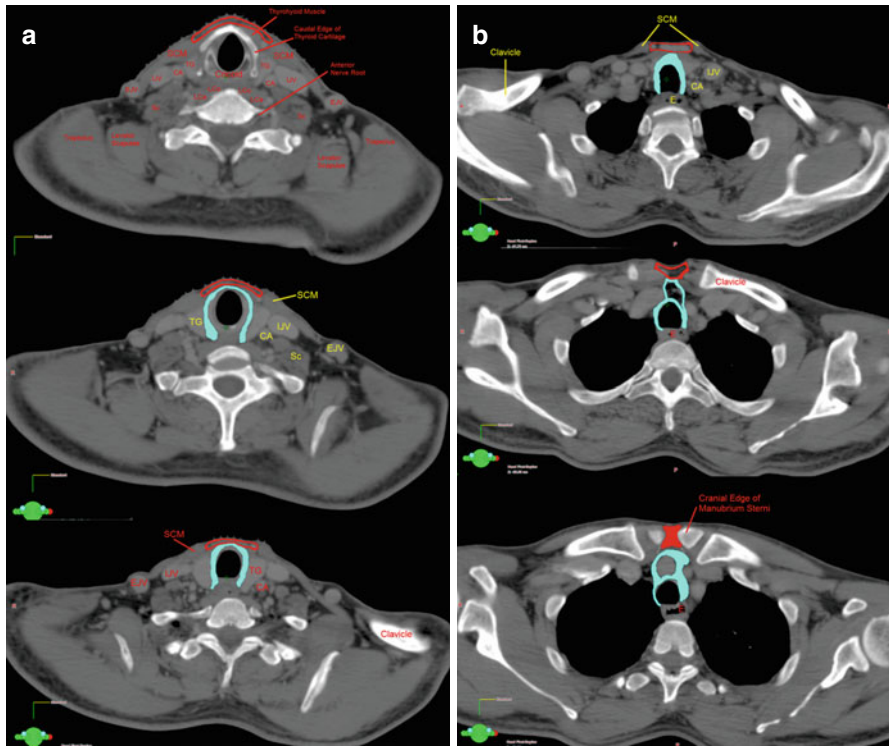


Fig. 3.6 Delineation of level VI lymph nodes (Level VIa red, Level IVb aqua). (EJV external jugular vein, IJV internal jugular vein, CA common carotid artery, SCM sternocleido mastoid muscle, Sc scalenius muscle, E esophagus, TG thyroid gland, LCo longus colli muscle, LCa longus capitis muscle)

Table 3.9 Radiologic boundaries for retrostyloid space

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
RSS	Retrostyloid space	Base of skull (jugular foramen)	Upper limit level II	Parapharyngeal space	Vertebra, base of skull	Retropharyngeal nodes	Parotid space

Table 3.10 Radiologic boundaries for supraclavicular fossa lymph nodes

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
SCF	Supraclavicular	Lower border of IV/Vb	Sternoclavicular joint	SCM muscle, skin, clavicle	Anterior border of posterior scalenus muscle	Trachea/thyroid	Lateral border of posterior scalenus muscle

Table 3.11 Radiologic boundaries for retropharyngeal lymph nodes

Level	Terminology	Borders					
		Cranial	Caudal	Anterior	Posterior	Medial	Lateral
RP	Retropharyngeal	Base of skull	Superior border of hyoid bone (level of C3 vertebra)	Fascia, pharynx mucosa	Longus colli/capitus muscles	Midline	Medial border of ICA

ICA internal carotid artery

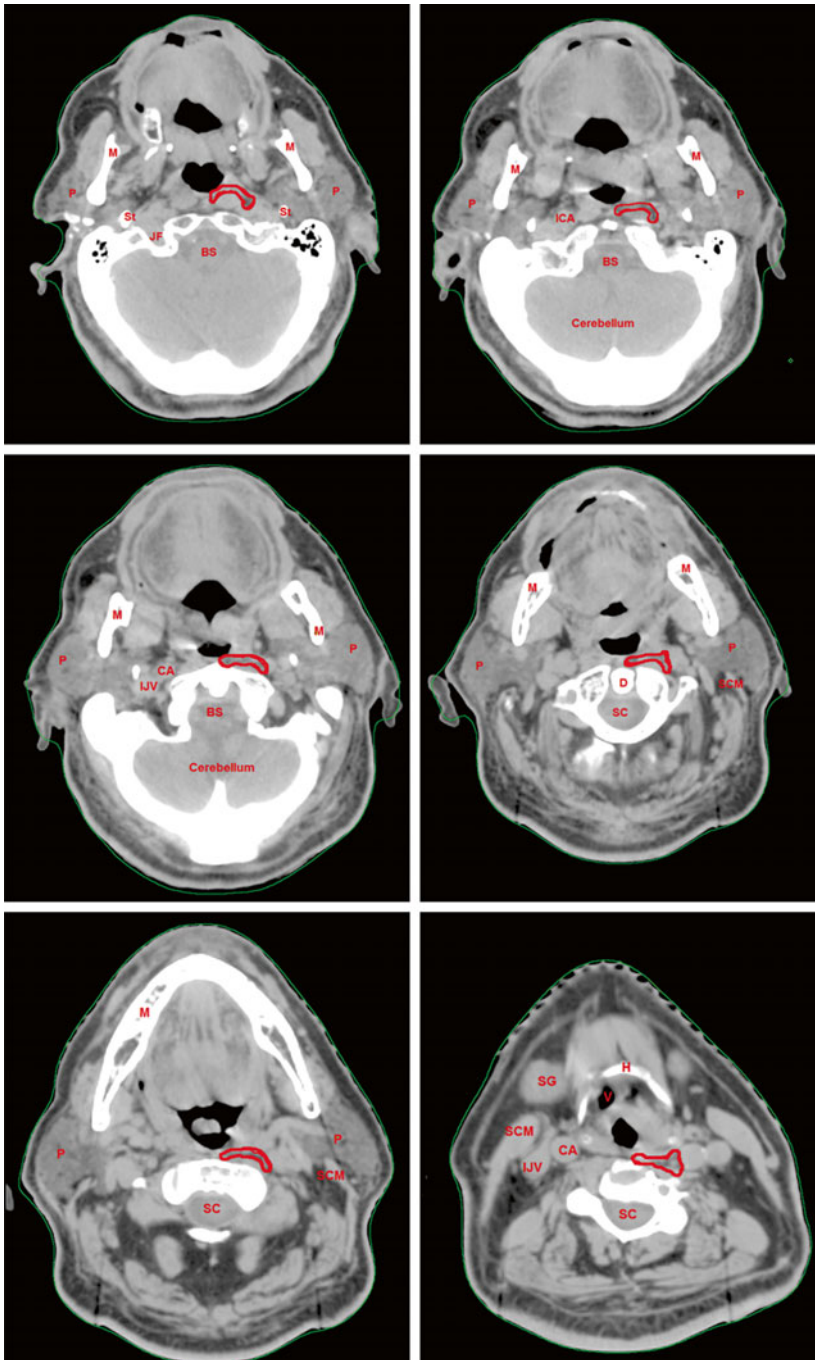


Fig. 3.7 Delineation of retropharyngeal lymph nodes. (SG submandibular gland, P parotid gland, SC spinal cord, IJV internal jugular vein, IC internal carotid artery, CA common carotid artery, H hyoid bone, V vallecula, M mandible, SCM sternocleido mastoid muscle, BS brain stem, JF jugular foramen, D Dens of axis, St Styloid process)

Table 3.12 Guidelines for clinical target volumes of the neck

Treatment modality	CTV1	CTV2	CTV3
Definitive IMRT	Gross lymph node	Positive lymph node levels	Elective nodal regions
Postoperative IMRT	Positive lymph node levels with ECE	Positive lymph node levels without ECE	Elective nodal regions

IMRT intensity-modulated radiation therapy, *CTV* clinical target volume, *ECE* extracapsular extension

Table 3.13 Recommendations for target volume dose prescriptions

Reference	Concurrent chemotherapy	CTV1	CTV2	CTV3
Butler et al. [33]	–	60/2.4 Gy	–	50/2 Gy
Chao et al. [31]	+	70/2 Gy	59.4/1.8 Gy	56/1.6 Gy
Lee et al. [49]	+	70/2.12 Gy	59.4/1.8 Gy	–
Eisbruch et al. (RTOG H-0022) [34]	–	66/2.2 Gy	60/2 Gy	54/1.8 Gy

CTV clinical target volume

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