This article discusses the classification, rationale, and future directions pertaining to neck dissections in the management of cancers of the head and neck. Most head and neck cancers arise from the squamous epithelium of the upper aerodigestive tract. In this article, the term “head and neck cancer” refers to squamous cell carcinoma (SCC) of the upper aerodigestive tract.

The development of lymph node metastasis is a critical factor in guiding the treatment and determining the prognosis of individuals diagnosed with head and neck carcinoma. The presence of lymphatic metastases is associated with a decrease in the survival rate of up to 50% of patients [1,2]. Radical neck dissection (RND), first described by Crile [3] in 1906, and popularized by Martin et al [4], has remained the cornerstone of the surgical treatment of cervical lymph node metastasis throughout most of the 20th century. The classic RND requires en bloc resection of the cervical lymph nodes, internal jugular vein, sternocleidomastoid muscle (SCM), and spinal accessory nerve. This operative procedure has significant long-term morbidity, including shoulder dysfunction, cosmetic deformity, cutaneous paresthesia, and chronic neck and shoulder pain syndrome. These morbidities are exacerbated when postoperative radiotherapy is added. For these reasons, and because of a lack of rationale for removing all cervical lymph
nodes, a change in the surgical approach to managing cervical metastasis was initiated by Suarez [5] in the late 1950s. In anatomic studies, Suarez demonstrated that cervical lymphatics are contained within well-defined fascial compartments, separate from muscles, nerves, blood vessels, and other visceral structures of the neck. Thus, he proposed that muscles, blood vessels, and nerves that were routinely removed during an RND could be preserved without compromising regional disease control in patients who had limited neck disease. Bocca et al [6] subsequently popularized this “functional neck dissection” concept, or neck dissection with the preservation of vital structures. The development of a better understanding of lymph node drainage patterns [7,8], the discovery of fascial compartments separating cervical lymph nodes from neck structures commonly removed in RND, and an improved understanding of the role of adjuvant radiation therapy [9,10] have been the impetus for the development of current modifications of the RND.

In response to a need for an organized approach for describing and classifying neck dissection, the Committee for Head and Neck Surgery and Oncology of the American Academy of Otolaryngology/Head and Neck Surgery standardized neck dissection terminology in 1991 [11], and a more recent update was published in 2002 [12]. Neck dissection classification categories are shown in Box 1.

In the current classification schema, the location of cervical lymph node groups is delineated by the level system [11]. This system is easy to remember and has become widely accepted (Fig. 1).

Recently, the concept of neck sublevels has been introduced into the classification schema, because areas have been identified within the six neck levels that seem to have independent oncologic significance [12]. These sublevels include level IA (submental nodes), level IB (submandibular nodes), levels IIA and B (upper jugular nodes), level VA (spinal accessory nodes), and level VB (supraclavicular nodes). The lymph node groups contained in these levels and the anatomic boundaries of the six neck levels are shown in Table 1. Lymph node groups not located within these regions should be referred to by their specific nodal group name. Examples include retropharyngeal, periparotid, and suboccipital nodal groups.

The structures defining the anatomic boundaries of the neck levels and sublevels are depicted in Fig. 2. Most of these anatomic boundaries are

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**Box 1. Neck dissection classification**

- Radical neck dissection
- Modified radical neck dissection
- Selective neck dissection
- Extended neck dissection
familiar and well-defined anatomic structures, with few exceptions. The posterior boundary of levels II through IV is delineated by the posterior border of the SCM or by the sensory branches of the cervical plexus. These cervical plexus sensory nerve branches also define the anterior boundary of level V. The anterior border of level IIA is defined by the stylohyoid muscle (see Table 1).

**Imaging-based classification of cervical lymph node groups**

Imaging studies were not used in the initial neck dissection classification scheme in 1991 [11].

Radiologists therefore have recently identified landmarks that accurately define the location of lymph nodes and have devised an imaging-based classification scheme for the cervical lymph node groups [13]. This radiologic classification was designed as an adjunct to the clinically based nodal classifications. Using imaging landmarks, level IA includes the lymph nodes that are located between the medial margin of the anterior belly of the digastric muscles, superior to the body of the hyoid bone, and below the mylohyoid muscle. Level IB includes nodes that also lie below the
<table>
<thead>
<tr>
<th>Level</th>
<th>Superior</th>
<th>Inferior</th>
<th>Medial (anterior)</th>
<th>Lateral (posterior)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Mandibular symphysis</td>
<td>Hyoid bone body</td>
<td>Contralateral digastric muscle, anterior belly</td>
<td>Ipsilateral digastric muscle, anterior belly</td>
</tr>
<tr>
<td>IB</td>
<td>Mandibular body</td>
<td>Posterior belly of digastric muscle</td>
<td>Anterior belly of digastric muscle</td>
<td>Stylohyoid muscle</td>
</tr>
<tr>
<td>IIA</td>
<td>Base of skull</td>
<td>Plane (horizontal) defined by inferior border of hyoid bone</td>
<td>Stylohyoid muscle</td>
<td>Plane (vertical) defined by spinal accessory nerve</td>
</tr>
<tr>
<td>IIIB</td>
<td>Base of skull</td>
<td>Plane (horizontal) defined by inferior border of hyoid bone</td>
<td>Plane (vertical) defined by spinal accessory nerve</td>
<td>Sternocleidomastoid muscle, lateral border</td>
</tr>
<tr>
<td>III</td>
<td>Plane (horizontal) defined by inferior border of body of hyoid</td>
<td>Plane (horizontal) defined by inferior border of cricoid cartilage</td>
<td>Sternohyoid muscle, lateral border</td>
<td>Sternocleidomastoid muscle, lateral border, or cervical plexus sensory branches</td>
</tr>
<tr>
<td>IV</td>
<td>Plane (horizontal) defined by inferior border of cricoid cartilage</td>
<td>Clavicle</td>
<td>Sternohyoid muscle, lateral border</td>
<td>Sternocleidomastoid muscle, lateral border, or cervical plexus sensory branches</td>
</tr>
<tr>
<td>VA</td>
<td>Apex of the point of convergence of the trapezius and sternocleidomastoid muscles</td>
<td>Plane (horizontal) defined by inferior aspect of cricoid cartilage</td>
<td>Sternocleidomastoid muscle, posterior border, or cervical plexus sensory branches</td>
<td>Trapezius muscle, anterior border</td>
</tr>
<tr>
<td>VB</td>
<td>Plane (horizontal) defined by inferior border of cricoid cartilage</td>
<td>Clavicle</td>
<td>Sternocleidomastoid muscle, posterior border, or cervical plexus sensory branches</td>
<td>Trapezius muscle, anterior border</td>
</tr>
<tr>
<td>VI</td>
<td>Hyoid bone</td>
<td>Sternum</td>
<td>Common carotid artery</td>
<td>Common carotid artery</td>
</tr>
</tbody>
</table>
mylohyoid muscle and above the hyoid bone but are posterior and lateral to
the anterior belly of the digastric muscles and anterior to the posterior
border of the submandibular gland. Level II nodes are contained in the
space defined superiorly by the skull base, inferiorly by the hyoid bone,
anteriorly by the posterior border of the submandibular gland, and
posterior to a transverse line drawn on each axial image through the
posterior edge of the SCM. The deep border of level II is defined by the
internal carotid artery in that any nodes lying medially to this vessel are
considered to belong to the retropharyngeal nodal group. Level III nodes
are located between the lower border of the hyoid bone and the lower
margin of the cricoid cartilage. These nodes lie laterally to the common
carotid artery. On both sides of the neck, the medial margin of the carotid
arteries separates the level III nodes, which are located laterally to level IV
nodes, which lie medially to the vessels. Level IV nodes lie inferiorly to the
lower border of the cricoid cartilage and superiorly to the clavicle. The
boundaries of levels V and VI are the same as in the clinical classification.

**Neck dissection classification**

The neck dissection classification system has arisen because radical neck
dissection remains the standard procedure for cervical lymphadenectomy,
with other operations representing alterations of this classic operation (see Box 1). The term “modified radical neck dissection” (mRND) is used when one or more nonlymphatic structures routinely removed in an RND is preserved. In general, currently preserved structures include the SCM, the accessory nerve, and the internal jugular vein. If one or more lymph node levels that are routinely removed in an RND are preserved, the procedure is termed a “selective neck dissection” (SND). Finally, if the procedure includes removal of additional nonlymphatic structures or lymph node groups (relative to the RND), the operation is termed an “extended neck dissection.”

The anatomic boundaries of the RND include the following: superiorly, the inferior border of the mandible; inferiorly, the clavicle; medially, the midline; and posteriorly, the anterior border of the trapezius muscle. Included within these boundaries are lymph node levels I through V, the SCM, the internal jugular vein (IJ), and accessory spinal nerve (cranial nerve XI), which are removed at surgery (Fig. 3).

An mRND refers to the removal of lymph node levels I through V, with preservation of one or more nonlymphatic structures that are routinely removed during the course of an RND. In describing an mRND, the anatomic structure or structures preserved should be clearly specified (e.g., mRND with preservation of the internal jugular vein).

SNDs are commonly used in the staging and treatment of the clinically undetectable (or N0) neck tumor. In this type of neck dissection, one or
more lymph node levels are preserved. The lymph node levels removed are based on the location of the primary tumor because the clinical patterns of cervical lymphatic metastasis from head and neck tumors have been shown to be predictable in multiple, large-scale, retrospective studies [8,14,15].

The lymph nodes at risk for laryngeal, hypopharyngeal, and oropharyngeal carcinomas are usually found within levels II, III, and IV. For thyroid cancer and subglottic cancers, the nodes in level VI are at greatest risk of harboring metastatic disease. Lymph nodes in levels I, II, and III are at greatest risk of harboring microscopic metastatic disease in patients who have oral cavity primary cancers. Skip metastasis to level IV may potentially represent a problem in patients who have oral tongue carcinoma [16].

The most significant paradigm shift in the management of cervical lymph node disease over the past decade has been the selective removal of lymph node groups that are at greatest risk of harboring metastases. Although this change in treatment philosophy has been applied mostly to patients with N0 nodal disease, SND also has a role in the treatment of N-positive neck tumors [17,18].

Selective neck dissection for oropharyngeal, laryngeal, and hypopharyngeal cancer

The lymphadenectomy of choice in the treatment of cancers affecting these anatomic sites includes the removal of lymph node groups in levels II, III, and IV (SND II–IV). Patients who have SCC of the larynx rarely present with metastases at the submandibular triangle (level I) [19]. Data from two recent studies support the use of SND II–IV for the treatment of N0 laryngeal and hypopharyngeal carcinomas [20] and transglottic carcinomas (supraglottic tumors that cross the laryngeal ventricle and invade the glottis) [21]. The anatomic limits of this lymphadenectomy are as follows: the clavicle inferiorly, the skull base superiorly, the lateral border of the sternohyoid muscle medially, and the posterior border of the SCM and cutaneous sensory branches of the cervical plexus posteriorly (Fig. 4).

With the exception of the glottic larynx, cancers of the oropharynx, hypopharynx, and larynx have bilateral lymphatic drainage patterns. Thus, the procedure of choice for patients with N0 primary tumors in these locations is a bilateral SND II–IV in cases where the neck is managed surgically. In cancers involving the walls of the hypopharynx and oropharynx, the retropharyngeal nodes may harbor metastatic disease. Therefore, in this circumstance, removal of this nodal group should be considered. The procedure would be termed SND II–IV, retropharyngeal nodes. In laryngeal and hypopharyngeal carcinomas extending below the glottic larynx, level VI lymph nodes are usually included in the neck dissection (SND II–IV, VI), because they are at risk [21].
Selective neck dissection for cancer of the oral cavity

In oral cavity cancer, the nodal groups at risk are located in levels I, II, and III [8]. The procedure of choice is SND I–III (Fig. 5). Some evidence suggests that, in cancer of the anterior tongue, level IV nodes may contain metastatic disease [16]. Therefore, it is recommended that lymph nodes in level IV be removed in patients who have cancer of the tongue (Fig. 6). In cancers involving midline structures, including the floor of the mouth, the indicated procedure is a bilateral SND I–III, because the lymph nodes on both sides of the neck are at risk for containing metastases. The adequacy of SND I–III for treating clinically negative neck tumors in patients who have oral carcinomas has been examined thoroughly [9,10,22]. In addition, investigators have demonstrated that, in patients with pathologically positive lymph nodes, the addition of postoperative radiotherapy following SND I–III can achieve regional control comparable to that of level I–V dissection and postoperative radiotherapy [9].

Anterior neck dissection (selective neck dissection VI)

Level VI, central compartment neck dissection refers to the removal of bilateral, paratracheal, delphian, and perithyroidal lymph nodes, including
Fig. 5. Selective neck dissection I–III. (Drawing by Paul Tomljanovich, MD, medical illustrator.)

Fig. 6. Selective neck dissection I–IV for oral tongue cancer. (Drawing by Paul Tomljanovich, MD, medical illustrator.)
nodes adjacent to the recurrent laryngeal nerves [7]. The superior boundary of the dissection is the body of the hyoid bone, and the inferior margin is the suprasternal notch. The lateral margins are defined by the common carotid arteries. SND VI is most commonly indicated in the treatment of thyroid cancer, advanced laryngeal cancer with subglottic extension, and cervical esophageal carcinoma (Fig. 7). In thyroid cancer where there is clinical evidence of nodal metastases in the neck, either preoperatively or intraoperatively, the procedure of choice also would include levels II to V, and is designated SND II–VI.

Extended neck dissection

Extended neck dissection is by definition more extensive than an RND. Extended neck dissection involves the removal of additional lymph node groups or nonlymphatic structures not included in an RND. The anatomic structures and lymph node groups removed during the course of this operation must be documented. Examples of such lymph node groups include the retropharyngeal, suboccipital, and paratracheal nodes. Examples of nonlymphatic structures that may be removed include the vagus nerve, carotid artery, and the strap muscle (Fig. 8).
Posterolateral neck dissection

Posterolateral neck dissection is an SND that involves removal of the suboccipital lymph nodes, postauricular lymph nodes, and lymph nodes in levels II through V (Fig. 9). SND II–V (postauricular, suboccipital) is the procedure of choice to treat the neck in patients with cutaneous carcinomas of the posterior scalp and neck [23].

The superior limit of the dissection is the base of skull and the nuchal line. The inferior limit of the dissection is the clavicle. The anterior (medial) limit of the dissection is the lateral border of the sternohyoid muscle. The lateral (posterior) limit is the anterior border of the trapezius muscle inferiorly and the midline of the neck superiorly [24,25].

Sentinel lymph node biopsy: a new paradigm for staging N0 neck tumors

Sentinel lymph node biopsy (SLNBX) has become an accepted technique for staging the first extratumoral echelon of draining lymph nodes in individuals diagnosed with melanoma or breast cancer. Similar to SND, SLNBX is based on the principle that lymphatic metastases do not occur in a random manner, but rather predictably, in accordance with preexisting lymphatic anatomy. As discussed, the practice of Staging SND, performed...
by removing nodal levels with the highest probability of harboring metastatic disease, is based on studies examining the pattern and incidence of metastases in large patient cohorts. Unlike SND, however, SLNBX is a lymphatic mapping technique that allows for the direct evaluation of the lymph node or nodes that initially receives metastatic disease, in a specific individual, with a tumor at a specific location.

Patients who have N0 head and neck cancer may benefit most from SLNBX. Approximately 20% to 40% of patients who have N0 disease harbor microscopic tumor foci [26–28]. Thus, approximately two thirds of patients who have N0 head and neck cancer will have no pathologic evidence of metastatic disease [26,29]. Taking a “wait and see” approach in patients with N0 cancer has been associated with disease recurrence and a worsened prognosis [26]. SLNBX has the potential of avoiding either overtreatment or undertreatment of the neck. In addition, SLNBX has the added benefit of improved disease staging by directing the pathologist to the “highest risk” lymph node or nodes, which may be more extensively evaluated by either immunohistochemical or molecular techniques. Hamakawa et al [30] determined that routine histologic evaluation of neck dissection specimens miss micrometastatic disease in up to 28% of patients. It is this group of “understaged” patients with head and neck cancer that may especially benefit from SLNBX.

Recently, Wiseman et al [31] presented the results of a pilot study using an isosulfan blue dye technique to carry out SLNBX in patients with early-
stage N0 oral cavity head and neck cancer. Although SLNBX was technically feasible, and no adverse effects were observed in the authors’ patient population, the sentinel node identification rate was only 57%, and when identified, the sentinel node accurately predicted the pathologic status of the neck in 75% of patients. The negative predictive value for the absence of cervical metastases was 67% [31]. The authors’ experience was similar to that of other investigators who found that a vital dye technique alone had a low rate of sentinel node identification (0%–67%), and even when identified, the sentinel node often did not accurately predict the pathologic status of the neck (0%–75%) [32,33]. The poor clinical utility of the vital dye methodology is a sharp contrast to the high rate of sentinel node identification reported when a radiotracer technique is used (in most series, 100% of sentinel nodes were identified) [34–44]. In addition, using the radiotracer technique, the sentinel node almost always accurately reflected the pathologic status of the neck. Other investigators have used a combined vital dye/radiotracer technique and have reported that these methodologies complement one another and also have high rates of sentinel node identification (90%–100%) and accurate nodal staging (97%–100%) [43–45].

Recently, Ross et al [46] reported pooled results, from 22 centers, of SLNBX being performed on 316 patients who had N0 head and neck cancer. Although this study was not prospective, and the study population was treated heterogeneously, these investigators reported a 95% rate of sentinel node identification and an overall sensitivity of 90% for this procedure. At centers that performed 10 or fewer procedures, the sensitivity was 57%; centers that performed more than 10 procedures had a sensitivity of 92% [46].

Although the data reported by Ross et al [46] are provocative, they must be interpreted with caution because this study was performed in a patient cohort that was nonrandomized, uncontrolled, retrospectively collected, and heterogeneous. The results reported in the current literature are encouraging, however. SLNBX does seem to be a technically feasible and accurate method for staging N0 neck cancer. There remain many issues that must be addressed before SLNBX becomes integrated into the management algorithm of N0 neck cancer. Critical unresolved issues include the identification of patient/tumor characteristics appropriate for this methodology (eg, stage, site, subsite) and a determination of the technique (eg, radiotracer, vital dye, or combination technique) most appropriately applied to these individuals.

Summary

For individuals diagnosed with head and neck cancer, neck dissection may be performed for therapy or disease staging. The classification of neck dissection and the definition of precise anatomic landmarks have allowed
for this operation, and its many variations, to become standardized world-
wide. SLNBX shows promise in its ability to accurately stage N0 head and
neck cancer and may allow patients with no micrometastatic disease to
avoid neck dissection. Before this technique becomes adopted into routine
clinical practice, however, it must first be prospectively scrutinized in large
patient populations. Regardless of the future role of SLNBX in the man-
agement of head and neck cancer, currently it is only through a complete
understanding of the clinical, theoretic, and technical aspects of neck dis-
section that surgeons may benefit individual patients and the head and neck
cancer patient population as a whole.

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