Treatment of the Neck

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Core Message

Neck dissection has evolved from a radical resection to a more conservative operation targeting the highest risk cervical lymphatics while sparing surrounding neurovascular structures.

The location of the primary site of malignancy, the pathology of that malignancy, and the clinical and radiographic nodal burden will help predict whether a neck dissection is required. Selective neck dissection involving levels I–III has become the standard operation for oral cavity cancers that warrant a neck dissection, while levels II–IV have become standard levels to dissect for oropharyngeal cancers. Additional levels may be added to these selective neck dissections in order to more aggressively stage the patient or more aggressively treat the patient as indicated.

Neck dissection provides a transcervical approach to oral cavity and oropharynx tumors which require increased exposure to achieve adequate margins. Neck dissection results in the identification of important structures, including the extrinsic tongue musculature, the mandible, and the pharynx and more proximal aspects of the hypoglossal nerve, lingual nerve, lingual artery, and facial artery. These structures may be preserved or sacrificed as needed for complete tumor extirpation to optimize survival and improve quality of life.

24.1 Introduction

Neck management of oral cavity cancers is critical to provide the best outcomes and survival. It is important that consideration be given to evaluating and treating the neck, even with the smallest of tongue and floor of mouth cancers. The American Joint Committee on Cancer (AJCC) staging system, Eight Edition, for oral cancers incorporates depth of invasion (DOI) as a variable in staging of the primary site which is useful in predicting occult nodal metastasis [1]. With a high rate of regional metastases, appropriate management of the neck is crucial in the treatment of all oral cavity cancers. Understanding the risk of metastasis to the neck in different cancers or the oral cavity and oropharynx allows the head and neck cancer specialist to electively treat the clinically negative neck when appropriate. In the electively treated neck and the clinically positive neck, the extent of dissection is dependent on the identification of structures that must be resected and those that should be preserved. A detailed discussion defining discrete node-bearing regions of the neck and the indications for when and how to dissect those regions will be elaborated during this chapter.

24.2 History of Neck Dissection

Historically, neck dissection has evolved from a philosophy of removing all structures in the region to the current state of selectively removing only node-bearing tissue while preserving all non-involved structures. Radical neck dissection (RND) was the early terminology for all neck dissections but is rarely used in the twenty-first century. The following descriptions provide the reader with the evolution of this procedure over time supporting the role of more conservative techniques used in recent years (Table 24.1).

Table 24.1 Classification of neck dissection [2]

Neck dissection term	Levels dissected	Structures sacrificed
Radical neck dissection	I, II, III, IV, V	Internal jugular vein, sternocleidomastoid muscle, spinal accessory nerve
Modified radical neck dissection	I, II, III, IV, V	One or all of the above structures preserved
Selective neck dissection	Less levels than I–V. Each variation formally described by the levels removed (i.e., SND 2–4)	All structures preserved
(a) Suprahyoid	SND (I, II, III)	All structures preserved
(b) Lateral	SND (II, III, IV)	All structures preserved
(c) Posterolateral	SND (II, III, IV, V)	All structures preserved
(d) Anterior	SND (VI)	All structures preserved
Extended neck dissection	Additional lymph node levels (i.e., suboccipital)	Additional structures resected (i.e., carotid artery)

Modified from Robbins et al. (2002)

Warning

It is important to consider recommendations regarding the boundaries between levels I and II and between levels III/IV and VI and the terminology of the superior mediastinal nodes.

24.2.1 Radical Neck Dissection

The surgical treatment of cervical lymphatics in head and neck cancer became feasible in the mid-nineteenth century with the advent of improved anesthesia and surgical techniques. Incomplete descriptions of cervical lymphadenectomy were described by multiple European surgeons in the late 1800s, including the prominent surgeons Billroth and Kocher [3]. The first complete description of an en bloc neck dissection can be found in the Polish literature and was published by Franciszek Jawdynski in 1881 [4]. In the early twen-

tieth century, neck dissection was popularized by George Crile of the Cleveland Clinic who described a series of 132 neck dissections in 1906 [5]. Crile's publication documented his approach to neck dissection described as an en bloc resection of cervical lymphatics in continuity with the primary tumor. This approach is similar in philosophy to the approach espoused by Crile's contemporary, William Halsted, for the treatment of breast cancer.

Crile's descriptions and drawings included a full spectrum of cervical lymphadenectomy procedures ranging from a radical neck dissection to a more limited supraomohyoid neck dissection [5]. Throughout the early twentieth century, surgeons became more facile with neck dissection techniques, and these procedures became widespread.

In 1951, Hayes Martin of Memorial Hospital in New York presented 599 neck dissections which involved dissection of levels I through V including resection of the sternocleidomastoid (SCM), internal jugular vein (IJV), and spinal accessory nerve [6]. This standardized lymphadenectomy, referred to as a radical neck dissection, was the default procedure for patients with regional metastases to the neck. At the time, it was felt that a radical neck dissection was the only approach that could safely ensure all node-bearing tissue was removed.

24.2.2 Modified Radical Neck Dissection

While surgeons of the early twentieth century predominantly utilized radical neck dissection in their practice, many began to perform more limited dissections that did not result in the same functional and aesthetic morbidity as well as mortality associated radical neck dissection. Throughout the mid-twentieth century, continued reports of modifications to the radical neck dissection were published and became more formalized.

Bocca and Pignataro, in a 1967 publication, described a series of 90 patients who underwent a "conservation neck dissection" or "functional neck dissection" which would today be described as a modified radical neck dissection (MRND) [7]. After discussing the anatomy of the cervical fascia described by Truffert in the 1920s, they describe a more conservative neck dissection which may spare the sternocleidomastoid muscle, jugular vein, and spinal accessory nerve as long as there is a fascial plane separating each structure from the tumor.

After this landmark publication, additional studies continued to show similar results, including Jesse et al., who reviewed 300 neck dissections that spared the spinal accessory nerve, and Chu et al., who reviewed 261 patients who had no difference in outcomes whether a radical or a modified radical neck dissection was performed [8, 9].

In a "Surgical Grand Rounds" paper from Memorial Hospital in 1981, the progression from radical neck dissection in the 1950s, as described by Martin, to modified radical neck dissection in the 1980s is outlined [10]. The mid-twentieth century resulted in a transition from radical resection of surrounding muscle and neurovasculature in the neck to a more focused approach on the cervical lymphatics and the fascia that envelops them. The late-twentieth century was marked by a transition from the modified radical neck dissection to the selective neck dissection.

24.2.3 Selective Neck Dissection (Specific Consideration to Supraomohyoid)

The selective neck dissection gained popularity in the late twentieth century as multiple surgeons began to evaluate whether a comprehensive removal of the entirety of the cervical lymphatics was required to achieve local and regional control in head and neck cancers. The unique distribution of neck metastases from the different subsites of the upper aerodigestive tract was outlined in a series of 2044 patients from MD Anderson in 1972 [11]. Additional studies helped to define specific regions of the neck that required dissection and excision to achieve acceptable rates of regional control. The posterior triangle was shown to have a low rate of regional metastases with one study showing no involvement of the posterior triangle in a series of 50 elective and therapeutic neck dissections [12]. A suprahyoid neck dissection involving only the submandibular triangle but omitting the jugulodigastric chain was deemed to be inadequate as there were higher rates of regional recurrence in a series of 261 patients [9].

The "regional neck dissection" espoused by Ballantyne at MD Anderson in the 1970s involves tailoring the extent of neck dissection to the specific primary site of the tumor. An early study, following a retrospective cohort of greater than 400 patients at MD Anderson, showed comparable rates of control in these regional neck dissections compared to modified radical and radical neck dissections [8]. These "various types of modified radical neck dissections" were further defined by Byers in his description of approximately 1000 neck dissections performed at MD Anderson from 1970 to 1980 [13]. In this paper, the supraomohyoid (levels I, II, III) and anterior (levels II, III, IV) neck dissections are described. Additional study demonstrated specific patterns of occult spread along the submaxillary lymph nodes and upper jugulodigastric chain during elective neck dissection in N0 disease of the oral cavity [14].

This same pattern of regional spread was further demonstrated at Memorial Sloan Kettering Cancer Center among 1081 patients over a 20-year period. After looking at the patterns of spread in over 1000 radical neck dissection specimens, Shah recommended that, when an elective neck dissection is indicated, a supraomohyoid neck dissection should be performed for oral cavity cancers, and an anterolateral neck dissection (similar to Byer's anterior neck dissection) should be performed for oropharynx cancers [15].

Over a 100-year period of time, a progression of more radical surgery to more conservative surgery occurred in the treatment of the neck for oral cavity and oropharynx cancers. In the late twentieth century and early twenty-first century, these operations would be further standardized and defined for the purposes of improved communication and higher-quality research.

24.3 Important Terminology in Neck Dissection

As the use of neck dissection expanded among surgeons in the twentieth century, so did the use of varying terms to describe the location of cervical lymphatics and the method by which those lymphatics were removed from the neck. At the end of the twentieth century and the beginning of the twenty-first century, a concerted effort among the head and neck surgery and oncology community resulted in standardized terms for the location of lymph nodes within the neck as well as standardized terms for the different types of neck dissections that can be performed.

24.3.1 Levels of the Neck

Lymph nodes and their associated lymphatic channels can be found running throughout the fibrofatty regions of the neck. The French anatomist Henri Rouvière in his seminal work *Anatomy of the Human Lymphatic System* described the rich lymphatic system of the neck using topographical anatomy that is still used today [16]. Further study showed the specific patterns of spread from the upper aerodigestive tract to the cervical lymphatics but often required more complex terms or detailed drawings [11]. Though topographical anatomy provides information about the location of a given cervical lymph node, these terms may vary from author to author and result in difficulty compiling data across institutions. The Memorial Sloan Kettering group outlined their diagrammatic representation of cervical lymph nodes by level in a 1981 publication [10]. These levels were ultimately adopted by the Committee for Head and Neck Surgery and Oncology of the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) [17]. The addition of a seventh level as well as refinement of the original six levels occurred during future meetings resulting in more descriptive anatomic boundaries and subdivisions of level I, II, and V [2, 18] (Table 24.2).

24.3.2 Staging of the Neck by AJCC Criteria

In addition to the location of lymph nodes within the neck, it is of paramount importance to clearly define the burden of regional lymph node metastases in each patient diagnosed with head and neck cancer. The American Joint Committee on Cancer (AJCC) staging criteria stratifies patients into different groups based upon the degree of regional lymphatic spread which ultimately informs the overall stage of that patient's cancer.

Early studies showed that lymph node burden and distribution impacted outcomes [19, 20]. The AJCC system takes into account lymph node size, number, and laterality to separate patients into different groups. The most recent *AJCC Cancer Staging Manual*, Eight Edition, also takes into account additional factors including extracapsular spread and human papillomavirus positivity which have both been shown to influence prognosis in head and neck cancer [1] (Table 24.3).

Important
Standardization of terminology for neck dissection is important for communication among clinicians and researchers.

24.3.3 Classifications of Neck Dissection

As the approach to dissection evolved from a radical procedure to a more selective procedure, multiple terms were coined by different authors. Different terms were used to describe the same procedure, while the same term sometimes described two different procedures. The Committee for Neck Dissection Classification of the American Head and Neck Society and the Committee for Head and Neck Surgery and Oncology of the AAO-HNS have come to a consensus regarding appropriate neck dissection nomenclature [18].

A *radical neck dissection* (*RND*) includes the removal of levels I through V. By definition, this also involves the removal of the sternocleidomastoid muscle, internal jugular vein, and spinal accessory nerve. A radical neck dissection also includes removal of the submandibular gland (SMG) and often intraparotid nodes within the posterior aspect of the submandibular triangle.

An *extended radical neck dissection* includes additional lymph node groups such as the suboccipital triangle, retropharyngeal nodes, superior mediastinal nodes, or paratracheal nodes as well as nonlymphatic structures such as muscles or nerves that have been directly invaded by tumor.

A *modified radical neck dissection (MRND)* also involves the removal of levels I through V but preserves at least one of the nonlymphatic structures removed in a radical neck dissection. It is advised that when performing a MRND, the preserved structures should be specifically named.

A *selective neck dissection (SND)* refers to a cervical lymphadenectomy in which there is preservation of one or more lymph node levels which are removed in a RND. Most elective and even therapeutic neck dissections performed today are selective neck dissections sparing level V. As discussed previously, level V can be preserved for the majority of upper aerodigestive squamous cell carcinomas (SCC) as there is a low propensity for metastasis to this region [12, 15]. It is recommended that the levels dissected be written in parenthesis after the term SND in order to provide an accurate account of the surgery. Although writing in each level dissected for a SND is preferred, the supraomohyoid neck dissection and anterolateral neck dissection are two variations which merit further discussion. The supraomohyoid neck dissection was the term previously used to signify a SND (levels I, II, III) which is commonly utilized in the setting of an elective neck dissection for oral cavity cancer. The anterolateral neck dissection is a SND (levels II, III, IV) uti-

Table 24.2 Delineation of nodal levels in the electively treated neck based upon anatomic boundaries [2, 17, 18]

Level	Superior	Inferior	Anterior/medial	Posteriorateral	Deep
IA	Inferior border of the mandible	Hyoid bone	Anterior belly contralateral digastric muscle	Anterior belly of ipsilateral digastric muscle	Mylohyoid muscle
IB	Inferior border of the mandible	Posterior belly of digastric muscle	Anterior belly of ipsilateral digastric muscle	Stylohyoid muscle	Hyoglossus muscle
IIA	Skull base	Inferior edge of hyoid	Posterior border of SMG or stylohyoid muscle	Spinal accessory nerve and deep surface of the SCM	Levator scapulae and splenius capitis
IIB	Skull base	Inferior edge of the hyoid	Spinal accessory nerve and internal jugular vein	Deep surface of the SCM	Levator scapulae and splenius capitis
III	Inferior edge of the hyoid	Inferior edge of the cricoid and transverse plane at which omohyoid crosses IJV	Lateral border of the sternohyoid muscle	Deep surface of the SCM and sensory branches of the cervical plexus	Scalene muscles and levator scapulae
IV	Inferior edge of the cricoid and transverse plane at which omohyoid crosses IJV	Clavicle/transverse cervical vessels	Lateral border of the sternohyoid muscle	Deep surface of SCM and sensory branches of the cervical plexus	Scalene muscles and levator scapulae
Va	Apex of the convergence of the sternocleidomastoid and trapezius muscles	Horizontal plane defined by the lower border of the cricoid cartilage	Posterior border of the SCM and/or sensory branches of the cervical plexus	Anterior border of the trapezius	Scalene muscles and levator scapulae
Vb	Horizontal plane defined by the lower border of the cricoid cartilage	Clavicle	Posterior border of the SCM and/or sensory branches of the cervical plexus	Anterior border of the trapezius	Scalene muscles and levator scapulae
VI	Hyoid bone	Subclavian artery/innominate artery	Trachea	Common carotid artery/carotid sheath	Anterior scalene muscle and longus colli muscle

Adapted from Robbins et al. (1991, 2002, 2008)

lized in the setting of an elective neck dissection for oropharyngeal cancer as well as laryngeal and hypopharyngeal cancers.

Lastly, a *super selective neck dissection* involves the removal of one to two contiguous neck levels. Although this surgery is not indicated as a primary method for therapeutic or elective neck dissection, it is useful in salvage surgery after primary chemoradiation to limit dissection in a radiated field.

24.4 Indications for Neck Dissection in Oral Cavity Cancer

Cervical lymphadenectomy allows for therapeutic treatment of clinically evident nodal metastases during the excision of the primary oral cavity tumor or as a staged procedure. In the N0 neck, it allows for the removal of occult disease. It additionally provides pathologic staging of the cervical lymphatics which informs adjuvant therapy.

Unfortunately, when a patient initially presents with a lesion in the oral cavity, it is unknown if it is benign, premalignant, or malignant until a biopsy is performed. Even with a biopsy, the tissue removed and sent to the pathologist may not represent the entire lesion. The surgeon must be prepared for a lesion of the oral cavity to have various components including various grades of dysplasia, carcinoma in situ, and invasive squamous cell carcinoma. The new staging system also incorporates both surface area measurements and depth of invasion (DOI) which can confuse the surgeon if the initial biopsy did not include the deepest part of the lesion. In this scenario, the final DOI and need to treat the neck may not be fully known until after the pathology is finalized from an excision of the primary site.

The following algorithm is used by the authors to evaluate and manage the neck in early oral cancer (Fig. 24.1).

Table 24.3 AJCC cervical lymph node staging system

N category	Clinical criteria	Pathologic criteria
Nx	Regional lymph nodes cannot be assessed	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis	No regional lymph node metastasis
N1	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension and ENE (–)	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension and ENE (–)
N2	Metastasis in a single ipsilateral node larger than 3 cm, but not larger than 6 cm in greatest dimension and ENE (–); *or* in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension and ENE (–)	Metastasis in a single ipsilateral lymph node, 3 cm or smaller in greatest dimension and ENE (+); *or* larger than 3 cm, but not larger than 6 cm in greatest dimension and ENE (–); *or* metastases in multiple ipsilateral lymph nodes, none larger than 6 cm in greatest dimension and ENE (–);*or* in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension and ENE (–)
N2a	Metastasis in a single ipsilateral node larger than 3 cm, but not larger than 6 cm in greatest dimension and ENE (–)	Metastasis in a single ipsilateral or contralateral node 3 cm or smaller in greatest dimension and ENE (+); *or* a single ipsilateral node larger than 3 cm, but no larger than 6 cm in greatest dimension and ENE (–)
N2b	Metastasis in multiple ipsilateral nodes, none larger than 6 cm in greatest dimension and ENE (–)	Metastasis in multiple ipsilateral nodes, none larger than 6 cm in greatest dimension and ENE (–)
N2c	Metastasis in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension and ENE (–)	Metastasis in bilateral or contralateral lymph nodes, none larger than 6 cm in greatest dimension and ENE (–)
N3	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE (–) *or* metastasis in any node (s) and clinically overt ENE [ENE (+)]	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE (–) *or* in a single ipsilateral node larger than 3 cm in greatest dimension and ENE (+)
N3a	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE (–)	Metastasis in a lymph node larger than 6 cm in greatest dimension and ENE (–)
N3b	Metastasis in any node(s) and ENE (+)	Metastasis in a single ipsilateral node larger than 3 cm in greatest dimension and ENE (+) *or* multiple ipsilateral, contralateral, or bilateral nodes, any with ENE (+)

Note: A designation of "U" or "L" may be used for any N category to indicate metastasis above the lower border of the cricoid (U) or below the lower border of the cricoid (L)
Similarly, clinical and pathologic ENE should be recorded as ENE (–) or ENE (+)
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Eyecatcher

Decisions regarding the elective and therapeutic management of cervical lymph node metastases are made mainly on clinical findings in the neck as it is always difficult to predict cervical lymph node metastasis from the size and extent of invasion of the primary tumors.

24.4.1 Therapeutic Neck Dissection

Therapeutic neck dissection implies there is known cancer in the cervical nodes, and they are removed to therapeutically *treat* rather than stage or diagnose the neck. The role of the therapeutic neck dissection is to surgically excise all regional metastases. Accordingly, the type of neck dissection required must be tailored to the regional metastases that are present. Although a radical neck dissection may be necessary for bulky neck disease which has invaded the internal jugular vein, sternocleidomastoid, and spinal accessory nerve, this type of regional spread is fortunately uncommon. The radical neck dissection is, thus, uncommon in modern head and neck practice. A modified neck dissection may be utilized for bulky lymphadenopathy which has invaded the internal jugular vein, sternocleidomastoid muscle, or spinal accessory nerve in order to remove all tumors within the neck. The more commonly seen clinical scenario involves N1 or greater disease within the neck without clinical or radiographic signs of spread beyond the cervical lymphatics.

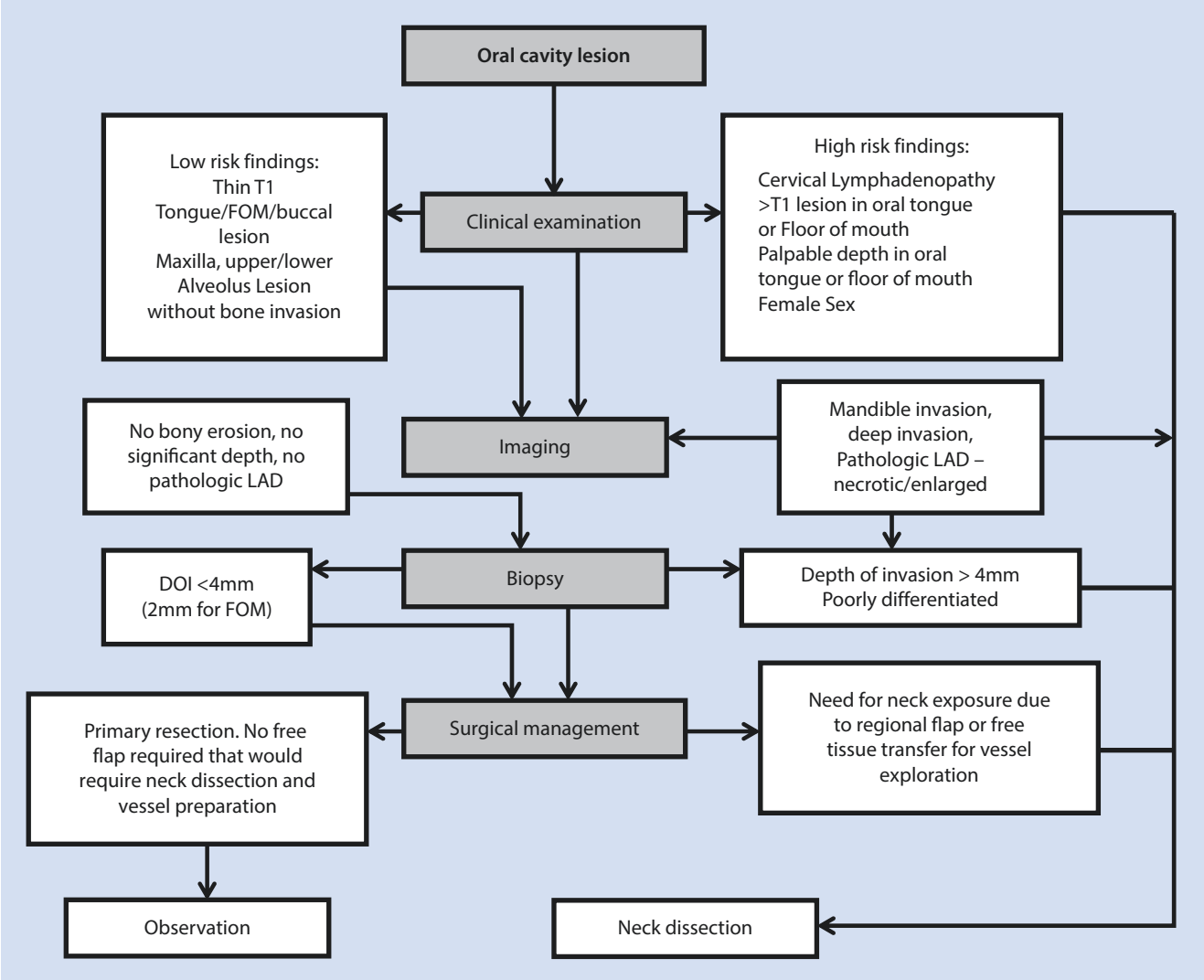

Fig. 24.1 Algorithm for neck dissection in oral cavity cancer

The selective neck dissection is currently the most common type of neck dissection used for the treatment of oral cavity cancer with regional metastatic disease. Studies from the late twentieth century have reported regional recurrence rates of 10–24% utilizing selective neck dissection [13, 21, 22]. These large retrospective case series provided a benchmark that further research has attempted to improve upon into the twenty-first century. It is important to note that radiation therapy and chemotherapy protocols each evolved as neck dissection techniques evolved throughout the twentieth century. The outcomes listed in studies from the 1980s and 1990s include a mix of patients who received either preoperative radiation therapy or postoperative radiation therapy [15, 13, 23]. The presence of extracapsular extension and increased nodal burden were noted to result in worse outcomes and informed the need for additional adjuvant radiation [24]. Trends toward postoperative radiation or chemoradiation dictated by these adverse pathologic features have resulted in improved regional control when selective neck dissection is performed [25, 26]. The landmark studies by the European Organization for Research and Treatment of Cancer (EORTC) and Radiation Therapy Oncology Group (RTOG) helped to standardize the indications for postoperative chemoradiation further [27, 28].

In the setting of a primary oral cavity cancer with clinically evident regional lymphatic spread, it is the author's preference to perform a selective neck dissection of levels IA, IB, IIA, IIB, III, and IV. Adjuvant radiotherapy or chemoradiotherapy is then given depending on the final pathology of the surgical specimen. A modified radical neck dissection would be performed if lymphadenopathy extended into level V. An extended neck dissection of the previously described selective dissection would be performed to the spinal accessory nerve, internal jugular vein, or sternocleidomastoid muscle if gross invasion was noted preoperatively or intraoperatively. Not uncommonly, a level I node is noted to be invading the mandible and may appear contiguous with the primary tumor. It is the authors practice to incorporate the cervical lymphatics with the specimen en bloc in this scenario.

In the event of carotid artery invasion, a balloon test occlusion (BTO) is performed to provide preoperative counseling to the patient and assist with operative planning. Early experience with carotid artery sacrifice in head and neck cancer showed unacceptable outcomes regarding perioperative cerebrovascular accident and mortality at 45% and 30%, respectively [29]. Biller and colleagues showed decreased rates of cerebrovascular injury and mortality and improved outcomes with carotid resection [30]. Over the years, techniques in vascular surgery, interventional radiology, and reconstructive surgery have improved. Carotid reconstruction is now routinely performed at many centers using autologous vein grafts. Interventional radiologists, neurologists, and neurosurgeons now perform angiography and additional preoperative testing including BTO to assess blood flow and intervene on occluded grafts. Microvascular free tissue transfer provides musculocutaneous cover over the repaired carotid in these complex ablative defects. A recent study by Mourad et al. has shown a 3.9% rate of vascular accident in the immediate postoperative period and an overall 2-year survival of 82% [31]. In patients with carotid involvement, we offer a carotid resection with vascular reconstruction after a frank discussion with the patient regarding the significant risks and benefits related to their advanced disease.

24.4.2 Elective Neck Dissection for Squamous Cell Carcinoma

Elective neck dissection implies that although there are no clinically detectable regional lymph nodes, there is a suspicion that occult microscopic regional metastases may be present. Thus, the neck dissection is performed to *diagnose and stage* the neck. If cancer was present, the type of neck dissection that was originally performed should ideally have resulted in a therapeutic neck dissection that removed all nodal tissue at risk of harboring metastatic disease.

In the setting of oral cavity cancer without clinically apparent regional disease, there has always been controversy over the management of the neck. The decision to perform an elective neck dissection is based upon the pathology of the primary tumor as well as its subsite within the oral cavity. The alternative to elective neck dissection has historically been "watchful waiting" with possible therapeutic neck dissection in the event of recurrence. Additional research has investigated the role of sentinel lymph node biopsy (SLNB) to determine whether a neck dissection is indicated.

While surgery is the primary treatment modality for the majority of oral cavity cancers, the treatment of the N0 neck is less well-defined. When radical surgery was popular in the early twentieth century, large groups of patients were treated with extirpation of their primary tumor and radical neck dissection to clear any clinically evident or occult regional metastases. As radical surgery gave way to more conservative methods in the late twentieth century, a more nuanced approach to elective dissection evolved. This approach placed importance on the risk of occult nodal metastasis and where those metastases might be harbored. A discussion with the patient would then include the risk of occult regional disease, the extent of neck dissection required, and the morbidity associated with that neck dissection. While many authors feel that rates of occult disease greater than 20% are an indication for elective neck dissection, the risk that a patient is willing to accept varies depending on many different factors.

Early studies did not show a significant difference in survival for patients treated with elective neck dissection versus therapeutic neck dissection (which would occur after regional recurrence to salvage the patient) [32, 33]. More recent analyses have shown better outcomes when elective neck dissection is performed. An elective neck dissection can more accurately stage the patient's neck and inform whether he or she requires adjuvant radiation or chemoradiation. This approach ultimately decreases recurrence rates and results in better survival [34, 35, 36]. If elective neck dissection is not performed, the cancer may be deemed unresectable if it recurs regionally. Additional study has also shown that salvage neck dissection provides worse regional control than upfront elective neck dissection [37, 38, 35, 36]. It is therefore important to know when an elective neck dissection is indicated for oral cavity squamous cell carcinomas and which levels need to be dissected.

The rate of occult and clinical metastases is known to be directly associated with increasing tumor stage [39, 37, 40, 41, 42, 43]. This rate varies from subsite to subsite within the oral cavity. The location of the primary tumor also dictates whether lymphatic spread will be primarily ipsilateral or whether there is a risk for spread to the contralateral neck [40].

In squamous cell carcinoma of the lip, there is a high rate of cure at approximately 90% and a low rate of regional metastasis. Occult and clinical metastases to the neck are associated with worse survival. Tumor size greater than 3 cm, grade IV histology, and local recurrence are all predictors of regional recurrence; however, this rate is still below 10% [44]. Neck dissection in cancer of the lip should be considered in cases with clinically positive nodal disease or in patients with large, aggressive tumors.

More extensive literature exists for cancers of the oral tongue and floor of the mouth (FOM) due to their increased prevalence compared to other subsites. The rich lymphatic channels and vascularity of these subsites predispose them to regional metastatic spread. T2 lesions of these subsites have been shown to harbor occult metastases in greater than 20% of patients. A bilateral neck dissection is warranted for midline lesions, especially for lesions of the floor of the mouth [40]. With the additional risk of a bilateral elective neck dissection, appropriately stratifying a patient's likelihood of harboring occult metastatic disease is imperative. In earlier tumor stage lesions, additional variables associated with the primary tumor have been sought to predict which patients require an elective neck dissection

In oral cavity cancers, deep ulceration and deep infiltration have been shown to be important factors in the risk for neck metastases [39]. Two objective measures for tumor

infiltration that are quantified by pathologic analysis are tumor thickness and depth of invasion. Tumor thickness is meant to measure the distance between the surface of the tumor and the deepest extent of the infiltrative ulcer. Depth of invasion (DOI) measures the deepest extent of invasion beyond the mucosal basement membrane. DOI requires the creation of a horizontal plane connecting two regions of intact squamous mucosa adjacent to the tumor, since the basement membrane is often distorted or destroyed by the invasive front of squamous cell carcinomas. A "plumb line" is then dropped from that horizon to the deepest extent of invasion [1]. Despite their differing definitions, these two terms are often used interchangeably in the literature. Depth of invasion has been utilized by the AJCC since its Sixth Edition, and the more recent Eight Edition utilizes depth of invasion as a variable in determining tumor stage (■ Table 24.4) [1]. Additional analyses have shown that either tumor thickness or depth of invasion can provide helpful prognostic value in the event that an institution uses one measure more consistently than the other [45].

The first report which described tumor thickness as predictive of occult nodal metastases in oral tongue and floor of the mouth squamous cell carcinoma stratified patients into three groups consisting of thickness less than 2 mm and greater than 2 mm [46]. Fukano et al. determined that 5 mm was the significant cutoff in an analysis of 34 patients in 1997 [47]. In 2004, Sparano et al. performed a multivariate analysis of 45 patients and identified multiple factors associated with occult nodal disease. These factors included tumor thickness greater than 4 mm, perineural invasion (PNI), angiolymphatic invasion, an infiltrative invasive front, and poorly differentiated tumor cells [41]. Melchers, in evaluating all subsites of the oral cavity, recommends 4 mm to be the cutoff for elective neck dissection after evaluating a retrospective series of 246 patients [48]. In evaluating multiple retrospective studies in the literature, the majority of authors would recommend an elective neck dissection for somewhere between 2 mm and 4 mm depth of invasion or tumor thickness for oral tongue cancer.

In the treatment of floor of the mouth squamous cell carcinomas, a higher propensity for occult regional metastasis and a lower rate of salvage for recurrent disease argues for a more aggressive approach [49]. In evaluating 121 FOM cancers, Balasubramanian et al. recommend a cutoff of 2 mm in deciding whether an elective neck dissection is warranted in the N0 neck [50].

Performing an elective neck dissection in all patients with oral tongue and floor of the mouth cancer regardless of depth of invasion is the most conservative approach. Elective neck dissection in patients with T1 and T2 oral tongue tumors resulted in improved survival and decreased recurrence in multiple retrospective studies [49, 38]. The Neck Disease Management Group at the Tata Memorial Centre in Mumbai, India, has performed the only large-scale prospective, randomized controlled trial evaluating elective versus therapeutic neck dissection on overall survival and disease-free survival in node-negative oral cancer. After enrolling 500 patients (the majority of whom had oral tongue cancer), their trial was ended early on the basis of evidence showing the superiority of elective neck dissection over therapeutic neck dissection [36]. Though DOI was analyzed, a significant difference could not be found, and the authors recommended elective neck dissection for all early-stage node-negative oral cavity squamous cell carcinomas.

While a high rate of occult nodal metastases in early-stage oral cavity cancers is accepted, there is no such agreement regarding tumors of the hard palate and upper alveolus even in T3 and T4 tumors. Due to the relative rarity of maxillary alveolus and hard palate tumors compared to other subsites and trends that advocate a "wait and see" approach, there is less data available regarding the rate of occult nodal metastases in these subsites. An analysis of the Surveillance, Epidemiology, and End Results (SEER) Database showed a low rate of cervical metastases below 20% in T1–T3 hard palate and maxillary alveolus squamous cell carcinomas and a rate of 24.7% in T4 tumors [51]. Retrospective analyses from multiple institutions demonstrate a different trend consisting of higher rates of occult disease when elective neck dissection is performed as well as high rates of regional recurrence when neck dissection is not performed [43, 52, 53, 54, 55]. Givi et al., in a retrospective analysis of 199 patients undergoing elective neck dissection for hard palate and upper alveolus cancers, demonstrated occult disease greater than 20% for all T-stages, lower rates of neck recurrence, and superior 5-year recurrence-free survival [53]. In the setting of high occult metastasis rates and regional recurrence rates for T3 and T4 tumors of the hard palate and maxillary alveolus, we recommend elective neck dissection. Adjuvant radiation may

■ Table 24.4 T Category for oral cavity cancer, Eight Edition, staging manual

T category	T criteria
Tx	Primary tumor cannot be assessed
Tis	Carcinoma in situ
T1	Tumor <= 2 cm, <=5 mm depth of invasion (DOI)
T2	Tumor <=cm, DOI >5 mm and <=10 mm *or* > 2 cm but <=4 cm, and <=10 mm DOI
T3	Tumor > 4 cm *or* any tumor >10 mm DOI
T4	Moderately advanced or very advanced local disease
T4a	Moderately advanced local disease
T4b	Very advanced local disease; tumor invades masticator space, pterygoid plates, or skull base and/or encases internal carotid artery

be offered in place of surgery for patients who are poor surgical candidates or are resistant to elective neck dissection; however, further prospective research is needed regarding the efficacy of this treatment option. For T1 and T2 tumors, further research is needed and patients are offered close observation.

Similar to the maxillary alveolus and hard palate, there are conflicting opinions regarding the rate of cervical metastases in squamous cell carcinoma of the buccal mucosa. While multiple studies describe the more locally aggressive nature of buccal squamous cell carcinoma, the rate of occult neck metastases is poorly understood. In a series of 119 patients from MD Anderson Cancer Center, 6 of 23 patients treated with elective neck dissection were ultimately positive for metastasis. The majority of those patients with occult positive lymph nodes had T2 primary tumors [56]. Jing et al. have additionally shown rates of regional metastasis at 30% for T2 tumors with higher rates of 52.9% and 70% for T3 and T4 tumors, respectively [42]. Due to the aggressive nature and high recurrence rates of buccal squamous cell carcinoma, the resection of T2 and greater buccal mucosa tumors with appropriate margins often requires microvascular reconstruction to appropriately repair the ablative defect while also preventing trismus. We perform elective neck dissection in the N0 setting for any tumor that is T2 or greater. Additional T1 tumors with aggressive pathologic features or T1 tumors that require microvascular reconstruction with vessel exploration undergo elective neck dissection as well in our practice.

Once the decision is made to perform an elective neck dissection, the extent of that neck dissection must be well-defined. The concept of an elective neck dissection in the setting of N0 disease spurred the development of more conservative forms of neck dissection such as modified radical neck dissection and selective neck dissection. In reviewing 1119 radical neck dissections at the Memorial Sloan Kettering Cancer Center, Shah describes 343 elective radical neck dissections with an occult positive rate of 33%. The pattern of metastasis to each neck level for each site of the upper aerodigestive tract is detailed as well with the majority of metastases in levels I, II, and III for oral cavity squamous cell carcinomas [15]. In comparison to radical neck dissection, multiple retrospective series from this time showed equivalent regional control in N+ patients treated with a supraomohyoid neck dissection. Low regional recurrence rates of approximately 5% in patients with pathologic N0 disease were demonstrated as well [13, 46, 21, 22]. With the effective clearance of potentially occult nodal disease while sparing the patient the morbidity of more radical procedures, the supraomohyoid neck dissection or selective neck dissection of levels I, II, and III increased in popularity throughout the 1990s and 2000s with multiple retrospective publishing their results [26, 25].

Sparano et al., in evaluating risk factors for occult metastasis, further described a lack of level IV or V metastases in their series. This further validated the use of supraomohyoid neck dissection [41]. However, in an evaluation of 277 patients with squamous cell carcinoma of the oral tongue, Byers et al. detail a 15.8% rate of level III and level IV metastases without evidence of metastases in levels I or II. These types of regional metastases were described as "skip metastases" [57]. Many surgeons choose to perform a selective neck dissection of levels I–IV in order to identify these "skip metastases" in the elective setting.

The question of whether IIB should be dissected is an additional controversy in the elective setting. While IIB is considered to be at high risk in oropharynx cancer, the rate of occult metastasis to this region is less defined in oral cavity cancer. Lim et al. describe a 5% rate of involvement of level IIB and no instances of isolated IIB metastases in a series of 74 patients [58]. Maher et al. describe a rate of 5.6%, while Villaret et al. demonstrated a rate of 10% [59, 60]. In order to perform a level IIB dissection, the spinal accessory nerve must be skeletonized. When the spinal accessory nerve runs posterior to the internal jugular vein, additional manipulation of the nerve is required to dissect the lymphatic packet free of its surrounding structures. Significant shoulder dysfunction may occur with dissection of the spinal accessory nerve, and manipulation should be kept to a minimum [61]. In the setting of an elective neck dissection for oral cavity squamous cell carcinoma, our practice is to perform a level I, IIA, and III neck dissection. If firm, rounded nodes are noted during the dissection which were not clinically or radiographically noted preoperatively, then levels IIB and IV are dissected as well.

In an elective neck dissection, it is important to perform a surgery which is thorough enough that it reflects an adequate sampling of lymph nodes within the neck. "Nodal yield" or the number of nodes removed during a neck dissection is an objective measure indicating whether a representative number of nodes were removed during a selective neck dissection. Ebrahimi et al. have shown that nodal yields of less than 18 lymph nodes result in decreased disease-specific survival and decreased disease-free survival [62].

As selective and super selective neck dissections have evolved from the traditional radical neck dissection, recent studies have evaluated the role of sentinel lymph node biopsy in the staging of oral cavity cancer. Civantos et al., in a prospective multi-institutional study, evaluated 43 patients with oral cavity squamous cell carcinoma with sentinel lymph node biopsy and showed a predictive value of 92% with upstaging from N0 to N+ disease in 16% of cases [63]. Additional research has shown a 94% sensitivity and 96% negative predictive value for SLNB in oral cavity SCC [64].

24.4.3 Neck Dissection for Non-Squamous Cell Carcinoma Pathology

Although the majority of this text has focused on squamous cell carcinoma, salivary gland malignancies may also be encountered. These malignancies arise from the submandibular gland, sublingual gland, and minor salivary glands of the oral cavity. In the setting of clinically evident regional meta-

static disease, salivary gland cancers should be managed by therapeutic neck dissection.

In patients who do not have clinically evident regionally metastatic disease, the risk of occult metastasis is based upon the pathology, histologic grade, and tumor stage of the malignant lesion. Occult metastases are most commonly seen in mucoepidermoid carcinoma and adenocarcinoma of the salivary glands. High-grade tumors result in occult metastatic rates greater than 20% and thus warrant an elective neck dissection. Low-grade tumors have a 0–10% rate of metastasis, while intermediate-grade tumors may approach but have not been shown to exceed a rate of 20%. Tumor size greater than 4 cm is also predictive of occult metastatic disease [65, 66]. Adenoid cystic carcinoma and acinic cell carcinomas demonstrate a low propensity to regionally metastasize to the neck. For salivary gland malignancies of the oral cavity, we recommend elective neck dissection of levels I, II, and III for high-grade tumors of any T-stage and tumors greater than 4 cm in size. For intermediate-grade mucoepidermoid carcinomas and adenocarcinomas, the risk of occult disease should be discussed with the patient, and elective neck dissection versus close observation is offered depending upon patient preference.

24.5 Indications for Neck Dissection in Oropharynx Cancer

Therapeutic neck dissection for node-positive oropharyngeal squamous cell carcinoma is necessary when surgery is utilized in the treatment of the primary tumor. In contrast to oral cavity squamous cell carcinoma, where surgery is the primary modality of treatment, oropharyngeal squamous cell carcinoma may be treated with surgical excision or nonsurgical treatment using primary radiation or chemoradiation. Radiation and chemoradiation were increasingly used in the late twentieth century for oropharyngeal cancers. The development of endoscopic techniques in the early twenty-first century, including transoral laser microsurgery (TLM) and transoral robotic surgery (TORS), has resulted in a paradigm shift with surgery taking an increasingly prominent role [67]. An increase in the prevalence of oropharyngeal squamous cell carcinoma has been noted and is associated with the human papilloma virus (HPV) [68]. These HPV-positive tumors often present with cervical lymphadenopathy, a small primary tumor, and are associated improved survival [69].

When a therapeutic neck dissection is to be performed for oropharyngeal squamous cell carcinoma, the primary goals of surgery are to excise lymphatic tissue which may be harboring metastases and to appropriately stage the patient's neck pathologically. Early retrospective studies of radical neck dissection demonstrated levels II, III, and IV as the nodal basins at greatest risk for metastasis from an oropharyngeal primary [15, 14, 70]. Additional studies showed excellent regional control for selective neck dissection [13, 26, 25]. A selective neck dissection of levels II, III, and IV may be referred to as a "lateral neck dissection" or "anterolateral neck dissection." Controversies have emerged in the past regarding the management of levels I and IV in oropharyngeal cancer. Some proponents of supraomohyoid neck dissection have noted a higher rate of metastasis to level I as compared to level IV [46, 71]. Others have noted a much higher rate of metastasis to level IV [72, 73]. Recent research has shown that although level I involvement may occur at a low rate of 5% when there is regional metastasis to levels II and III, isolated level I metastases do not occur [74]. We recommend a selective neck dissection of levels IIA, IIB, III, and IV in patients requiring therapeutic neck dissection for oropharyngeal squamous cell carcinoma. Levels I and V may be included if there is preoperative or intraoperative concern.

As there is a high propensity for regional metastasis in early-stage oropharyngeal squamous cell carcinoma, an ipsilateral elective neck dissection should be performed for any oropharynx cancer which is being treated with surgical resection. In the event that the ipsilateral neck is staged as a pathologic N0 after neck dissection, the patient must be advised regarding the risk of occult contralateral neck metastases in oropharyngeal cancers which are not well-lateralized [75]. This risk approaches 10%. If a patient undergoes single modality treatment and will avoid adjuvant radiation of the neck, a contralateral neck dissection may be offered to confirm that the patient does not have N2c disease.

24.6 Structures to be Resected/Preserved

24.6.1 Submental Triangle (Level IA)

The removal of lymphatics from the submental triangle or level IA requires adequate exposure, identification of the lateral and deep boundaries of the fibrofatty packet, and identification of the superior and inferior boundaries consisting of the inferior border of the mandible and the hyoid bone, respectively. A subplatysmal flap should be elevated until the contralateral anterior belly of the digastric, the hyoid bone, and the inferior border of the mandible along the digastric fossa can all be palpated. Care must be taken while elevating the subplatysmal flap as the platysma is often dehiscent in the midline, and superficial dissection may result in a buttonhole in the skin flap. The fascia is then incised along the fibrofatty packet at the level of the contralateral digastric, the hyoid inferiorly, the digastric fossae along the inferior inner table of the mandible, and the ipsilateral digastric. The deep plane of the packet is then elevated off of the mylohyoid in the midline and the anterior bellies of the digastric muscles laterally. There are no significant neurovascular structures within the submental space during this dissection. Branches of the anterior jugular vein as well as neurovascular branches of the mylohyoid may be ligated or cauterized as they are encountered.

Care should be taken to remove the lymphatics at the anterosuperior most aspect of level IA. This region can be inadequately exposed and subsequently incompletely dissected and may be a site of regional recurrence for oral cavity cancers.

24.6.2 Submandibular Triangle (Level IB)

In the dissection of the submandibular triangle or level IB, it is important to identify and preserve the lingual nerve, hypoglossal nerve, and marginal mandibular nerve. The identification and subsequent sacrifice or preservation of the facial artery and facial vein is also necessary during dissection level IB.

The elevation of a subplatysmal flap above the inferior border of the mandible is performed for adequate exposure of IB. The incision should be located at least two finger breadths below the inferior border of the mandible to avoid transection of the marginal mandibular nerve during flap elevation. Additionally, the subplatysmal flap must be immediately along the deep fascia of the platysma to ensure that the marginal mandibular nerve is not inadvertently injured.

To protect the marginal mandibular nerve, the authors recommend the elevation of a "marginal mandibular nerve flap" consisting of the fascia overlying the capsule of the submandibular gland. This flap is incised in a transverse plane at the inferior border of the submandibular gland and extends from the sternocleidomastoid muscle posteriorly to the anterior belly of the digastric anteriorly. This flap is then elevated to the inferior border of the mandible and allows for exposure of the facial vein. Once elevated, this flap reflects the marginal mandibular nerve while exposing the lymph nodes and fibrofatty tissue surrounding the submandibular gland, facial artery, and facial vein.

With the marginal mandibular branch of the facial nerve protected, dissection of the level IB can then proceed. The fascia along the anterior belly, tendon, and posterior belly of the digastric muscle is incised to release the lymphatics of level IB. When skeletonizing the posterior belly of the digastric muscle, the common facial vein can be found coursing over the digastric muscle and may be preserved or ligated. The packet is then skeletonized along the inferior border of the mandible, identifying the distal facial artery and facial vein which can be ligated or preserved.

With its superficial attachments released, dissection can then proceed in a deep plane along the mylohyoid from medial to lateral. Neurovascular branches to the mylohyoid can then be ligated until the lateral margin of the mylohyoid is identified. The mylohyoid is then retracted, and the lingual nerve, submandibular ganglion, and submandibular duct are identified. The submandibular duct and submandibular ganglion are ligated with preservation of the lingual nerve. Level IB including the submandibular gland can then be bluntly dissected away from the posterior belly of the digastric, as well as the hyoglossus, and genioglossus muscles until the proximal facial artery is identified as it courses from the external carotid artery, deep to the posterior belly of the digastric muscle, and penetrates the substance of the submandibular gland. The facial artery can then be ligated with removal of level IB, or it can be preserved by tracing its course through the substance of the submandibular gland, ligating approximately four to five perforating branches (Fig. 24.2).

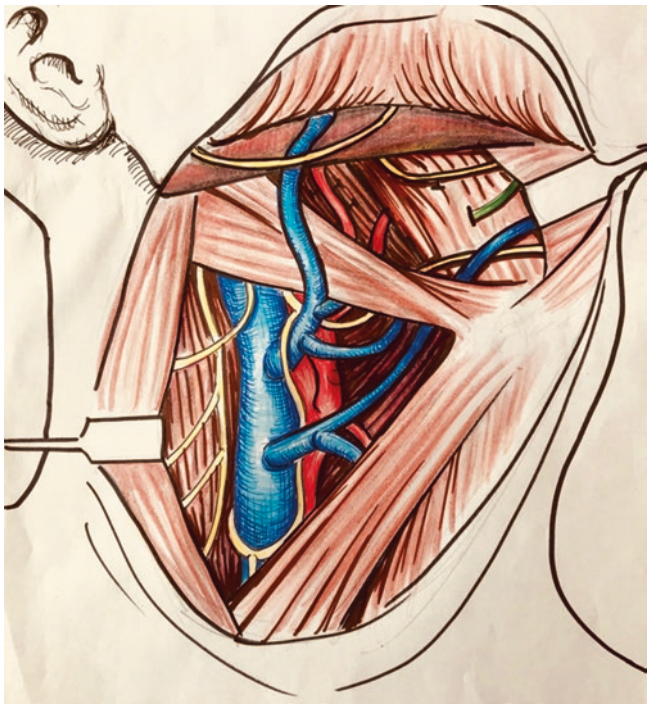

Fig. 24.2 Selective neck dissection (levels I–III) intraoperative drawing demonstrating removal of lymphatics with preservation of relevant neurovascular structures

24.6.3 Jugulodigastric Chain

The dissection of the lymphatics along the jugulodigastric chain is important in the treatment of both oral cavity and oropharynx cancers. While the upper, mid-, and lower jugular chain nodes (levels II, III, and IV) have distinct boundaries, they are often dissected as a single lymphatic packet and divided after removal from the neck.

In order to obtain adequate exposure, subplatysmal flaps should be elevated above the inferior border of the submandibular gland superiorly and along the anterior border of the sternocleidomastoid (SCM) from the mastoid tip to the clavicle inferiorly. The omohyoid should be identified anteriorly, and the external jugular vein and greater auricular nerve can be identified and preserved overlying the SCM posteriorly.

While the superior limit of level II is the skull base, the first step in defining this level is identification of the posterior belly of the digastric muscle. If a level IB dissection has been performed, the posterior belly of the digastric muscle will have already been skeletonized. If a level I dissection will not be performed, as in the setting of an elective neck dissection for oropharyngeal cancer, then the digastric is found by incising along the inferior border of the submandibular gland and retracting the gland superiorly until the posterior belly of the digastric muscle is identified.

With the fascia incised superiorly, the posterior aspect of the lymphatic packet can be dissected by incising the fascia along the anterior border of the SCM and then unwrapping the fascia along the entire length of its anterior and deep surface until the lymphatic packet is freed from the SCM poste-

riorly. During this dissection, the tendon of the SCM can be identified as it courses toward the mastoid tip. The spinal accessory nerve will be found just deep to this tendon, traveling from the skull base and piercing the muscle as it courses toward the trapezius in the posterior triangle. This nerve should be identified and preserved whenever possible in the setting of a selective or modified radical neck dissection. The posterior belly of the digastric muscle can then be retracted superiorly, and the jugular vein, hypoglossal nerve, and spinal accessory nerve can then be skeletonized. The floor of the neck is then identified consisting of the levator scapulae and splenius capitis in this region. The lymphatics of level IIB superior to the spinal accessory nerve and IIA inferior to the spinal accessory nerve can then be dissected inferiorly until level III is encountered.

With the SCM unwrapped along its length and level II dissected, level III can be dissected free of the sensory branches of the cervical plexus, the floor of the neck, and the internal jugular vein. The fascia overlying the splenius capitis, levator scapulae, and the scalene muscles should remain intact, thus allowing for preservation of the phrenic nerve and the brachial plexus. Dissection of the lymph node packet proceeds inferiorly until the omohyoid muscle is encountered crossing superficial to the internal jugular vein as it courses inferolaterally toward the scapula. If a selective neck dissection of levels I, II, and III (a supraomohyoid neck dissection) is being performed, then the lymphatic packet can be truncated inferiorly. If a level IV dissection is to be performed, then dissection proceeds inferiorly.

To complete the level IV neck dissection, the omohyoid muscle is retracted inferiorly. The investing fascia of the lymphatics is incised immediately above the level of the clavicle, and the lymphatic packet is bluntly retracted superiorly, exposing the transverse cervical artery and vein. During dissection along the internal jugular vein, care must be taken to avoid injury to the thoracic duct on the left side. On the right side, there are substantial unnamed lymphatic vessels, and care should be taken to avoid any injury to these vessels as well. Injury to the dilated lymphatic channels in level IV may result in a postoperative chyle leak and is associated with perioperative morbidity.

Once the jugulodigastric lymphatic packet has been dissected free of the attachments described above, it must be freed from the carotid sheath and jugular vein. The carotid artery, vagus nerve, and jugular vein are identified and preserved in a selective neck dissection. The ansa cervicalis and ansa hypoglossi branch of the hypoglossal nerve will be seen running along the jugular vein and may be preserved or ligated. In a radical or modified radical neck dissection, the internal jugular vein may be ligated inferiorly and superiorly and left in continuity with the cervical lymphatics.

After the nodal packet has been freed from the carotid sheath, the remaining attachments to the common facial vein and superior thyroid artery and vein are dissected. The specimen is then divided into its respective levels for pathologic diagnosis (Fig. 24.3).

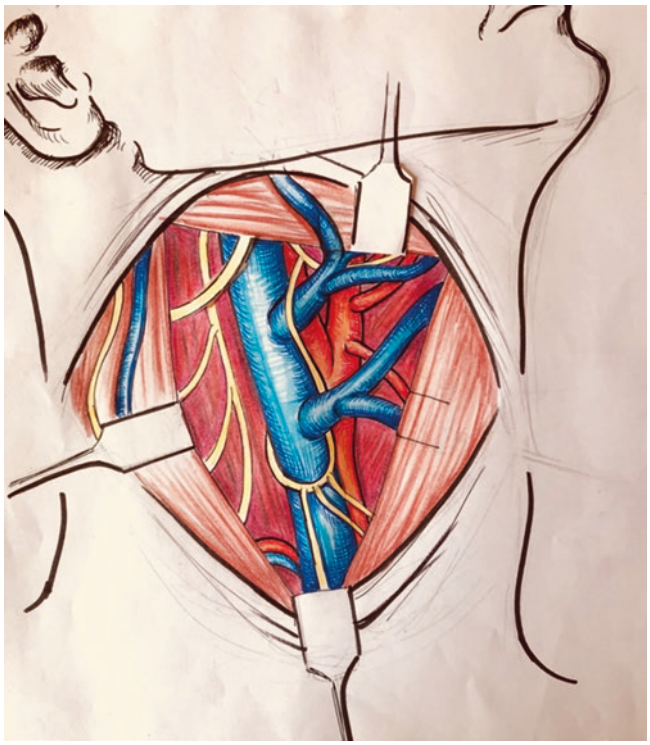

Fig. 24.3 Selective neck dissection (levels II–IV) intraoperative drawing demonstrating removal of lymphatics with preservation of relevant neurovascular structures

24.6.4 Posterior Triangle

The dissection of the posterior triangle is necessary when performing radical neck dissection, modified radical neck dissection, or salvage neck dissections if recurrence is noted within level Va or Vb. To obtain adequate exposure to the posterior triangle, the incision can be extended posteriorly, or an additional inferior limb can be added to the standard neck incision. The posterior border of the sternocleidomastoid should be skeletonized from the clavicle to the mastoid tip. The spinal accessory nerve can be traced from level IIA/IIB posteriorly to the SCM until it is seen exiting the posterior margin of the SCM as it courses deep to the trapezius muscle. If the jugulodigastric chain has not been dissected, the nerve can be found along posterior margin of the SCM with careful dissection as it courses deep to the trapezius muscle. The anterior margin of the trapezius is then identified superiorly and is traced inferiorly toward the acromioclavicular joint.

Dissection then proceeds to the floor of the neck along the posterior margin of the sternocleidomastoid muscle, taking care to preserve or ligate the external jugular vein as necessary. The omohyoid can be identified coursing posteroinferiorly toward the scapula dividing level V into the occipital triangle, or level Va, superiorly, and the supraclavicular triangle, or level Vb, inferiorly. The lymphatic packet is then dissected away from the floor of the neck. The cervical sensory rootlets may need to be sacrificed at this point if the specimen is to be removed en bloc.

Superiorly, the levator scapulae and splenius capitus are skeletonized as the deep plane of dissection. As dissection proceeds inferiorly, the scalene muscles are encountered. Care must be taken to avoid the phrenic nerve which courses inferomedially and the brachial plexus which courses inferolaterally along the surface of these muscles. Within the supraclavicular triangle, the transverse cervical vessels will be encountered and may be preserved or ligated as necessary.

24.6.5 Transcervical Approaches to the Oral Cavity and Oropharynx

A transcervical approach to the oral cavity or oropharynx may be required for the extirpation of large, deeply invasive tumors. The exposure provided by varying transcervical approaches allows for excellent visualization. These approaches also provide the access needed to make well-defined cuts around the tumor, thus ensuring negative margins. Lastly, the transcervical approach allows for the identification and preservation of important neurovascular structures which may not be readily identifiable when approaching a tumor transorally.

A level I dissection is necessary to provide exposure during the resection of oral cavity tumors which will result in a through-and-through defect into the neck. The submandibular and submental triangles may also be intimately associated with the primary tumor requiring an en bloc resection. Level I dissection exposes the inferior border and lateral surface of the mandible, thus providing access for a mandibulectomy. A lip-split and mandibulotomy can be combined with the neck dissection to provide wide exposure of oral cavity and oropharynx tumors. Release of the periosteum from the lingual surface of the mandible allows for a pull-through approach where the tongue and floor of the mouth are delivered into the neck. This provides excellent exposure of the posterior oral tongue, base of the tongue, and pharynx without requiring a mandibulotomy.

Level IA, IB, and IIA dissection results in exposure of the suprahyoid musculature and pharyngeal constrictors. With exposure of these muscle groups, a suprahyoid pharyngotomy or a lateral pharyngotomy may be utilized to access the oropharynx.

In the setting of large oral cavity lesions where a portion of the oral tongue can be spared, it is our practice to identify the hypoglossal nerve and lingual artery on the side of the neck where the tongue will be preserved. The hypoglossal nerve is found proximally and traced distally as it courses superficially to the hyoglossus muscle. The lingual artery is then identified branching from the external carotid artery and traced deep to the hyoglossus muscle. Attention can then return to resection of the primary tumor.

24.7 Conclusions

Neck dissection has evolved from a radical resection to a more conservative operation targeting the cervical lymphatics while sparing surrounding structures.

In oral cavity squamous cell carcinomas, elective neck dissection is required for advanced tumor stages for each subsite. In early-stage tumors, depth of invasion of greater than 2 mm for floor of the mouth lesions and 4 mm for oral tongue lesions is associated with high levels of occult neck disease. High-grade salivary gland malignancies warrant elective neck dissection. Selective neck dissection of levels IA, IB, IIA, and III should be performed in the elective setting. Level IV should be included for oral tongue squamous cell carcinomas due to the risk of skip metastases.

In oropharyngeal squamous cell carcinomas, a selective neck dissection of levels IIA, IIB, III, and IV should be performed in the elective setting.

Neck dissection allows for multiple transcervical approaches to oral cavity and oropharynx, providing increased exposure. Important muscles and neurovascular structures can be identified during neck dissection which facilitates a safer and more efficient transoral resection.

References

1. Lydiatt WM, Patel SG, O'Sullivan B, et al. Head and neck cancers-major changes in the American Joint Committee on cancer eighth edition cancer staging manual. - PubMed - NCBI. CA Cancer J Clin. 2017;67(2):122–37.
2. Robbins KT, Clayman G, Levine PA, et al. Neck dissection classification update: revisions proposed by the American Head and Neck Society and the American Academy of Otolaryngology–Head and Neck Surgery. Arch Otolaryngol Head Neck Surg. 2002;128(7):751–8. https://doi.org/10.1001/archotol.128.7.751.
3. Ferlito A, Johnson JT, Rinaldo A, et al. European surgeons were the first to perform neck dissection. - PubMed - NCBI. Laryngoscope. 2007;117(5):797–802. https://doi.org/10.1097/MLG.0b013e3180325b59.
4. Jawdynski F. Przypadek raka pierwotnego syzi. T.z. raka skrzelowego volkmann'a. Wyciecie nowotworu wraz z rezekcyja tetnicy szjowej wspolnej i zyly szyjowej wewnetrznej. Wyzdrowieneie. Gaz Lek. 1888;28:530–55.
5. Crile G. Excision of cancer of the head and neck. With special reference to the plan of dissection based on one hundred and thirty-two operations. JAMA. 1906;47:1780–6.
6. Martin H. Neck dissection. Cancer. 1951;4(3):441–99.
7. Bocca E, Pignataro O. A conservation technique in radical neck dissection. Ann Otol Rhinol Laryngol. 2016;76(5):975–87. https://doi.org/10.1177/000348946707600508.
8. Jesse RH, Ballantyne AJ, Larson D. Radical or modified neck dissection: a therapeutic dilemma. Am J Surg. 1978;136(4):516–9.
9. Chu W, Strawitz JG. Results in suprahyoid, modified radical, and standard radical neck dissections for metastatic squamous cell carcinoma: recurrence and survival. Am J Surg. 1978;136(4):512–5.
10. Shah JP, Strong E, Spiro RH, Vikram B. Surgical grand rounds. Neck dissection: current status and future possibilities. Clin Bull. 1981;11(1):25–33.
11. Lindberg R. Distribution of cervical lymph node metastases from squamous cell carcinoma of the upper respiratory and digestive tracts. Cancer. 1972;29(6):1446–9.

12. Skolnik EM, Yee KF, Friedman M, Golden TA. The posterior triangle in radical neck surgery. Arch Otolaryngol. 1976;102(1):1–4.
13. Byers RM. Modified neck dissection. A study of 967 cases from 1970 to 1980. Am J Surg. 1985;150(4):414–21.
14. Byers RM, Wolf PF, Ballantyne AJ. Rationale for elective modified neck dissection. Head Neck Surg. 1988;10(3):160–7.
15. Shah JP. Patterns of cervical lymph node metastasis from squamous carcinomas of the upper aerodigestive tract. Am J Surg. 1990;160(4):405–9.
16. Rouviere H. Lymphatic system of the head and neck. In: Rouvier H, editor. Anatomy of the human lymphatic system. 1st ed. Ann Arbor: Edwards Brothers, Inc.; 1938. p. 5–28.
17. Robbins KT, Medina JE, Wolf GT, Levine PA, Sessions RB, Pruet CW. Standardizing neck dissection terminology. Official report of the Academy's Committee for Head and Neck Surgery and Oncology. Arch Otolaryngol Head Neck Surg. 1991;117(6):601–5.
18. Robbins KT, Shaha AR, Medina JE, et al. Consensus statement on the classification and terminology of neck dissection. Arch Otolaryngol Head Neck Surg. 2008;134(5):536–8.
19. Kalnins IK, Leonard AG, Sako K, Razack MS, Shedd DP. Correlation between prognosis and degree of lymph node involvement in carcinoma of the oral cavity. Am J Surg. 1977;134(4):450–4.
20. Farr HW, Arthur K. Epidermoid carcinoma of the mouth and pharynx 1960-1964. J Laryngol Otol. 1972;86(3):243–53.
21. Medina JE, Byers RM. Supraomohyoid neck dissection: rationale, indications, and surgical technique. Head Neck. 1989;11(2):111.
22. Pelliteri PK, Robbins KT, Neuman T. Expanded application of selective neck dissection with regard to nodal status. Head Neck. 1997;19(4):260–5. https://doi.org/10.1002/(sici)1097-0347(199707)19:4<260::aid-hed3>3.0.co;2-z.
23. Leemans CR, Tiwari R, van der Waal I, Karim ABMF, Nauta JJP, Snow GB. The efficacy of comprehensive neck dissection with or without postoperative radiotherapy in nodal metastases of squamous cell carcinoma of the uppe... - PubMed - NCBI. Laryngoscope. 1990;100(11):1198. https://doi.org/10.1288/00005537-199011000-00012.
24. Johnson JT, Barnes EL, et al. The extracapsular spread of tumors in cervical node metastasis. Arch Otolaryngol. 1981;107(12):725–9.
25. Chepeha DB, Hoff PT, Taylor RJ, Bradford CR, Teknos TN, Esclamado RM. Selective neck dissection for the treatment of neck metastasis from squamous cell carcinoma of the head and neck. - PubMed - NCBI. Laryngoscope. 2002;112(3):434–8. https://doi.org/10.1097/00005537-200203000-00005.
26. Ambrosch P, Kron M, Pradier O, Steiner W. Efficacy of selective neck dissection: a review of 503 cases of elective and therapeutic treatment of the neck in squamous cell carcinoma of the upper aerodigestive tract. Otolaryngol Head Neck Surg. 2001;124(2):180–7. https://doi.org/10.1067/mhn.2001.111598.
27. Cooper JS, Pajak TF, Forastiere AA, et al. Postoperative concurrent radiotherapy and chemotherapy for high-risk squamous-cell carcinoma of the head and neck. N Engl J Med. 2004;350(19):1937–44. https://doi.org/10.1056/NEJMoa032646.
28. Bernier J, Domenge C, Ozsahin M, et al. Postoperative irradiation with or without concomitant chemotherapy for locally advanced head and neck cancer. N Engl J Med. 2004;350(19):1945–52. https://doi.org/10.1056/NEJMoa032641.
29. Moore O, Baker HW. Carotid-artery ligation in surgery of the head and neck. Cancer. 1955;8(4):712–26.
30. Biller HP, Urken M, Lawson W, Haimov M. Carotid artery resection and bypass for neck carcinoma. Laryngoscope. 1988;98(2):181–3. https://doi.org/10.1288/00005537-198802000-00012.
31. Mourad M, Saman M, Stroman D, Lee T, Ducic Y. Carotid artery sacrifice and reconstruction in the setting of advanced head and neck cancer. Otolaryngol Head Neck Surg. 2015;153(2):225–30. https://doi.org/10.1177/0194599815586719.
32. Vandenbrouck C, Sancho-Garnier H, Chassagne D, Saravane D, Cachin Y, Micheau C. Elective versus therapeutic radical neck dissection in epidermoid carcinoma of the oral cavity: results of a randomized clinical trial. Cancer. 1980;46(2):386–90.
33. Fakih AR, Rao RS, Borges AM, Patel AR. Elective versus therapeutic neck dissection in early carcinoma of the oral tongue. Am J Surg. 1989;158(4):309–13.
34. Yuen AP, Wei WI, Wong YM, Tang KC. Elective neck dissection versus observation in the treatment of early oral tongue carcinoma. Head Neck. 1997;19(7):583–8.
35. Ganly I, Patel S, Shah J. Early stage squamous cell cancer of the oral tongue--clinicopathologic features affecting outcome. Cancer. 2011;118(1):101–11. https://doi.org/10.1002/cncr.26229.
36. D'Cruz AK, Vaish R, Kapre N, et al. Elective versus therapeutic neck dissection in node-negative oral cancer. N Engl J Med. 2015;373(6):521–9. https://doi.org/10.1056/NEJMoa1506007.
37. Eicher SA, Overholt SM, el-Naggar AK, Byers RM, Weber RS. Lower gingival carcinoma. Clinical and pathologic determinants of regional metastases. Arch Otolaryngol Head Neck Surg. 1996;122(6):634–8.
38. Haddadin KJ, Soutar DS, Oliver RJ, Webster MH, Robertson AG. Improved survival for patients with clinically T1/T2, N0 tongue tumors undergoing a prophylactic neck dissection. Head Neck. 1999;21(6):517–25. https://doi.org/10.1002/(sici)1097-0347(199909)21:6<517::aid-hed4>3.0.co;2-c.
39. Wallner PE, Hanks GE, Kramer S, McLean CJ. Patterns of care study. Analysis of outcome survey data-anterior two-thirds of tongue and floor of mouth. Am J Clin Oncol. 1986;9(1):50–7.
40. Shaha AR, Spiro RH, Shah JP, Strong EW. Squamous carcinoma of the floor of the mouth. Am J Surg. 1984;148(4):455–9.
41. Sparano A, Weinstein G, Chalian A, Yodul M, Weber R. Multivariate predictors of occult neck metastasis in early oral tongue cancer. Otolaryngol Head Neck Surg. 2004;131(4):472–6. https://doi.org/10.1016/j.otohns.2004.04.008.
42. Jing J, Li L, He W, Sun G. Prognostic predictors of squamous cell carcinoma of the buccal mucosa with negative surgical margins. - PubMed - NCBI. J Oral Maxillofac Surg. 2006;64(6):896–901. https://doi.org/10.1016/j.joms.2006.02.007.
43. Montes DM, Schmidt BL. Oral maxillary squamous cell carcinoma: management of the clinically negative neck. - PubMed - NCBI. J Oral Maxillofac Surg. 2008;66(4):762–6. https://doi.org/10.1016/j.joms.2007.12.017.
44. Zitsch R 3rd, Lee BW, Smith RB. Cervical lymph node metastases and squamous cell carcinoma of the lip. Head Neck. 1999;21(5):447–53.
45. Dirven R, Ebrahimi A, Moeckelmann N, Palme CE, Gupta R, Clark J. Tumor thickness versus depth of invasion - analysis of the 8th edition American Joint Committee on cancer staging for oral cancer. - PubMed - NCBI. Oral Oncol. 2017;74:30–3. https://doi.org/10.1016/j.oraloncology.2017.09.007.
46. Spiro RH, Huvos AG, Wong GY, Spiro JD, Gnecco CA, Strong EW. Predictive value of tumor thickness in squamous carcinoma confined to the tongue and floor of the mouth. Am J Surg. 1986;152(4):345–50.
47. Fukano H, Matsuura H, Hasegawa Y, Nakamura S. Depth of invasion as a predictive factor for cervical lymph node metastasis in tongue carcinoma. Head Neck. 1997;19(3):205–10.
48. Melchers LJ, Schuuring E, van Dijk BAC, et al. Tumour infiltration depth ≥4 mm is an indication for an elective neck dissection in pT1cN0 oral squamous cell carcinoma. - PubMed - NCBI. Oral Oncol. 2012;48(4):337–42. https://doi.org/10.1016/j.oraloncology.2011.11.007.
49. McGuirt WJ, Johnson JT, Myers EN, Rothfield R, Wagner R. Floor of mouth carcinoma. The management of the clinically negative neck. Arch Otolaryngol Head Neck Surg. 1995;121(3):278–82.
50. Balasubramanian D, Ebrahimi A, Gupta R, et al. Tumour thickness as a predictor of nodal metastases in oral cancer: comparison between tongue and floor of mouth subsites. - PubMed - NCBI. Oral Oncol. 2014;50(12):1165–8. https://doi.org/10.1016/j.oraloncology.2014.09.012.

51. Lin HW, Bhattacharyya N. Survival impact of nodal disease in hard palate and maxillary alveolus cancer. - PubMed - NCBI. Laryngoscope. 2009;119(2):312–5. https://doi.org/10.1002/lary.20054.
52. Eskander A, Givi B, Gullane PJ, et al. Outcome predictors in squamous cell carcinoma of the maxillary alveolus and hard palate. - PubMed - NCBI. Laryngoscope. 2013;82(10):n/a–n/a. https://doi.org/10.1002/lary.24079.
53. Givi B, Eskander A, Awad MI, et al. Impact of elective neck dissection on the outcome of oral squamous cell carcinomas arising in the maxillary alveolus and hard palate. Head Neck. 2015;38(S1):E1688–94. https://doi.org/10.1002/hed.24302.
54. Simental AA Jr, Johnson JT, Myers EN. Cervical metastasis from squamous cell carcinoma of the maxillary alveolus and hard palate. - PubMed - NCBI. Laryngoscope. 2006;116(9):1682–4. https://doi.org/10.1097/01.mlg.0000233607.41540.28.
55. Morris LGT, Patel SG, Shah JP, Ganly I. High rates of regional failure in squamous cell carcinoma of the hard palate and maxillary alveolus. - PubMed - NCBI. Head Neck. 2010;33(6):824–30. https://doi.org/10.1002/hed.21547.
56. Diaz EM, Holsinger FC, Zuniga ER, Roberts DB, Sorensen DM. Squamous cell carcinoma of the buccal mucosa: one institution's experience with 119 previously untreated patients. Head Neck. 2003;25(4):267–73. https://doi.org/10.1002/hed.10221.
57. Byers RM, Weber RS, Andrews T, McGill D, Kare R, Wolf P. Frequency and therapeutic implications of "skip metastases" in the neck from squamous carcinoma of the oral tongue. Head Neck. 1997;19(1):14–9.
58. Lim YC, Song MH, Kim SC, Kim KM, Choi EC. Preserving level IIb lymph nodes in elective supraomohyoid neck dissection for oral cavity squamous cell carcinoma. Arch Otolaryngol Head Neck Surg. 2004;130(9):1088–91. https://doi.org/10.1001/archotol.130.9.1088.
59. Maher NG, Hoffman GR. Elective neck dissection for primary oral cavity squamous cell carcinoma involving the tongue should include sublevel IIb. J Oral Maxillofac Surg. 2014;72(11):2333–43. https://doi.org/10.1016/j.joms.2014.05.022.
60. Villaret AB, Piazza C, Peretti G, et al. Multicentric prospective study on the prevalence of sublevel IIb metastases in head and neck cancer. Arch Otolaryngol Head Neck Surg. 2007;133(9):897. https://doi.org/10.1001/archotol.133.9.897.
61. Kuntz AL, Weymuller EA Jr. Impact of neck dissection on quality of life. Laryngoscope. 1999;109(8):1334–8. https://doi.org/10.1097/00005537-199908000-00030.
62. Ebrahimi A, Zhang WJ, Gao K, Clark JR. Nodal yield and survival in oral squamous cancer: defining the standard of care. Cancer. 2011;117(13):2917–25. https://doi.org/10.1002/cncr.25834.
63. Civantos FJ, Zitsch RP, Schuller DE, et al. Sentinel lymph node biopsy accurately stages the regional lymph nodes for T1-T2 oral squamous cell carcinomas: results of a prospective multi-institutional trial. J Clin Oncol. 2010;28(8):1395–400. https://doi.org/10.1200/JCO.2008.20.8777.
64. Thompson CF, St John MA, Lawson G, Grogan T, Elashoff D, Mendelsohn AH. Diagnostic value of sentinel lymph node biopsy in head and neck cancer: a meta-analysis. Eur Arch Otorhinolaryngol. 2012;270(7):2115–22. https://doi.org/10.1007/s00405-012-2320-0.
65. Armstrong JG, Harrison LB, Thaler HT, Friedlander-Klar H, Fass DE, Zelefsky MJ, Shah JP, Strong EW, Spiro RH. The indications for elective treatment of the neck in cancer of the major salivary glands. Cancer. 1992;69(3):615–9.
66. Lau VH, Aouad R, Farwell DG, Donald PJ, Chen AM. Patterns of nodal involvement for clinically N0 salivary gland carcinoma: refining the role of elective neck irradiation. Head Neck. 2014;67:n/a–n/a. https://doi.org/10.1002/hed.23467.
67. Cracchiolo JR, Baxi SS, Morris LG, et al. Increase in primary surgical treatment of T1 and T2 oropharyngeal squamous cell carcinoma and rates of adverse pathologic features: National Cancer Data Base. Cancer. 2016;122(10):1523–32. https://doi.org/10.1002/cncr.29938.
68. Chaturvedi AK, Engels EA, Pfeiffer RM, et al. Human papillomavirus and rising oropharyngeal cancer incidence in the United States. JCO. 2011;29(32):4294–301. https://doi.org/10.1200/JCO.2011.36.4596.
69. Ang KK, Harris J, Wheeler R, et al. Human papillomavirus and survival of patients with oropharyngeal cancer. N Engl J Med. 2010;363(1):24–35. https://doi.org/10.1056/NEJMoa0912217.
70. Candela FC, Kothari K, Shah JP. Patterns of cervical node metastases from squamous carcinoma of the oropharynx and hypopharynx. Head Neck. 1990;12(3):197–203.
71. Vartanian JG, Pontes E, Agra IMG, et al. Distribution of metastatic lymph nodes in oropharyngeal carcinoma and its implications for the elective treatment of the neck. Arch Otolaryngol Head Neck Surg. 2003;129(7):729–32. https://doi.org/10.1001/archotol.129.7.729.
72. Jose J, Coatesworth AP, Johnston C, MacLennan K. Cervical node metastases in oropharyngeal squamous cell carcinoma: prospective analysis of prevalence and distribution. J Laryngol Otol. 2006;116(11):925–8. https://doi.org/10.1258/00222150260369471.
73. Lim YC, Koo BS, Lee JS, Lim J-Y, Choi EC. Distributions of cervical lymph node metastases in oropharyngeal carcinoma: therapeutic implications for the N0 neck. Laryngoscope. 2006;116(7):1148–52. https://doi.org/10.1097/01.mlg.0000217543.40027.1d.
74. Rassekh CH, O'Malley BW Jr, Bewley AF, Montone KT, Livolsi VA, Weinstein GS. Feasibility and relevance of level I substation node counts in oropharyngeal carcinoma. Head Neck. 2016;38(8):1194–200. https://doi.org/10.1002/hed.24356.
75. Capote-Moreno A, Naval L, Muñoz-Guerra MF, Sastre J, Rodríguez-Campo FJ. Prognostic factors influencing contralateral neck lymph node metastases in oral and oropharyngeal carcinoma. J Oral Maxillofac Surg. 2010;68(2):268–75.