NECK DISSECTION

Introduction

Since its introduction by Crile in 1906 and popularization by Martin and co-workers in the 1950s, classic radical neck dissection (RND) has been the mainstay of surgical management of cervical lymph node metastasis from head and neck squamous cell carcinoma. Martin championed the concept that a cervical lymphadenectomy for cancer was inadequate unless all the lymph-node-bearing tissues of one side of the neck were removed. He felt this was impossible unless the spinal accessory nerve, the internal jugular vein, and sternocleidomastoid muscle were included in the resection. In fact, he categorically stated, "Any technique that is designed to preserve the spinal accessory nerve should be condemned unequivocally." 1

Unfortunately resection of the SCM, IJV and SAN, lead to significant morbidity both functionally and cosmetically. In the last thirty years, studies have shown that the classic radical neck dissection is not indicated for all cervical lymphadenectomy, and several modifications of this procedure were introduced. This lead to many inconsistencies in the nomenclature referring to lymph node regions, and in classification and types of neck dissection performed for various squamous cell malignancies of the head and neck. The following will summarize the changes, current nomenclature, and studies leading up to the most commonly performed dissections based on nodal stage and tumor location and size. Additionally, brief comments will be made regarding pertinent anatomy and technique of neck dissection.

Staging

The staging of head and neck cancer includes a classification for nodal disease. It is important to note the critical difference in size of nodes with break points at 3 and 6 cm. The staging system for head and neck malignancies considers all malignancies with palpable cervical adenopathy as Stage 3 or Stage 4, reflecting the grim prognostic implications of palpable nodal disease. 2 The most important prognostic indicator in patients with squamous carcinoma of the head and neck remains the status of the cervical lymph nodes. 3

NX: Regional lymph nodes cannot be assessed

N0: No regional lymph node metastasis

N1: Metastasis in a single ipsilateral lymph node, 3 cm or less in greatest dimension

N2a: Metastasis in a single ipsilateral lymph node more than 3 cm but not more than 6 cm in greatest dimension

N2b: Metastasis in multiple ipsilateral lymph nodes, none more than 6 cm in greatest dimension

N2c: Metastasis in bilateral or contralateral nodes, no more than 6 cm in greatest dimension

N3: Metastasis in a lymph node more than 6 cm in greatest dimension 2

Nodal Regions

Memorial Sloan-Kettering Cancer Center developed the lymph node regional definitions most widely used today.

Region I: Submental and submandibular triangles. Ia is the submental triangle bound by the anterior bellies of the digastric and the mylohyoid. Ib is the triangle formed by the anterior and posterior bellies of the digastric and body of mandible.

Region II, III, IV: nodes associated with the IJV; fibroadipose tissue located medial to the posterior border of SCM and lateral to the border of the sternohyoid.
Region II: upper third including the upper jugular and jugulodigastric nodes and the upper posterior cervical nodes. Region bound by the digastric muscle superiorly and the hyoid bone (clinical landmark) or the carotid bifurcation (surgical landmark) inferiorly. IIA contains nodes in the region anterior to the spinal accessory nerve and IIB posterior to the nerve.

Region III: middle third jugular nodes extending from the carotid bifurcation superiorly to the cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark).

Region IV: lower jugular nodes extending from the omohyoid muscle superiorly to the clavicle inferiorly.

Region V: posterior triangle group of lymph nodes located along the lower half of the spinal accessory nerve and the transverse cervical artery. The supraclavicular nodes are also included in this group. The posterior boundary is the anterior border of the trapezius muscle, the anterior boundary is the posterior border of the sternocleidomastoid muscle, and the inferior boundary is the clavicle.

Region VI: anterior compartment group comprises lymph nodes surrounding the midline visceral structures of the neck extending from the level of the hyoid bone superiorly to the suprasternal notch inferiorly. On each side, the lateral boundary is the medial border of the carotid sheath. Located within this compartment are the perithyroidal lymph nodes, paratracheal lymph nodes, lymph nodes along the recurrent laryngeal nerves, and precricoid lymph nodes.

Classification

In the past few decades, the radical neck dissection, originally described by Crile and later popularized by Martin et al., has been modified in various ways, giving rise to several types of cervical lymph node dissections that are currently used for the surgical treatment of the neck. These modifications were classified according to a random system of terminology depending on the author at the time. It was not until 1991 that the Academy’s Committee for Head and Neck Surgery and Oncology published an official report standardizing the classifications for these modified neck dissections. The committee classified four major types of neck dissections:

1) Radical neck dissection;
2) Modified radical neck dissection;
3) Selective neck dissection including supraomohyoid, posterolateral, lateral, and anterior; and
4) Extended radical neck dissection.

Medina in 1989 published an editorial of which the committee adopted many of his descriptions. Many of the descriptions not adopted by the committee are widely referred to in common practice. In Medina’s article the term comprehensive neck dissection encompasses radical neck and modified radical neck dissections. The other major headings are selective and extended.

The radical neck dissection is defined as removing all of the lymphatic tissue in regions I-V including removal of the spinal accessory nerve, (SAN), sternocleidomastoid muscle (SCM), and internal jugular vein (IJV). It does not include removal of the suboccipital nodes, periparotid nodes except for infraparotid nodes located in the posterior aspect of the submandibular triangle, buccal nodes, retropharyngeal nodes, or paratracheal nodes.

Modified radical neck dissection (MRND) is defined as excision of all lymph nodes routinely removed by radical neck dissection with preservation of one or more nonlymphatic structures, i.e., SAN, IJV, SCM. Medina subclassifies the MRND into types I-III; where type I MRND preserves the SAN, type II MRND preserves the SAN and IJV, and type III MRND preserves the SAN, IJV, and SCM. The type III MRND is also referred to as the “functional neck dissection" as popularized by Bocca, however in his classic description the submandibular gland is not excised.
Selective neck dissection is defined as any type of cervical lymphadenectomy where there is preservation of one or more lymph node groups removed by the radical neck dissection. There are four common subtypes, the first of which is the supraomohyoid neck dissection. This removes lymph tissue contained in regions I-III. The posterior limit of the dissection is marked by the cutaneous branches of the cervical plexus and the posterior border of the SCM. The inferior limit is the superior belly of the omohyoid muscle where it crosses the IJV. The second subtype, posterolateral neck dissection, refers to the removal of the suboccipital lymph nodes, retroauricular lymph nodes, levels II-IV, and level V. This procedure is used most often to remove nodal disease from cutaneous melanoma of the posterior scalp and neck. Originally described by Rochlin in 1962, the SAN, SCM, and IJV were preserved. Medina suggests subclassification of the posterolateral neck dissection to types I-III to mirror preservation of SAN, IJV, and SCM as in MRND. The lateral neck dissection removes lymph tissue in levels II-IV. Anterior neck dissection is the last subtype of selective neck dissection and refers to the removal of lymph nodes surrounding the visceral structures of the anterior aspect of the neck previously defined as level VI.4

The last major subtype is the extended neck dissection defined literally as removal of one or more additional lymph node groups and/or nonlymphatic structures not encompassed by radical neck dissection, such as parapharyngeal, superior mediastinal, and paratracheal. In practice, any of the previous neck dissections may be extended to include other structures. With those definitions in place, the evolution and current indications of the various neck dissections shall be discussed.

Rationale

Once again, the most important factor in the prognosis of squamous carcinoma of the upper aerodigestive tract is the status of the cervical lymph nodes. The cure rates drop to nearly half with involvement of regional lymph nodes. In the past, the radical neck dissection was believed to be the only adequate method of cervical lymphadenectomy. Several authors, but most recently Anderson and colleagues found that actuarial 5-year survival and neck failure rates for RND were 63% and 12% respectively compared to 71% and 12% for MRND I. These results were not statistically different when controlled for pathologic N stage, presence of extra capsular spread, and pathologic presence of nodes along the SAN. Additionally, there was no difference in the pattern of neck failure. 6

Radical neck dissection is still indicated when there are multiple clinically obvious cervical lymph node metastases, particularly when lymph nodes of the posterior triangle of the neck are involved and closely related to the SAN. It is also indicated with large metastatic tumor mass or multiple matted nodes in the upper part of the neck. As a general rule, tumor should not be dissected to preserve structures in the neck. The indications for MRND type I include patients with clinically obvious lymph node metastases, but without the SAN being involved by tumor. This is usually an intraoperative decision, much like preservation of the facial nerve in parotid surgery. 1 MRND type II are rarely planned. This procedure is done in the rare case where tumor is adherent to the SCM, but away from the IJV, and SAN. The use of MRND type III evolved from work by Suarez who observed in autopsy and surgical specimens of larynx and hypopharynx that the lymph nodes were in fibrofatty tissue, and even when near blood vessels but did not share the same adventitia. He also noted that lymph nodes were not within the muscular aponeurosis or the glandular capsule (submandibular gland), but are found within the parotid gland. 1 Type III MRND was popularized by Bocca and coined “functional neck dissection”.

Many retrospective studies have been performed examining the use of MRND type III, however the results are difficult to interpret or compare because of the use of radiation therapy. In general, it appears as if survival approximates that of MRND type I assuming IJV, and SCM not involved by tumor. Type III MRND is widely accepted in Europe and is the neck dissection of choice for the treatment of N0 necks, especially when the primary tumor is in the larynx or hypopharynx. Molinari and associates also feel it is indicated for the treatment of the N1 neck when nodes are mobile and no greater than 2.5 to 3 cm. Bocca believes the indications for Type III are the same as those for RND, and that the only contraindication for use is the presence of node fixation. 1 Type III MRND is also clearly the operation of choice for differentiated carcinoma of the thyroid in patients with palpable lymph node metastases. Perhaps the most controversial changes that have been made to the management of SCCA of upper aerodigestive tract is in cases of the N0 neck and selective neck dissection; discussion follows.

Several options exist for the treatment of the N0 neck. The neck can be observed and treated only if it clinically converts; elective radiation therapy may be given; or elective neck dissection may be performed. The benefit of the
selective/elective neck dissection is low morbidity while staging the neck. It is generally accepted that the rate of occult metastasis in the clinically negative neck is between 20-30% despite thorough clinical exam and radiographic studies. However some authors disagree. In a recent study by Friedman et al, the combination of CT or MRI with clinical exam yielded an occult disease rate of only 12 %. Therefore they conclude that only primary tumors with a high chance of neck metastasis should undergo an elective neck dissection in a clinically N0 neck. 8 The rationale for selective neck dissection was studied by Fisch and Sigel. They demonstrated in anatomic studies that the lymphatic drainage of the mucosal surfaces of the head and neck follows relatively constant and predictable routes. Of interest is the fact that Fisch found that the lymphatic flow from the spinal accessory chain to the jugular chain was unilateral. 3

Many retrospective studies have been performed looking at the distribution of lymph node metastasis in SCCA of the upper aerodigestive tract. Shah obtained the most compelling evidence supporting the predictability of nodal metastases from SCCA of the head and neck. In a retrospective review of 1119 radical neck dissections Shah made observations regarding nodal spread by site for SCCA of the upper aerodigestive tract. Regarding the neck in primary oral cavity SCCA, 7 patients (3.5 %) had nodal involvement outside levels I-III. Four of the seven had involvement of level I-III and level IV. Whereas, three of the seven (1.5%) had isolated involvement outside level I-III without involvement of level I-III. This implies that three cases, if only level I-III were dissected, would have had undetected nodal disease. In the N+ neck with primary oral cavity SCCA, 50/246 patients had nodal disease in level IV and 10/246 patients had disease in level V. Therefore, sixty cases would have residual nodal disease if only level I-III were removed. In oropharyngeal and hypopharyngeal primary SCCA with a N0 neck, two patients with oropharyngeal and zero patients with hypopharyngeal had nodal metastasis outside level II-IV. Regarding oro/hypopharyngeal tumors with N+ necks, 12.6 and 9.7% of cases had nodal mets in level I and V respectively. Finally, for N0 SCCA of larynx, four patients had level I and two had level V metastasis. Only one of the four with level I disease had isolated mets to this level; implying only one case with undetected nodal disease with IV-IV selective neck dissection.

For primary laryngeal SCCA and a N+ neck, 12 patients had mets at level I and 8 at level V with 3 of 12 having isolated involvement of level I and 0 of 8 isolated to level V. Shah concluded that levels I, II, and III are at greatest risk for nodal mets from oral cavity and II, III, and IV at greatest risk from oropharynx, hypopharynx, and larynx. 9,10 He also concluded that selective neck dissection would not have resulted in adequate clearing of lymph nodes in N+ necks. The study did not make any conclusions regarding survival or the use of adjuvant therapy. 9 Byers found that selective neck dissection with postoperative radiotherapy in selected patients was adequate treatment, having similar recurrence rates with those patients treated with MRND type III. 3 In N+ necks, Spiro reported a high recurrence rate with supraomohyoid dissection (21 %). However in his study not all patients received radiation therapy. 3 In general selective neck dissection is a good option for the N0 neck, but may not be the best option for clinically N+ neck. However, when combined with XRT, selective neck dissection may be equal in certain cases. Medina feels supraomohyoid dissection is indicated for SCCA of the oral cavity in N0 necks and N1 necks when the palpable node is <3 cm, clearly mobile, and located in levels I or II. 1

Lateral neck dissection is indicated in SCCA of the larynx, oropharynx, and hypopharynx for N0 and selected N1 cases. 1 However, Shah recommends levels I-IV for oropharyngeal SCCA. 3 If 2-4 nodes are positive or there is evidence of extracapsular spread, adjuvant radiation must be given. 1 If during the course of a selective neck dissection nodal disease is encountered, the dissection may be upgraded to a RND or MRND after there is histologic confirmation of metastatic disease. Rashek showed that intraoperative palpation of nodes in clinically N0 necks yielded a 73 % false-positive rate and a 21 % false negative rate. This study concluded that frozen section evaluation was needed to confirm SCCA. 7

Anatomy

Blood Supply

Blood supply to the skin of the neck is derived from the descending branches of the facial, submental, and occipital arteries and by ascending branches of the transverse cervical and suprascapular arteries. After perforating the platysma these arterial branches anastomose forming a superficial network of vessels running predominately in a vertical direction. From a study by Freeland and Rogers, the incisions most likely to safeguard the blood supply to the skin flaps are the superiorly based apron-like incisions from mastoid to mentum, or the similar incision from mastoid through a natural skin crease to contralateral mastoid. 1
Platysma

The platysma muscle is a wide, quadrangular, sheet-like muscle extending obliquely from upper chest to lower face. Skin flaps for dissection are raised in a plane immediately deep to the platysma; however, if the extent of disease is such, the platysma may be left attached to the specimen and flaps raised superficial to this muscle. Because of the oblique direction, the platysma does not cover a variable inferiorly based triangle in the anterior and most posterolateral aspect of the neck. In these areas, the flaps must be raised in the subcutaneous plane. The posterior border of the platysma is slightly over or just anterior to the EJV and great auricular nerve.

Marginal Mandibular Nerve

When incising the superficial layer of the deep cervical fascia care must be taken to identify the marginal mandibular nerve. The nerve is located 1 cm in front of or below the angle of the mandible, deep to the superficial layer of the deep cervical fascia that envelops the submandibular gland, and superficial to the adventitia of the anterior facial vein. It is preferred to identify the nerve rather than ligating the anterior facial vein low "to protect the nerve" which can result in elevation of the prevascular and retrovascular lymph nodes.

Spinal Accessory Nerve

The spinal accessory nerve exits the jugular foramen located medial to the digastric and stylohyoid muscles and lies lateral (70%) and immediately posterior to the IJV. The nerve can also be medial to the IJV in 30% of the cases and actually splits the vein in 3 – 5% of cases. Its course runs obliquely inferiorly and posteriorly to reach the medial surface of the SCM near the junction of its superior and middle thirds, or within 1 cm above the point where the greater auricular nerve turns around the posterior border of the SCM, known as Erb’s point.

Trapezius Muscle

The trapezius muscle’s anterior border is the posterior boundary of level V. Despite its large size, identification may be difficult secondary to its deceptively superficial position; it is not uncommon to mistake the levator scapulae for the trapezius placing the 11th nerve and the nerve to the levator at risk. In order to preserve the cervical nerves, which form the nerve to the levator scapulae, dissection, must be kept superficial to the fascia of the levator muscle.

Digastric Muscle

Originating from a groove in the mastoid process called the digastric ridge is the digastric muscle. Also known as "the resident’s friend", the only structure superficial to the posterior belly of digastric muscle to be identified and preserved is the marginal mandibular nerve. This muscle lies directly superficial to the branches of ECA, hypoglossal nerve, ICA, IJV, and 11th nerve.

Omohyoid Muscle

The second "resident’s friend", the omohyoid muscle has two bellies and is the anatomic separation of nodal levels III and IV. The posterior belly lies superficial to the brachial plexus, phrenic nerve, and transverse cervical artery and vein. The anterior belly lies immediately superficial to the IJV.

Brachial Plexus and Phrenic Nerve

The brachial plexus exits between the anterior and middle scalene muscles and extends inferiorly deep to the clavicle, under the posterior belly of the omohyoid muscle. The transverse cervical artery and vein lie immediately superficial to this plexus. The phrenic nerve lies on top of the anterior scalene muscle and derives its cervical supply from contributions from the cervical plexus, C3-C5. Cervical rootlets must be transected only anteriorly to their contribution to the phrenic nerve.

Thoracic Duct
The thoracic duct is located in the lower left neck and arises immediately posterior to the jugular vein and anterior to the phrenic nerve and transverse cervical artery. This structure has exceptionally thin walls, and care must be taken to handle this tissue gently during ligation to avoid avulsion or tearing of walls leading to a chyle leak. If this occurs microscopic exam may aid in identification and repair. 2,3

Hypoglossal Nerve

The hypoglossal nerve exits near the jugular foramen via the hypoglossal canal, passes under the IJV and over the internal and external carotid arteries, and loops deep and inferiorly to the posterior belly of digastric, where it is enveloped by a venous plexus, the canine veins. It then travels under the fascia of the floor of the submandibular triangle before entering the tongue.

Summary

Unified classification of neck nodal levels and classification of neck dissection is relatively new. Indications for neck dissection and the type of neck dissection, especially in the N0 neck is a controversial topic. In general for SCCA of the oral cavity, anterior to the circumvalate papilla, a supraomohyoid, dissection should be considered. For oropharyngeal lesions either levels I-IV or level II-IV should be dissected. Lesions of the larynx and hypopharynx require dissection of levels II-IV. More extensive neck dissection is probably indicated for N+ necks, and adjuvant therapy is also necessary in necks with 2-4 positive nodes or extracapsular spread.