Chapter 78 – Neck Dissection

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Management of the neck remains the keystone of management of cancer of the head and neck. The cervical lymphatics play an active role in the biologic behavior of cancers of the head and neck. Cells from the primary cancer find their way into the multilevel, anastomosing network of lymphatics that drain through a series of lymph nodes. Cancer cells found in the lymphatic fluid are trapped by the nodes, where they often evade host immune defenses and proliferate. Distant metastatic disease often occurs quite late in patients with squamous cell carcinoma of the head and neck, despite the presence of involved cervical neck nodes, suggesting that the filtration function of the cervical lymphatics is effective. Unfortunately, the proliferation of cancer within the nodes often leads to uncontrolled regional disease and the eventual demise of the patient. The finding of cancer within the cervical lymph nodes downgrades the patient's curability by 50% and is responsible for 50% to 95% of recurrent disease. Depending on primary site and treatment, treatment plans must consider management of cervical metastatic disease. Leaving cancer in the cervical nodes, whether or not clinically apparent, inevitably results in unacceptable morbidity and mortality for the patient.

The staging system for cancer of the head and neck (with the exception of thyroid cancer) emphasizes the status of the cervical lymphatics. Patient outcomes strongly correlate with the presence and extent of metastatic disease in the regional nodes.[1,2] The critical differentiation for staging is the presence, number, and size of involved cervical nodes. A single, small node (N1) converts any early primary cancer (T1-2) to stage 3, and more than one lymph node or a lymph node greater than 3 cm (N2 or 3) to stage 4, reflecting the grim prognostic implications of palpable neck disease (Fig. 78-1). Metastatic deposits that are present, but not clinically evident, convey the same dismal implications for the patient because they will enlarge to become palpable at a later date. Cancer that has spread through the capsule into the surrounding fat (extracapsular spread, or ECS) is even worse, probably reflecting tumor biologic behavior rather than a geographic location (Fig. 78-2).[3]

Clinical staging includes information derived from imaging, which is considered to be complementary to physical examination. A definitive pathologic diagnosis is derived from fine-needle aspiration biopsy or examination of excised lymph nodes.[4]

Non–squamous cell carcinomas of the head and neck include malignant melanoma, cancers of salivary gland origin, and cancer of the thyroid. In contrast to other histologic variants, differentiated cancer of the thyroid metastatic to the cervical lymph nodes does not convey as grave a prognosis. Hence the staging system for thyroid cancer is weighted toward the primary cancer, with nodal disease being indicated only as present or absent, regardless of the size of the lymph nodes.

The staging system is inadequate to predict tumor behavior due to the heterogeneous nature of squamous cell carcinoma of the head and neck. Although additional markers are used routinely in cancers of other sites, as of this writing similar biologic indicators, such as the presence of ECS, have not been incorporated into the standard staging system for cancer of the head and neck.

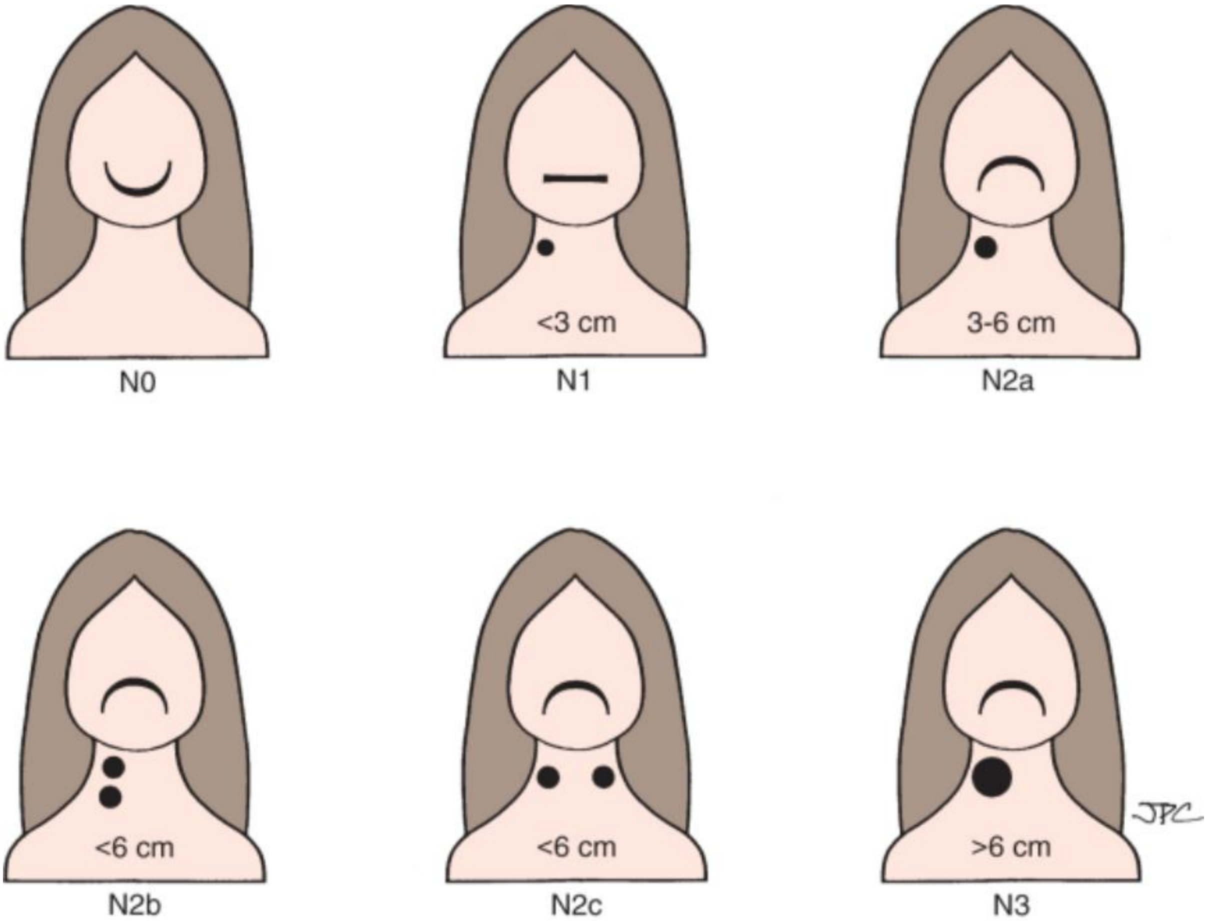

Figure 78-1 Staging system for head and neck cancer.

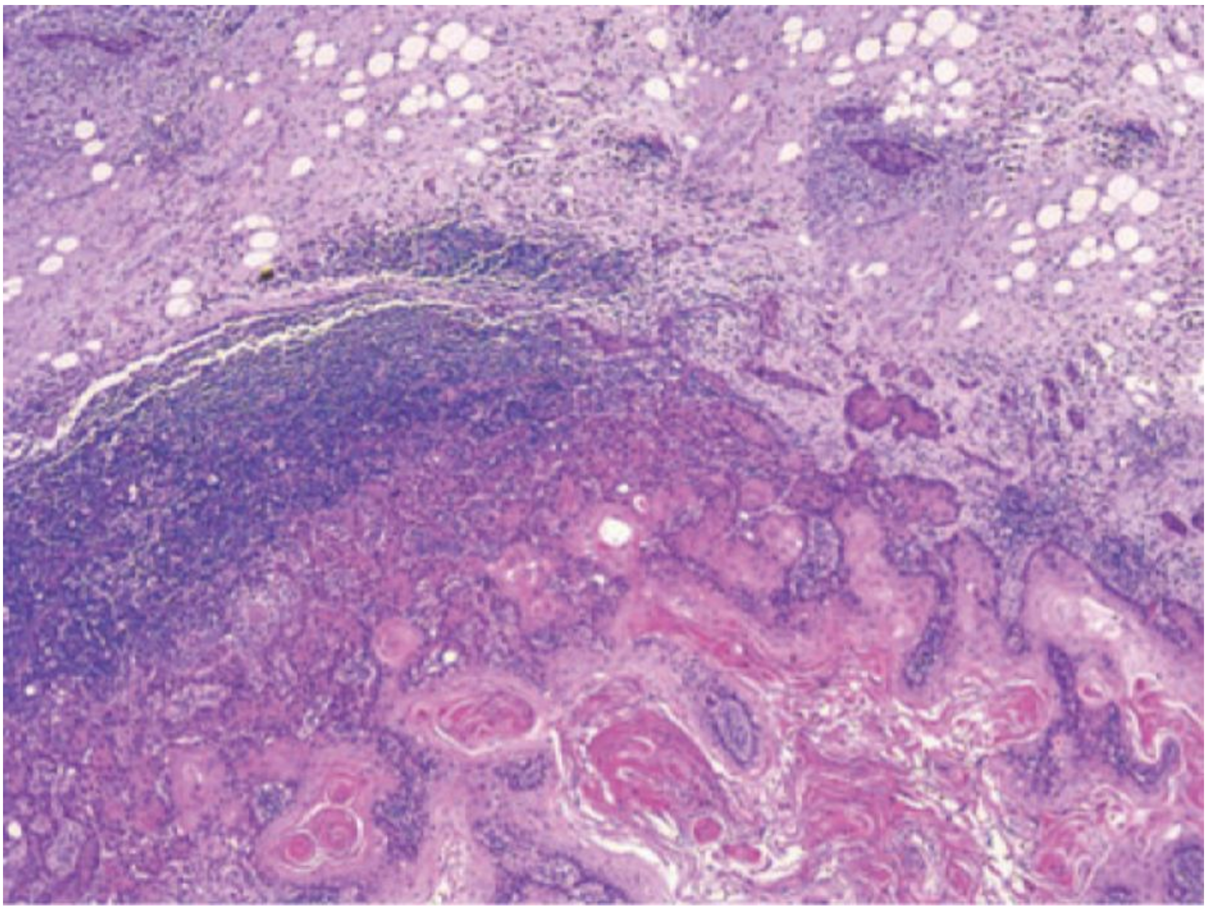

Figure 78-2 Extracapsular spread in the carotid lymph node invading the surrounding soft tissue.

OCCULT METASTASIS TO THE CERVICAL LYMPH NODES

More than 50% of patients with identified primary cancers of the head and neck present with obvious metastasis to cervical lymph nodes. Unfortunately, pathologic evidence of cancer deposits is found in 20% to 30% of patients without clinical or radiologic evidence of nodal involvement. Pathologic evidence of metastasis may be identified in lymph nodes that have been surgically removed, or evidenced by delayed tumor presentation in the neck despite the absence of recurrence of the primary cancer. The site and stage of the primary cancer predict the position and frequency of these “occult” metastases, and histologic diagnosis is dependent on specific sampling techniques. Successful therapy must consider treatment of nonpalpable nodes that may contain microscopic metastasis as well as clinically involved positive nodes. Decisions are dependent on probabilistic information and the willingness of the patient and surgeon to accept the risk of untreated occult disease.

Lymph node removal by neck dissection is performed for therapeutic removal of palpable enlarged lymph nodes, lymph nodes deemed enlarged through imaging modalities, or apparent normal lymph nodes considered to be at risk for metastatic spread. Removal of potentially involved but nonpalpable lymph nodes is beneficial not only for therapeutic purposes, but also as an effective means of determining pathologic stage and the need for further adjuvant therapy. The choice of treatment of the neck depends on the site and stage of the primary cancer, the probability of occult metastases, the treatment modality selected for the primary cancer, and the desires of the patient.

RADICAL NECK DISSECTION

The “classic” radical neck dissection effectively removes all of the lymph nodes present in the neck and their interconnecting lymphatics. In his classic article in 1906, Crile[5] for the first time described systematically the procedure that remained the standard form of neck dissection for more than 70 years. The radical neck dissection removes not only nodes and lymphatics with surrounding fat, but also the sternocleidomastoid muscle (SCM), submandibular gland, tail of the parotid gland, internal and external jugular veins, cervical sensory nerves, and the spinal accessory nerve, whether these structures are involved or not. These structures are removed to conform to the Halstedian concept of en bloc resection. Most of the morbidity of the procedure is thereby related to the removal of these additional structures, particularly the 11th cranial nerve, sternocleidomastoid muscle, and internal jugular vein (IJV), rather than the removal of the nodes per se. The radical neck dissection was the most commonly used form of neck dissection in the United States until the 1970s.[6] It has, however, largely been replaced by modifications of the procedure that preserve nonlymphatic structures such as muscles, nerves, and vessels.

FUNCTIONAL NECK DISSECTION

Cervical lymphatics are contained within fascial “envelopes,” consisting of the fascia covering the submandibular glands, carotid sheath, SCM, and deep cervical muscles and nerves. Suarez is generally credited as being the first to incorporate this anatomic fact into a modification of the classic neck dissection, removing only the lymph nodes. Ferlito and colleagues[7] and Bocca and Pignataro[8] coined the term “functional neck dissection” and described the technique in the English-speaking literature in 1967. Today we term procedures that remove all the lymphatics but preserve non–lymphatic-containing structures “modified neck dissection.”[9]

Cervical lymph nodes are divided into groups that roughly correspond to describe “levels” or zones that are the basis of various forms of neck dissection that remove only nodes at risk. Although these levels (and groups) are not discretely separated by anatomic structures, they nevertheless define a convenient classification system (Fig. 78-3).

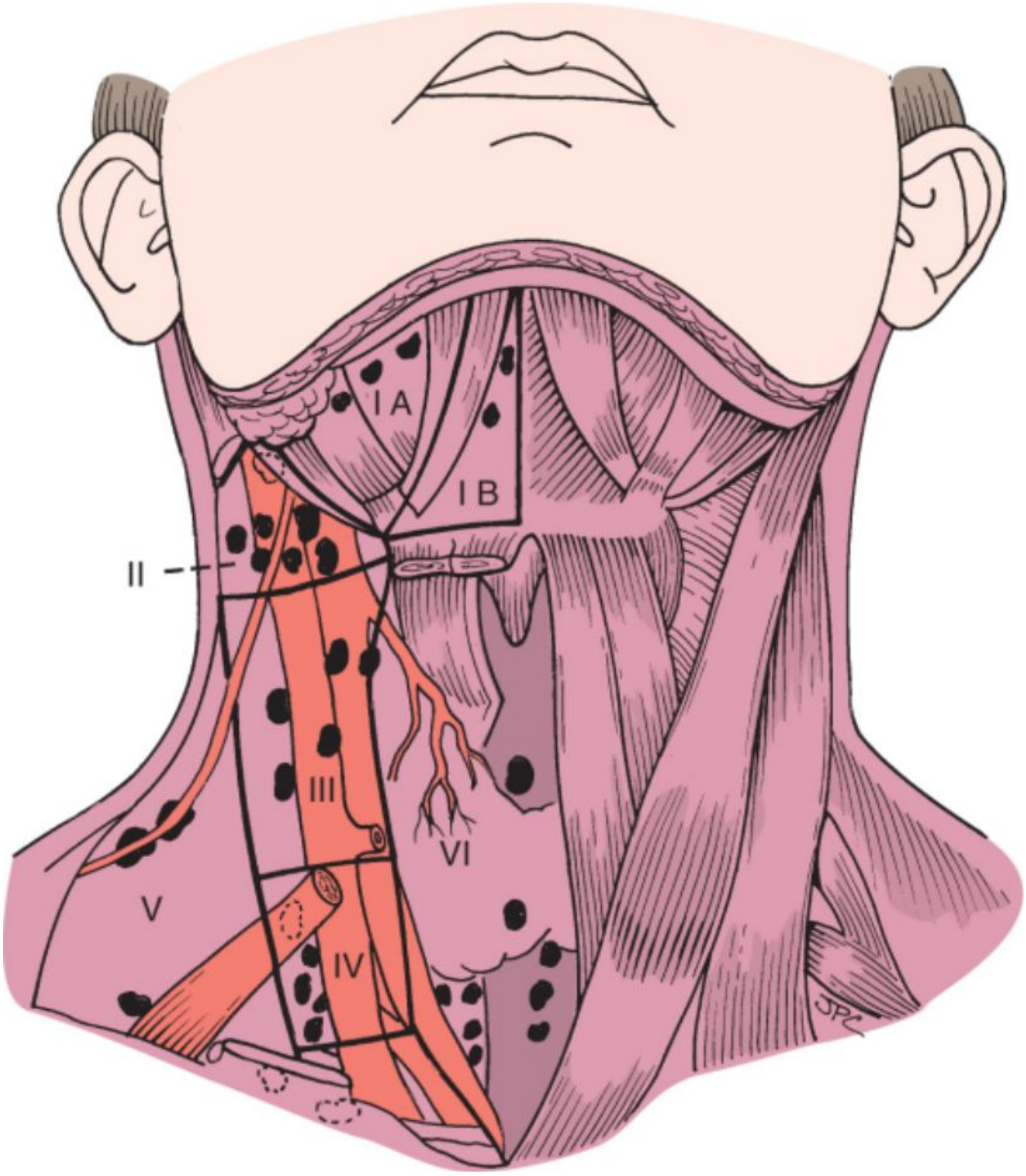

Figure 78-3 Levels of neck nodes. Selective neck dissections are labeled according to the levels of nodes removed.

ANATOMIC STRUCTURES

A basic review of the anatomy of the neck is beneficial in understanding the surgical approaches to the neck, particularly the various forms of neck dissection. The major muscles, nerves, and vessels are discussed in the following paragraphs.

Platysma Muscle

The platysma muscle lies just deep to the subcutaneous fascia and fat and extends from just over the mandible down to the upper chest. It runs obliquely from posteroinferior to anterosuperior, inserting into the superficial muscular aponeurotic system. It is deficient in the lower anterior midline in the neck and does not extend appreciably posterior to the exterior jugular vein and greater auricular (GA) nerve (Fig. 78-4). Its undersurface provides a convenient plane in which to elevate skin flaps, and it may also be used alone or with overlying skin as a flap in an intraoral closure technique.

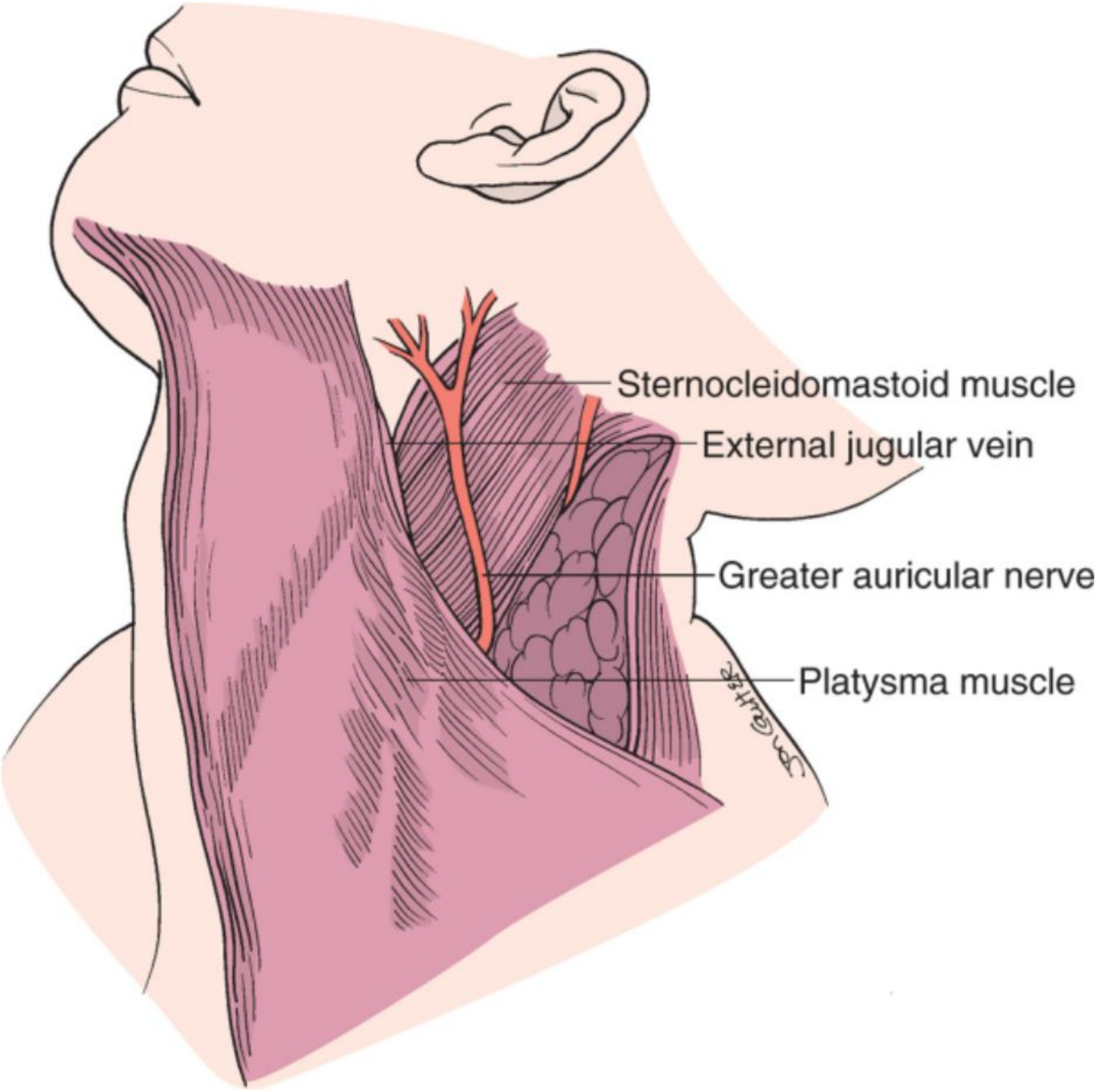

Figure 78-4 Detail of the platysma muscle, the external jugular vein, and the greater auricular nerve.

Sternocleidomastoid Muscle

The SCM runs obliquely from anteroinferior to posterosuperior, inserting on the mastoid tip. It can be readily differentiated from the platysma muscle by the direction of its fibers. It is crossed in an inferior-to-posterior direction by the GA nerve and the external jugular vein, which lie immediately deep to the platysma. If these structures are left on the surface of the SCM during flap elevation, the SCM assists in developing the fascial envelope in modified and selective neck dissections (Fig. 78-5). The posterior border of the SCM represents the posterior border of nodal levels II through IV and the anterior border of level V (Fig. 78-6). As the cervical contributions to the GA nerve leave the cervical plexus and sweep around the posterior border of the SCM, they artificially separate levels IV and V, identifying the posterior limit of the selective neck dissection.

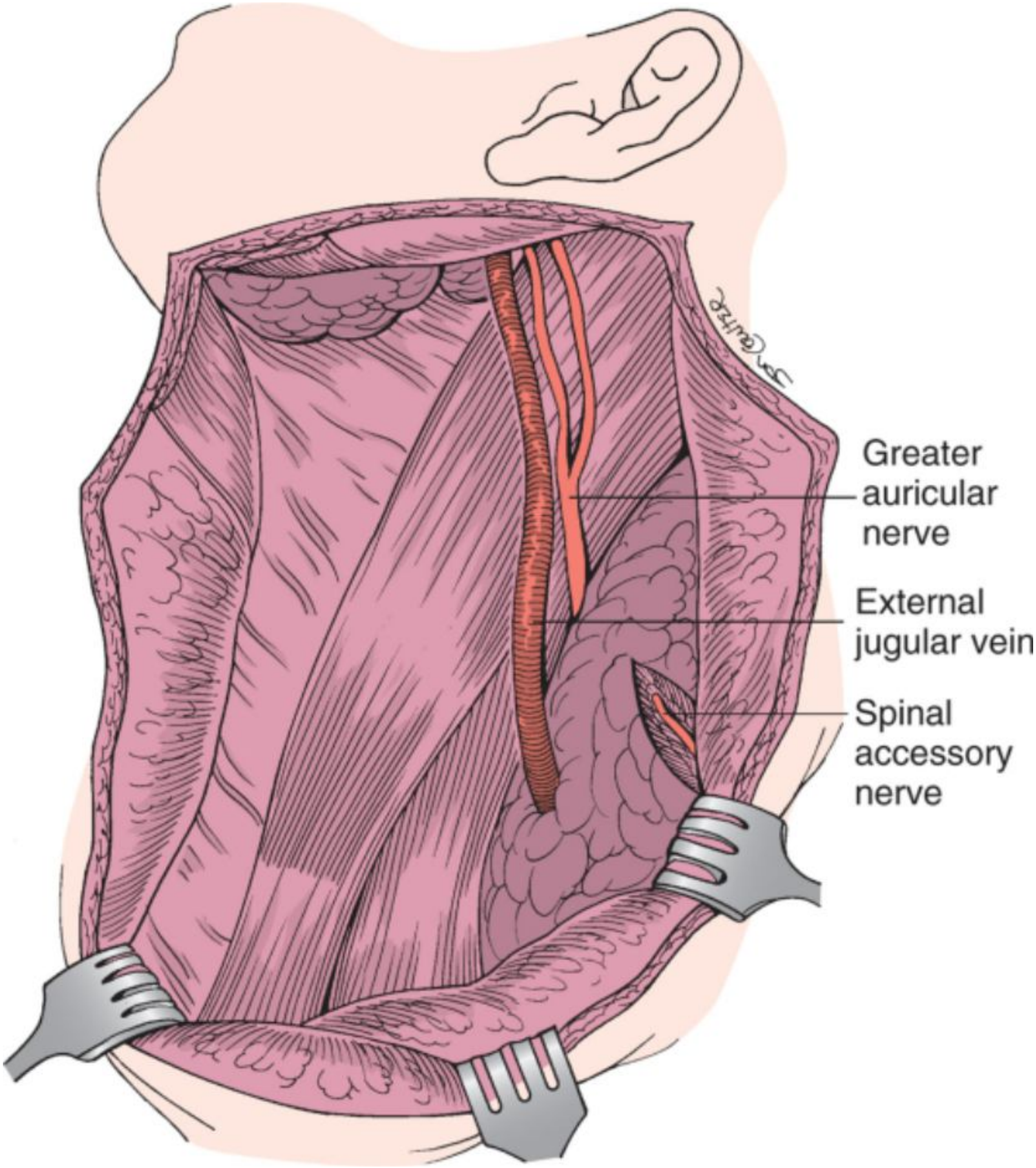

Figure 78-5 The 11th nerve is best identified posteriorly in the posterior triangle where it lies more superficially.

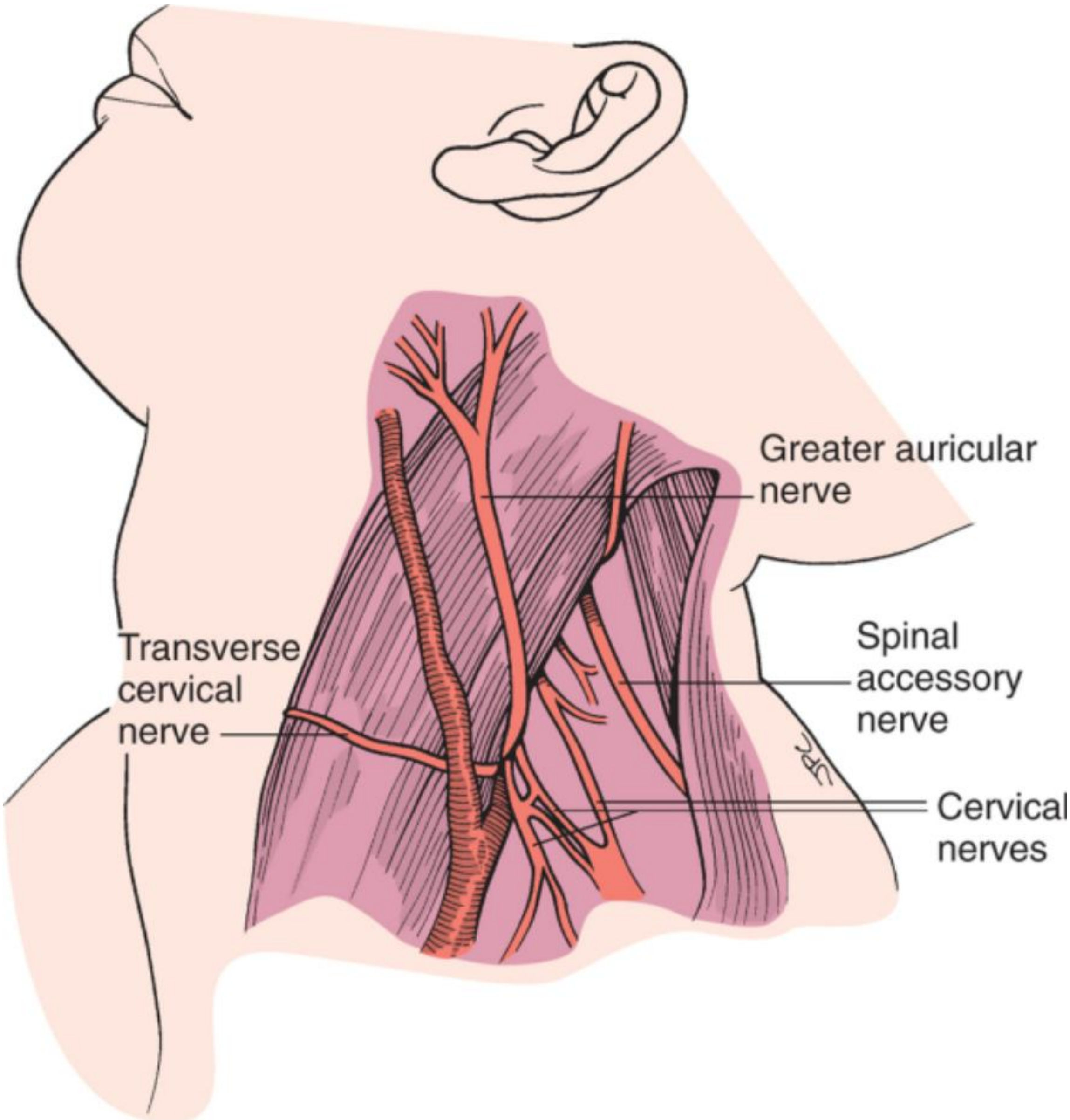

Figure 78-6 Detail of the cervical nerves and the greater auricular nerve at the posterior border of the sternocleidomastoid muscle. Note the 11th nerve as well as the anterior border of the trapezius muscle.

Greater Auricular Nerve

The GA nerve extends vertically from the posterior edge of the SCM obliquely over the SCM, roughly parallel and slightly posterior to the external jugular vein (see Fig. 78-4). It divides into two branches, the anterior of which enters the substance of the parotid gland. The GA nerve provides sensation to the auricle and dividing or injuring it results in hypesthesia, which can be quite problematic for some patients. We attempt to preserve the GA nerve during selective neck dissection, although it is impossible in the radical neck dissection or modified radical neck dissection. In the illustrations in this text, the nerve is illustrated as having been divided, but this is not always necessary.

Spinal Accessory Nerve

The spinal accessory nerve (the 11th cranial nerve) passes over the jugular vein in most instances at the level of the posterior belly of the digastric muscle. It then passes through the lymphoid tissue of level IIB (level II posterior to the jugular vein) and then in most cases pierces the SCM after giving off a branch that innervates the muscle. It occasionally passes *under* the IJV and rarely the vein will be found to split around the nerve. Although classic anatomic diagrams suggest that the nerve passes under the vein in 30% of the cases, the clinical experience of surgeons suggests that this figure is much less. Nevertheless, blindly cutting all tissue lateral to the nerve at the level of a digastric muscle may interrupt the IJV in some cases. These anatomic details are important to recall in vein-sparing procedures.

At the point where the accessory nerve enters the SCM, there is a vascular pedicle that may provide troublesome bleeding during dissection. These vessels are best ligated after identification in the performance of a selective or modified neck dissection. The 11th nerve exits the muscle deep to Erb's point (at which the GA nerve sweeps around from the posteroinferior aspect of the SCM) and then traverses level V in a fairly superficial plane to reach the anterior border of the trapezius muscle (see Fig. 78-6). It is the loss of trapezius muscle function that is responsible for much of the morbidity of the procedure. The fascial envelope of level V must be incised to free the nerve during a modified neck dissection if spinal accessory nerve preservation is to be accomplished. Even if the nerve is preserved, some deficit can be demonstrated in patients in whom it is dissected.[10] On reaching the anterior border of the trapezius muscle, the nerve does not directly pierce it, but rather extends inferiorly just anterior to the anterior border, from which ramifications enter the muscle. Dissecting “hard on” the muscle in its most lateral extent can result in inadvertent denervation in planned nerve-sparing procedures. The 11th nerve lies more superficial at its more posterior-inferior extent and can be injured during flap elevation. It frequently travels directly superficial to enlarged posterior cervical nodes and can be inadvertently divided when these nodes are removed for biopsy purposes. Particular care must be taken when a mass in the posterior triangle of the neck is biopsied under local anesthesia. The local anesthesia may result in loss of motor nerve function so that the characteristic motion of the trapezius on touching the nerve is eliminated. The nerve can thereby be inadver tently divided and the injury remains unrecognized until the local anesthetic dissipates. If resection is required, nerve repair has been demonstrated to be beneficial.[11]

Trapezius Muscle

The trapezius muscle extends from the posterior occiput and nuchal line along the posterior margin of the neck dissection and extends to the lateral third of the clavicle. Identification of this muscle may be difficult during flap elevation because of its superficial position and significant posterior positioning superiorly in the neck. Early identification of the 11th nerve and dissecting along its course to the trapezius are useful. In identifying the muscles, it is not uncommon to mistake the levator scapulae for the trapezius during flap elevation. Such a mistake might lead to inadvertent transection of not only the 11th nerve but also the nerves to the levator scapulae, resulting in shoulder disability. The trapezius muscle assists in stabilization of the shoulder girdle during arm abduction. The arm frequently cannot be elevated beyond horizontal after nerve injury. Functional disability arises such that there is shoulder drop and “winging” of the scapula (Fig. 78-7). The greatest morbidity, however, is not the decreased range of motion but rather severe shoulder discomfort due to the loss of function and torque on the acromioclavicular joint. The combination of loss of trapezius function and shoulder pain is referred to as “the shoulder syndrome” and can be detected in a high percentage of patients who have undergone neck dissection. Preservation of the 11th nerve reduces, but does not totally eliminate, this effect of nerve injury.

Figure 78-7 A patient with paralysis of the left trapezius and a dropped shoulder, resulting from 11th nerve sacrifice.

Omohyoid Muscle

The omohyoid muscle consists of two bellies, the posterior of which lies superficial to the brachial plexus, phrenic nerve, and transverse cervical artery and vein (Fig. 78-8). Its anterior belly lies immediately superficial to the jugular vein at the division point between nodal levels III and IV before turning superiorly to attach to the hyoid bone. Early identification of this muscle assists in the identification and preservation of the brachial plexus and phrenic nerve. It is often entitled the “resident's friend,” similar to the description of the digastric muscle (discussed next).

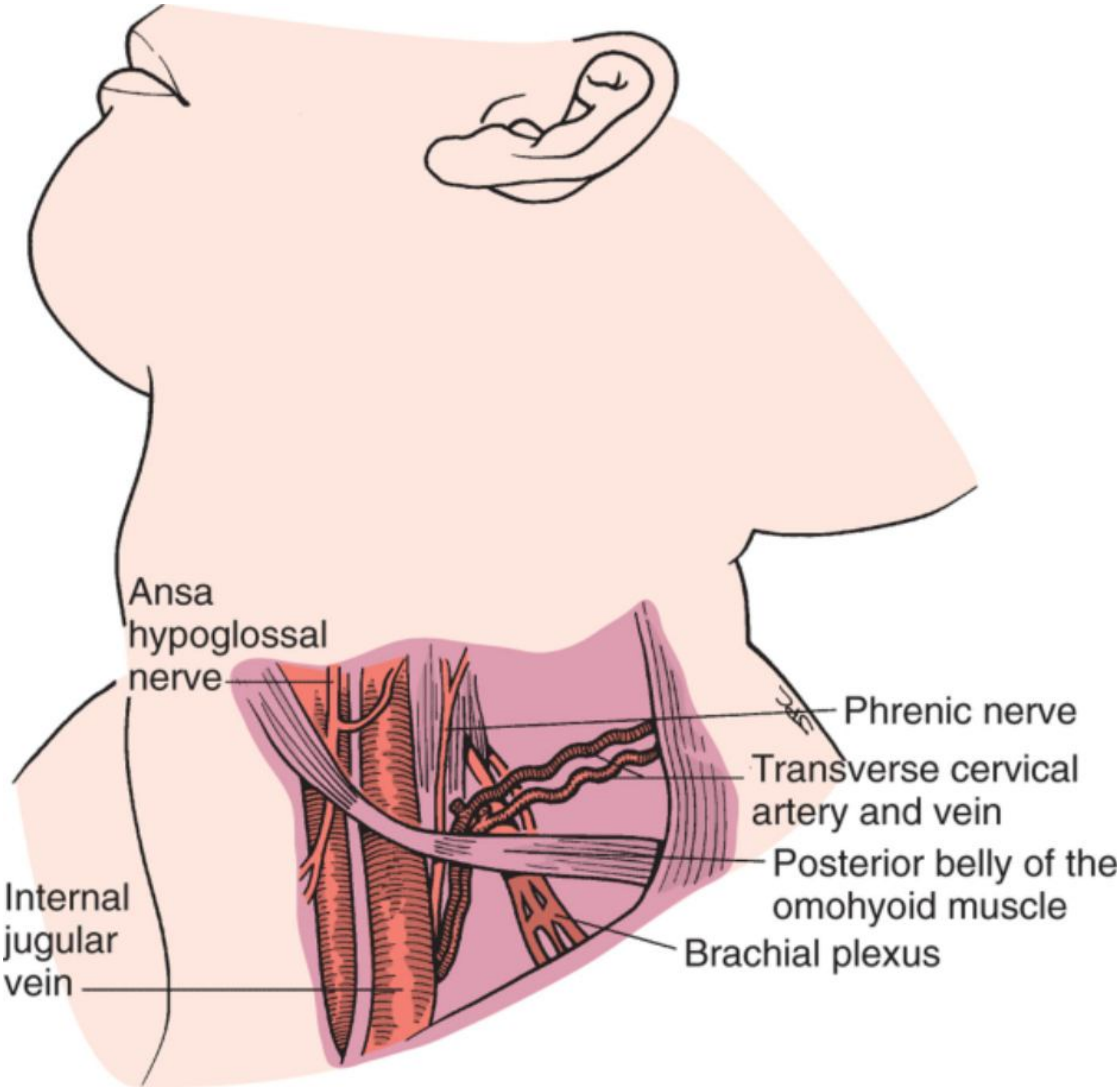

Figure 78-8 Detail of the inferior neck: omohyoid muscle, transverse cervical artery, brachial plexus, and jugular vein.

Digastric Muscle

The posterior belly of the digastric muscle extends from the greater corner of the hyoid bone to the deep undersurface of the mastoid tip. It inserts into a groove in the mastoid process of the temporal bone recognized from the mastoid side as the *digastric ridge.* The only critical anatomic structure superficial to the posterior belly of the digastric muscle is the marginal mandibular branch of the facial nerve (see later discussion). This muscle, often entitled the “resident's friend,” lies directly superficial to the branches of the external carotid artery, the hypoglossal nerve, the internal carotid artery, and the jugular vein (Fig. 78-9). The 11th nerve passes over the jugular vein and immediately deep to the posterior belly of the digastric muscle in the majority of patients. During selective neck dissection, definition of the angle created by the deep anterosuperior aspect of the SCM and the posterior belly of the digastric muscle helps free nodes located high and posteriorly in level II (2B) (see Fig. 78-9).

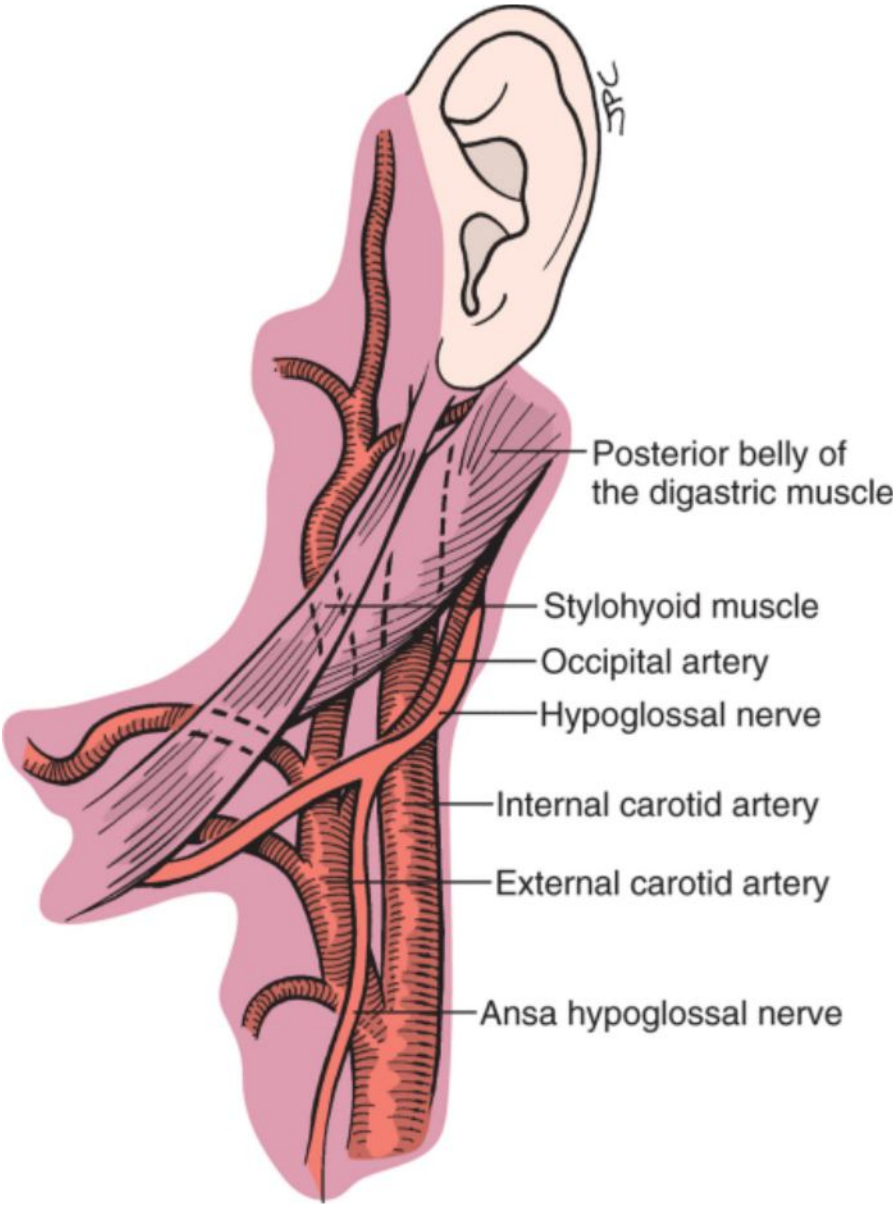

Figure 78-9 Detail of the superior neck, including the digastric muscle, the internal and external carotid arteries, and the hypoglossal nerve.

The anterior belly of the digastric muscle separates the submandibular triangle level IB from the submental triangle level IA. In patients with lesions of the anterior floor of the mouth, lip, or facial skin, it is important to remove the submental nodes anterior to the anterior belly of the digastric muscle. Removal of the muscle, fascia, and nodes immediately posterior to the anterior belly of the digastric muscle assists in identification of the mylohyoid muscle, a key step in safe dissection of the submandibular triangle. Exposure of the anterior belly of the digastric muscle can assist in defining the posterior belly as well, a time-saving step in cases in which a complete dissection of level I is not performed.

Facial Nerve

The facial nerve exits the stylomastoid foramen immediately anterior and superior to the digastric muscle and extends laterally and anteriorly within the substance of the parotid gland. The inferior division passes lateral to the posterior facial vein before bifurcating. The marginal mandibular nerve extends anteriorly and immediately deep to the fascia covering the submandibular gland before extending superiorly into the platysma muscle. Usually more than one branch is present, the most inferior of which may loop inferior to the submandibular gland. A sensory branch of the transverse cervical nerve may accompany this nerve, making identification difficult. The cervical branch, which must be sacrificed in neck dissection, extends inferiorly to innervate the platysma. Preservation of the marginal branches of the facial nerve is an important component of neck dissection. Unnecessary trauma to this nerve is to be avoided because it results in obvious lower lip and commissure deformity. However, removal of the nodal groups in level I requires that this nerve be dissected free from the prevascular and postvascular node region at the crossing of the facial artery and vein over the mandible at the mandibular notch. Although dividing the vein and artery low and sweeping the tissue superiorly will protect the nerve in this location, it is not adequate protection for the nerve posterior to the vein and leaves the lateral level I nodes undissected. These may be involved with tumor in the floor of the mouth and lateral oral cavity lesions such as those of the buccal mucosa and mandibular alveolus. Once the nerve is identified, it can be traced posteriorly to where it turns superiorly into the parotid gland. Tissue lateral and inferior to this point can be safely divided to expose the posterior belly of the digastric muscle. This is help-ful early in the performance of a selective neck dissection.

Hypoglossal Nerve

The hypoglossal nerve exits near the jugular foramen, passes under the IJV and over the internal and external carotid arteries, giving off the ansa hypoglossal branch. It then loops inferior and passes under the posterior belly of the digastric muscle, passing across the floor of the submandibular triangle. At the point where it passes under the digastric muscle, it is surrounded by numerous veins forming a venous sheath called the *Ranine veins*. It enters the submandibular triangle under the fascia of the floor of the triangle roughly parallel to the direction of the submandibular duct, crossing the submandibular triangle before entering the tongue musculature. Inadvertent clamping while controlling venous bleeding in the plexus posterior and inferior to the posterior belly of the digastric muscle can result in inadvertent injury to the hypoglossal nerve. Injury can also occur through inappropriate dissection through the fascia of the floor of the submandibular triangle, particularly when the nerve is adherent to the submandibular duct due to fibrosis.

Brachial Plexus and Phrenic Nerve

Injuries to key peripheral nerves during the performance of neck dissection can result in serious complications, typically with lifelong sequelae. Injuries to the brachial plexus or phrenic nerve are among the most devastating of these inadvertent injuries. Careful anatomic dissection is required and, if there are any questions as to location, the patient should not be paralyzed so that inadvertent (or intentional) stimulation of the nerve can be identified. Injuries to the brachial plexus and phrenic nerve are to be avoided. The brachial plexus exits between the anterior and middle scalene muscles and extends inferiorly deep to the clavicle and under the posterior belly of the omohyoid muscle. The transverse cervical artery and vein usually lie immediately superficial to the plexus and often can be preserved by careful dissection and division of the ascending branches in order to permit inferior displacement (see Fig. 78-8).

The phrenic nerve is formed by contributions from the cervical plexus ("three, four, and five keep the diaphragm alive") and must be preserved to avoid postoperative pulmonary compromise. The nerve should be identified early in the dissection of levels IV and V as it crosses the anterior scalene muscle immediately anterior to the brachial plexus and in proximity to the transverse cervical artery and vein. The nerve lies immediately under the enveloping fascia of the anterior scalene muscles, hence elevation of the fascia from the muscle can lead to inadvertent elevation of the nerve into the surgical specimen and inadvertent injury. A more common cause of injury to the phrenic nerve is through removal of the cervical plexus by inadvertently dividing the spinal contributions to the cervical plexus as they extend between the middle and anterior scalene muscles. This occurs when the surgeon dissects in too deep a plane across the scalene muscles, inadvertently elevating and removing the cervical plexus. This injury can be avoided by keeping the plane of dissection above the fascia and dividing the cervical nerves only after they exit the plexus and extend into the specimen. This technique avoids the inadvertent elevation of the plexus and its contribution to the phrenic nerve. Early identification of the phrenic nerve to keep it visualized throughout the procedure also assists in protecting the integrity of the nerve.

The cutaneous branches of the cervical plexus identify the posterior limit of dissection of levels II to IV. These nerves exiting the plexus should be identified and maintained intact. This technique assures that the cervical plexus and its contributions, particularly the phrenic nerve, remain undissected. Although these are routinely divided in the performance of a classic radical neck dissection, they are also divided again as they exit the cervical plexus. If during the performance of a selective neck dissection the cervical nerves are inadvertently divided, then they must be identified and followed to the cervical plexus and left in situ to avoid inadvertent dissection of the cervical plexus.

Internal Jugular Vein

The venous anatomy of the neck varies considerably in terms of both the relative size and the anatomy of the IJV and its tributaries. The disparity in size between right and left internal jugular veins can be marked in some cases. Typically, there are multiple small tributaries and several large branches; of particular importance is the common facial vein, located approximately two thirds of the way from the clavicle to the digastric muscle, which enters along with the superior thyroid vein in a trifurcation. Care must be taken when dissecting the fascia from the vein in the performance of a vein-sparing procedure to avoid tearing the smaller tributaries. Tearing these smaller tributaries can result in excessive blood loss and significant wasted time in an attempt to preserve the vein. Although the retromandibular vein can occasionally be preserved, the multiple tributaries in this region, the frequent occurrence of positive nodes at the trifurcation, and the risk of inadvertent injury to the hypoglossal nerve mitigate against the routine preservation of the retromandibular vein. When ligating the common facial vein, it is wise to leave a generous stump to avoid artificially constricting the IJV by ligature.

Carotid Artery

The carotid artery and vagus nerve travel within the carotid sheath immediately deep to the jugular vein. The vagus nerve can be dissected free from the carotid artery; care must be taken when dividing the IJV in the inferior portion of the neck to avoid elevating the vagus nerve with the vein before ligation and division. Here again identification is the best protection. The cervical sympathetic chain lies posterior and deep to the carotid sheath as the neck is dissected from posterior to anterior. Care must be taken not to dissect deep to the carotid artery or the cervical sympathetic chain will be elevated, resulting in Horner's syndrome.

Bradycardia or hypotension may occur during dissection in the region of the carotid bulb due to stimulation of the pressure receptors in this area. If this occurs, dissection around the artery should cease, and injection of 1% lidocaine (Xylocaine) without epinephrine into the adventitial tissue of the carotid artery can abort or prevent the problem. Patients with head and neck cancer frequently have concomitant vascular disease, so that excessive manipulation of the carotid artery should be avoided because this can precipitate embolic phenomena, including stroke. Gentle handling and minimal manipulation of the artery are necessary to avoid these difficulties. Dissection of adherent tumor from the carotid artery can be performed in the subadventitial plane. Dissection is tedious and high levels of both technical skills and surgical judgment are required to assure optimal outcome.

The superior thyroid artery, the first branch of the external carotid system, loops slightly superiorly before beginning its inferior transit toward the superior pole of the thyroid gland. At this point it is close to the superior laryngeal nerve, and preservation of the artery can assist not only in identification of the superior pole of the thyroid, but also in preservation of the superior laryngeal nerve.

Branches of the external carotid artery lay immediately deep to the hypoglossal nerve and in close proximity to the ranine veins. During dissection of the hypoglossal nerve and division of the ranine veins, care must be taken to avoid injury to these vessels, particularly sidewall types of injuries that can result in later postoperative bleeding.

Thoracic Duct

The thoracic duct ascends into the lower left neck immediately posterior to the jugular vein. The duct may extend several centimeters above the clavicle before turning anterior and lateral to empty into the jugular vein (Fig. 78-10). The anatomy of this thin-walled network of ducts varies considerably and it is usually impossible to individually identify and ligate the tributaries. It is important to recall that chyle is not milky in fasting patients who have received nothing by mouth for at least 8 to 12 hours; therefore identification of a leaking duct may be particularly difficult in elective procedures. The duct lies anterior to the phrenic nerve and the transverse cervical artery and vein. The preferred method to avoid a chyle leak is by en bloc ligation of the lymphatic pedicle in which the lymphatic duct(s) lie. This can be safe to perform only after the carotid artery, vagus nerve, IJV, and phrenic nerve are identified. Suture ligation of the pedicle is often warranted to prevent the tie from slipping loose and resulting in a leak. If a leak does occur, microscopic examination of the surgical field may be required to identify and repair the site of the leak. Fibrin glue has been reported to be useful in these situations.[12]

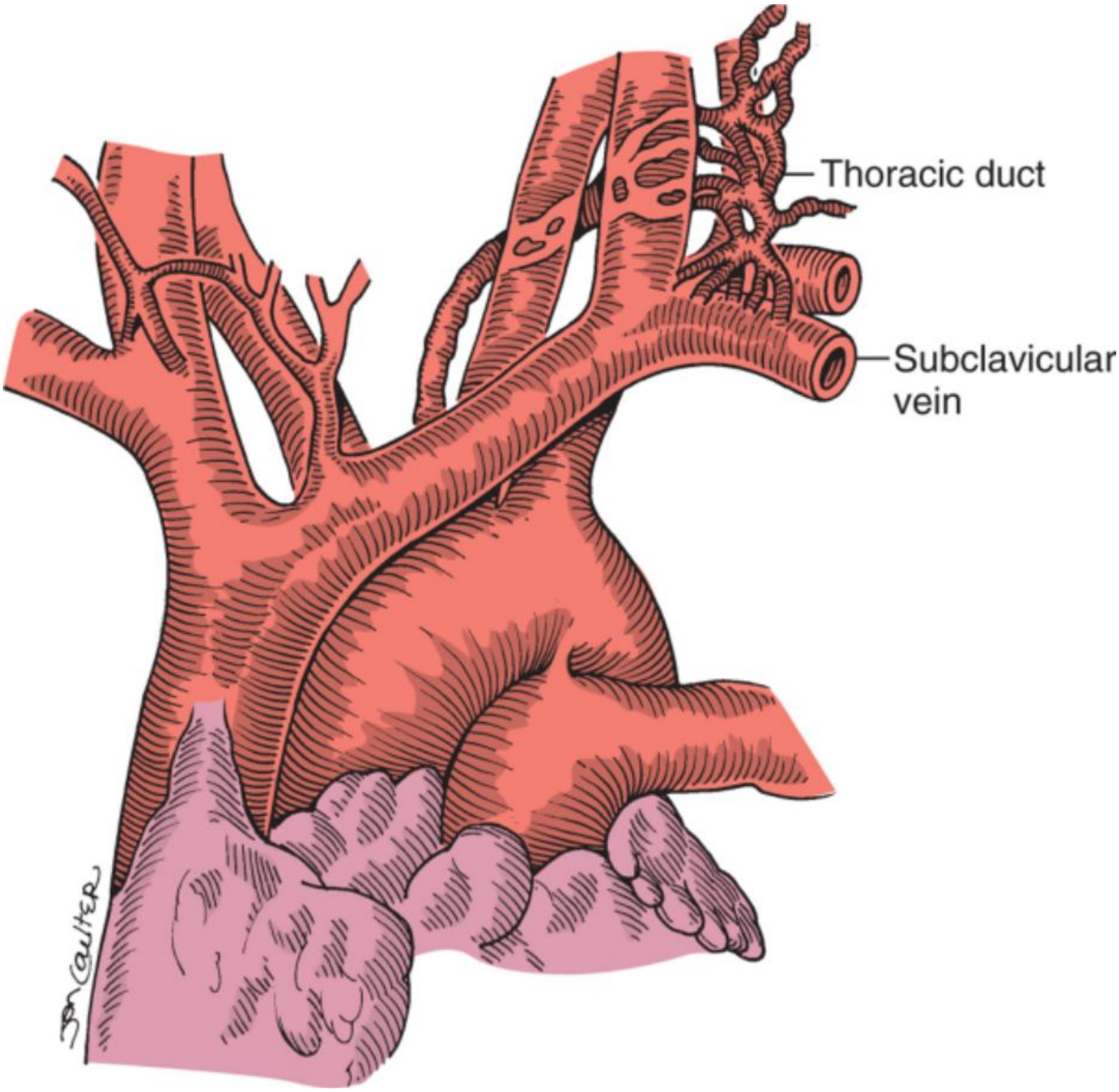

Figure 78-10 Detail of the thoracic duct and vascular structures in the inferior neck.

NODAL LEVELS

The anatomy of the neck is easier to comprehend when divided into triangles: submental, submandibular, anterior, and posterior cervical triangles. The predominant nodal groups are located in the anterior triangle, adjacent to the carotid sheath, extending from just inferior to the posterior belly of the digastric muscle to the thoracic inlet. Additional nodes are located in each of the other cervical triangles. Nodal groups are divided into regions or levels (see Fig. 78-3). Level I includes both the submental and submandibular regions, often-times referred to as levels IA and IB. Although similar, surgical and radiographic definitions of the divisions between the levels are not identical. For example, the radiographic division between levels III and IV is the inferior margin of the cricoid cartilage. However, chest wall configuration and neck positioning can result in variation of this position in relationship to the actual nodal groups. Level II includes the jugular digastric region from the level of the posterior belly to the digastric muscle down to the level of the hyoid bone. Level III extends from the hyoid bone to the level of the cricoid. Level IV nodes are those inferior to the level of the cricoid cartilage and extend down to the level of the clavicle where it is contiguous with the mediastinal nodes. Level V includes the posterior triangle nodes, which lie posterior to the SCM and envelop the path of the spinal accessory nerve, as well as the supraclavicular nodes. Level VI is the central anterior neck compartment and consists of the pretracheal (Delphian) and paratracheal nodes inferior to the thyroid gland and adjacent to the thymus.

Predictability of Nodal Drainage

Clinical experience suggests that the pattern of initial tumor spread from various primary sites to specific nodal groups is predictable. These patterns have been illustrated in a large clinicopathologic series of neck dissections performed on patients with clinically disease-free necks.[13] Anterior oral cavity malignancies tend to drain first to nodes in levels I, II, and III before involving nodes in levels IV and V. Although uncommon, inferior level III nodes under the omohyoid muscle can be the only nodes involved with anterior oral tongue lesions. Cancers arising in the oropharynx, hypopharynx, and supraglottic larynx initially metastasize to levels II, III, and IV. Level I nodes are infrequently involved in primary cancer of the hypopharynx or supraglottic larynx without clinical evidence of neck disease. Tumors of the thyroid gland may metastasize to levels II to IV, including the paratracheal lymph nodes, and to level V. A palpable level V node may be the only clinical evidence of a thyroid malignancy. This predictability facilitates the selection of specific modifications of neck dissection for specific patients.

Sentinel Node Biopsy

Evidence exists to suggest that the lymphatic drainage of various sites of the head and neck spread in a predicable manner to specific nodes. These nodes, termed *sentinel nodes*, are the first echelon in the drainage pattern and the presence or absence of tumor in these sentinel nodes can predict whether or not other nodes in the neck may be involved. Although standard therapy for melanoma[14] and breast cancer, sentinel node biopsy remains investigational in the management of squamous cell carcinoma of the head and neck.[15] Identification and careful examination of sentinel nodes has a high reliability in predicting the presence of tumor spread beyond the primary site, but reliability of the sampling is not infallible.[16] There are several technical challenges inherent with its usage. The first of these is the requirement that appropriate imaging material be injected into the area around the primary site at the correct timing to permit visualization. Interoperative identification of the node can be assisted by an interoperative detector. Many surgeons use isosulfan blue injected along with the sulfur colloid to permit visual staining of the sentinel node.[15]

Once the lymph node has been removed, a careful histologic examination must be performed to identify microscopic evidence of tumor involvement. Time-consuming serial sectioning of sampled nodes is required, hence sentinel node biopsy is not an interoperative tool as of this time. It is possible that in the future polymerase chain reaction or assisted sentinel node sampling may facilitate interoperative assessment of the positivity of sentinel nodes.

One of the more problematic features of head and neck cancer is the presence of more than one sentinel node in a significant percentage of patients. This requires the identification and dissection of several nodes, often through separate incisions at separate sites, leading to fairly extensive dissection and longer surgical procedures. As a result of this and the aforementioned issues, sentinel node biopsies for squamous cell cancer of the head and neck is currently performed in only a few centers in an investigational manner.

CLASSIFICATION OF NECK DISSECTION

Neck dissections can be classified into one of three basic types: comprehensive, selective, and extended. Comprehensive neck dissections remove all of the nodes removed by the classic radical neck dissection and may preserve several or all of the nonnodal structures typically resected in radical neck dissection. In the past, modified neck dissection was identified by number. The current classification system notes the levels removed and the structures preserved (Fig. 78-11).

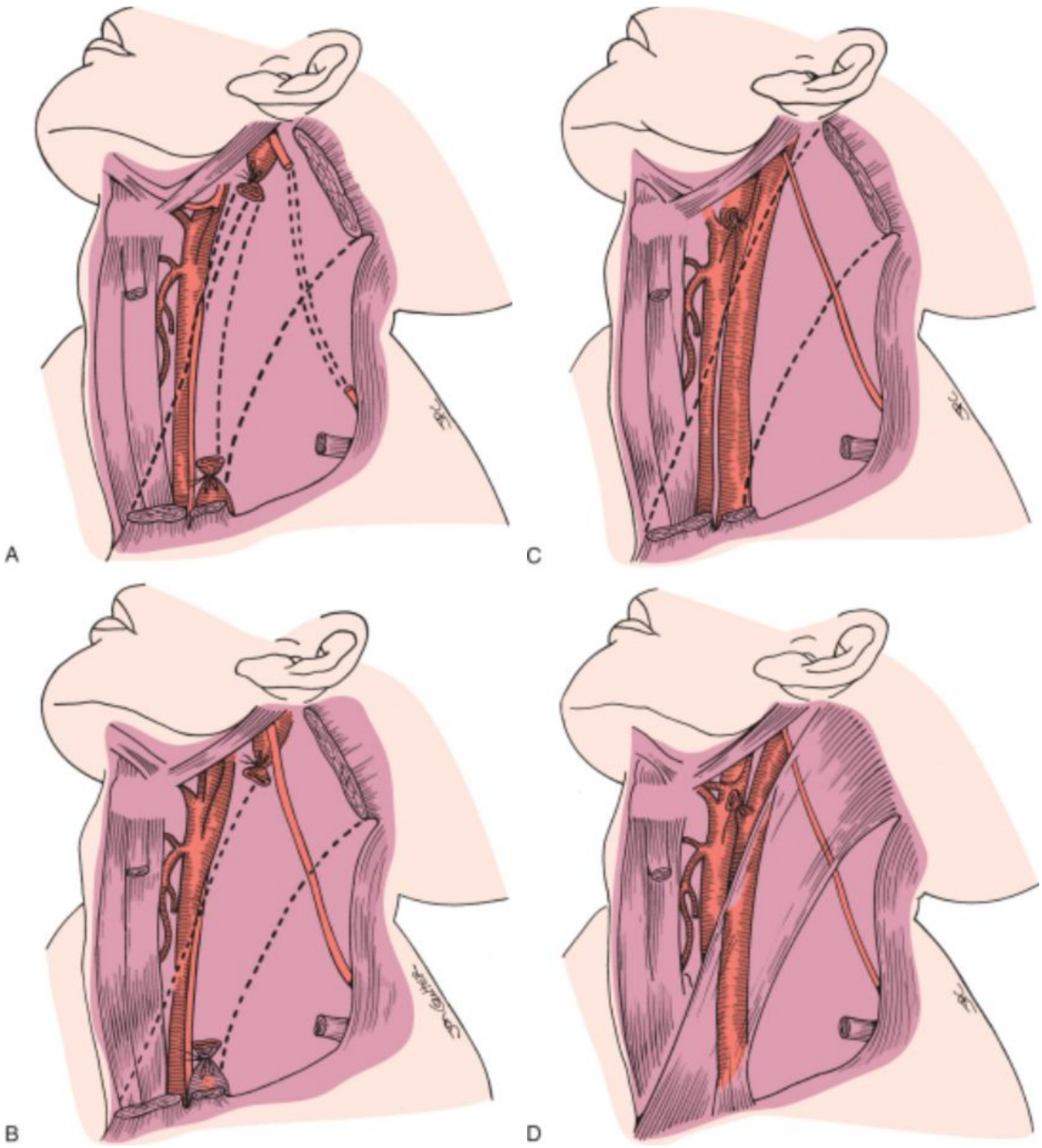

Figure 78-11 **A,** Radical neck dissection (RND)—the sternocleidomastoid muscle (SCM), the internal jugular vein (IJV), and the 11th nerve are all resected with the specimen. **B-D,** Three types of modified neck dissections, preserving one or more structures. **B,** Preserving the 11th nerve.

*Modified neck dissections, preserving the IJV and the 11th nerve (**C**) and the 11th nerve, the IJV, and the SCM.*

Selective neck dissections are designed to remove specific nodal groups. Which nodal groups are removed is dependent on the site and stage of the primary cancer. Although these procedures were initially used only for the elective management of the clinically negative neck, they are now used for removal of clinically involved nodes in selected cases. Clinical pathologic studies performed by Byers and colleagues 25 years ago provide the basis for the selection of specific nodal groups at highest risk for occult metastatic disease.[13] The anterior (or supraomohyoid) neck dissection was designed to remove nodes in levels I to III and is characteristically used when cancer originates in the oral cavity. Levels II through IV are removed for primary cancer originating in the supraglottic larynx and hypopharynx. Levels II through V are removed in cases of cancer of the posterior scalp along with the suboccipital nodes under the trapezius muscle posterior to level V. As such, this “posterior lateral neck dissection” is a form of extended neck dissection even though nodes in level I are not resected.

Extended neck dissections such as paratracheal dissections may be performed for lesions likely to involve the nodes in level VI, primarily cancer involving the subglottic larynx and thyroid gland.

RADIOLOGIC STAGING

Radiologic evaluation is not a prerequisite for the performance of neck dissection in most cases of cancer of the head and neck. Nevertheless, suspicious nodes may be identified in regions in which removal had not been previously contemplated. Preoperative imaging is becoming standard in the preoperative evaluation of these patients in most centers, with criteria for determination of node positivity demonstrated in Figure 78-12. Computed tomography (CT) increases the accuracy of visual examination of the neck by 10% to 15% but is still less than 100% reliable.[17] A negative CT scan should not lull the surgeon into complacency regarding the possibility of occult metastatic nodes.

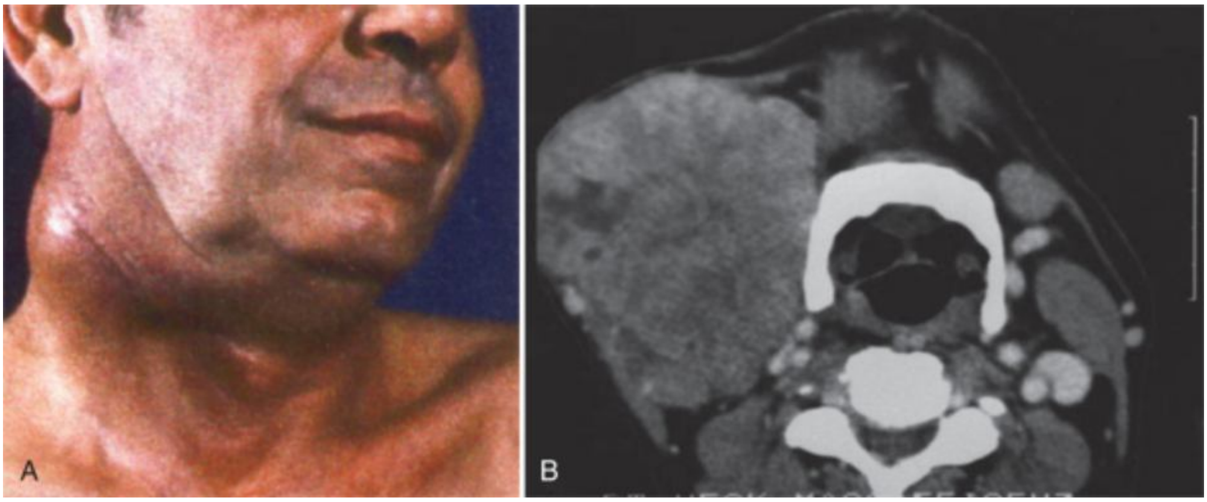

Figure 78-12 **A,** A patient with a massive right neck mass that is metastatic from a piriform sinus carcinoma. **B,** Axial computed tomography scan of the neck of the patient in **A**. The scan demonstrates enlarged nodes with central necrosis and obscured nodal margins, criteria for malignancy.

The use of MR scanning is standard in some institutions, although many surgeons find MR scan to be more difficult to interpret than CT scan. A multi-institutional trial comparing MR with CT scan demonstrated no significant benefit of one modality over the other.[17] Positron emission tomography (PET)/CT scanning is becoming a commonly used tool in the evaluation of patients with unknown primary cancers of the head and neck as well as of patients with extensive disease. Due to the requirement of a sizable deposit of metastatic disease to facilitate imaging, PET/CT is not as useful in the evaluation of the clinically negative neck—an indication that is primarily investigational as of this time.

PATIENT SELECTION

Surgical decision making for patients with head and neck cancer has become more challenging over the past decade with advances in nonoperative therapy. Organ preservation treatment protocols often yield survival rates similar to those of surgical management, typically with improved postoperative function for affected patients. Treatment of these patients usually includes management of the neck with nonoperative therapy concomitant with the treatment of the primary tumor. Treatment decisions for patients who have persistent evidence of neck disease following nonoperative therapy is not difficult, because salvage neck dissections are well tolerated and offer a survival benefit. Pathologic examination of the surgical specimens may not demonstrate viable tumor in up to 50% of these cases, but in the absence of preoperative certainty, surgery is indicated. PET/CT imaging may alter decision making in some of these patients.

More problematic is decision making for the patient with advanced neck disease (N2-3) who has demonstrated significant response to organ preservation therapy. Opinions are split,[18–20] although it would appear that apparently persistent viable tumor can be seen on histologic examination in approximately 20% to 30% of specimens. What is not clear, however, is the extent of the risk of continued tumor proliferation. It seems likely that this group of patients stands to benefit the most from routine posttreatment PET/CT imaging.

Selection of the appropriate surgical procedure for the management of the cervical nodes in a particular patient is based on multiple factors, including the primary site of the cancer, patient status, prior therapy, and treatment goals. The radical neck dissection, or modifications thereof, is preferred for advanced stage neck disease that is technically resectable. Identification of patients with technically unresectable advanced neck disease is a difficult clinical problem, even with the advent of CT and magnetic resonance imaging. Encasement of the internal carotid artery (Fig. 78-13) is usually a contraindication to neck dissection unless the surgeon is prepared to resect and graft the carotid artery and the patient has been evaluated to determine the consequences of this procedure. Newer techniques to identify patients with adequate cerebral blood flow after unilateral radical neck dissection with carotid sacrifice may be used to select a subset of patients with carotid involvement who would tolerate carotid excision without suffering unacceptable central nervous system compromise. Unfortunately, long-term outcomes in this group of patients are uniformly poor except in rare instances in which other structures are not involved by tumor. Similarly, patients with a mass in the neck attached to the deep cervical musculature are usually not considered candidates for radical neck dissection.

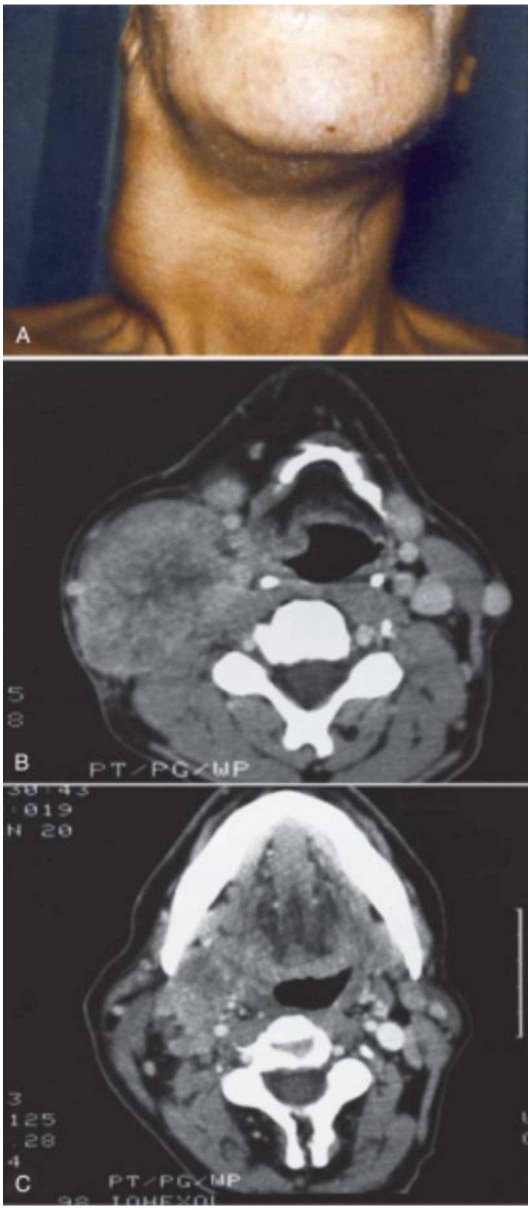

Figure 78-13 Photograph **(A)** and axial computed tomography (CT) scans (**B** and **C**) of the neck of a patient with massive cervical lymphadenopathy. The CT scans demonstrate encasement of the left carotid artery and suggest tumor invasion of the sternocleidomastoid muscle and the deep cervical muscles.

Modifications of the radical neck dissection may be appropriate for use in patients with palpable neck disease. Preservation of the 11th nerve is the most common modification, and preservation of the jugular vein is also common. Preservation of the SCM is more problematic due to the difficulty in dissecting level V during a comprehensive modified neck dissection while leaving the SCM intact.

Selective neck dissections remove selected groups of nodes at greatest risk of involvement. These procedures are used for the management of patients without palpable neck nodes but who are at risk for occult nodal disease. Because not all nodal groups are removed, these operations are tailored for individual patients. Often their primary value is as a staging procedure, although they may, in fact, be therapeutic for this group of patients in that the nodes removed are those most likely to contain microscopic cancer.[21] Selective neck dissections are best suited for patients without clinical evidence of metastatic disease or with small, single, mobile nodes.

Cancer in certain primary sites has a high propensity for bilateral nodal involvement. We have demonstrated lower levels of recurrence in the neck following bilateral, vein-preserving surgical procedures in selected sites such as the supraglottic larynx[1] and hypopharynx.[22] In our experience, radiation therapy administered postoperatively in adjuvant doses has not been effective in sterilizing necks containing occult metastatic disease. For this reason, we recommend bilateral selective neck dissections for primary squamous cell cancer of selected sites when surgery is selected as primary therapy.

Perhaps the most significant advantage to selective neck dissection is the histologic staging information provided. Identification of a subset of patients with advanced disease or with disease with poor prog-nostic signs, such as the presence of multiple positive nodes or nodes with ECS of tumor, enables selective use of adjuvant radiotherapy and, in some patients, chemotherapy.

If the neck dissection specimen contains no involved nodes or only one or two small nodes without ECS of tumor, adjuvant therapy may not be necessary. Single-modality therapy may significantly decrease mor-bidity and enhance the results of postoperative rehabilitation.

For these as well as other reasons (e.g., surgical access), we believe that selective neck dissection should be considered routine in the management of squamous cell cancer in selected patients who have no clinically palpable nodes.

PREOPERATIVE PLANNING

Patient selection is the most critical portion of preoperative planning. An assessment of the patient's disease, comorbidities, and treatment goals is required. Management of underlying medical diseases will usually mandate close cooperation with medical consultants. Patients who present with significant weight loss and hypoalbuminemia will fail to heal, and preoperative nutritional support is required. In most instances, this will require the placement of a nasogastric or gastrostomy tube. Nutritional status is particularly problematic in the group of patients who present for salvage neck dissection following nonoperative therapy. Although prior chemotherapy does not adversely affect wound healing, the depleted nutritional status of the patient does. There is consensus that prior radiotherapy affects wound healing, although the primary effect may be the severity of wound complications rather than the actual incidence for most patients.

Preoperative planning includes obtaining informed consent from the patient. It is appropriate to explain to the patient why a neck dissection is being performed and any alternative forms of therapy. It is probably appropriate to note that radiation therapy may be able to control 80% to 90% of disease-free necks but does not provide the pathologic staging information that a neck dissection does. Radiation therapy may, in the long run, have more significant long-term complications than selective or modified neck dissection (or for that matter, the classic radical neck dissection). Withholding radiation therapy when other options are available may permit its use later in the treatment of second primary cancers. We reserve radiation therapy for patients treated with nonoperative organ preservation protocols or for those with biologically advanced disease who require adjuvant therapy. Radiotherapy is not routinely offered as an alternative treatment for the disease-free neck, except when the primary tumor is managed with radiotherapy.

Perioperative antibiotics are required in the preoperative period if the procedure will involve going through the neck into the upper aerodigestive tract. There may be an advantage to the use of antibiotics in noncontaminated cases as well; Carrau and associates demonstrated a risk of postoperative wound infection of 10% in this population.[23]

SURGICAL TECHNIQUES

The technique of neck dissection varies with the location of palpable disease, the planned procedure for the primary tumor, and the type of neck dissection. The techniques are divided into the comprehensive neck dissections (with the classic radical neck dissection and its modifications) and the selective neck dissections.

Identification of a sequence for a surgical procedure is a valuable adjunct to the resident in learning the techniques used in a specific operation. Perhaps this is most important in the performance of a neck dissection because an orderly sequence of events will result in the identification and preservation of vital structures and ensure the safety as well as the expediency of the procedure. Tables 78-1 and 78-2 list the sequences of the operative procedures we perform for the radical and modified radical neck dissections and selective neck dissection. The exact sequence used by the operating surgeon may vary. However, reviewing this sequence or keeping it on a 3 × 5 note card for preoperative reference will be valuable to the resident and the infrequent operator.

Table 78-1 -- STEPS IN RADICAL NECK DISSECTION

Perioperative antibiotic?
Position on shoulder roll
Prepare and drape (staples)
Incision
Avoid trifurcation over carotid
Avoid narrow flaps
Incise through platysma

Raise subplatysmal flaps
Leave greater auricular nerve and external jugular vein on sternocleidomastoid muscle (SCM)
Identify/preserve marginal mandibular nerve
Level I dissection
Remove submandibular nodes and submandibular gland
Ligate facial artery above digastric muscle
Include submental fat pad
Expose anterior border of trapezius muscle
Incise SCM 1 to 2 cm above clavicle
Identify and trace omohyoid
Transect omohyoid posteriorly
Bluntly dissect and identify brachial plexus and phrenic nerve
Bluntly dissect and transect posterior triangle
Incise along anterior border of trapezius
Incise superior end of SCM
Rotate specimen anteriorly
Re-identify and preserve brachial plexus, phrenic nerve
Identify cervical nerves and incise *high on specimen*
Identify carotid (and vagus)
Return neck specimen to anatomic position and identify, cut, and ligate inferior jugular vein
Do not incise vagus nerve!
Re-identify phrenic and vagus nerves; then clamp, cut, and ligate lymphatic pedicle to avoid chyle leak
Elevate specimen from carotid and vagus, proceeding superiorly
Identify and preserve hypoglossal nerve
Ligate superior jugular vein at the digastric muscle
Rotate specimen anteriorly
Ligate ranine veins
Preserve superior thyroid artery and superior laryngeal nerve
Resect specimen with anterior cervical veins and fascia
Irrigate wound
Ensure hemostasis
Insert drains
Close wound
Pressure dressing

Table 78-2 -- STEPS IN SELECTIVE NECK DISSECTION

Raise subplatysmal flaps Leave external jugular and greater auricular nerve on sternocleidomastoid muscle (SCM) Posterior elevation not necessary
If level I dissection: Identify and preserve marginal mandibular nerve Expose anterior belly of digastric muscle Expose mylohyoid muscle Elevate mylohyoid muscle Identify lingual, hypoglossal nerves Divide duct, vessels Resect submaxillary gland
Identify posterior belly of digastric muscle Identify posterior digastric muscle (Under submaxillary gland if not level I) Follow posterior digastric muscle to SCM Incise SCM fascia, including external jugular vein and external jugular greater auricular nerve Unwrap SCM Peel muscle from fascia

Identify accessory nerve Trace accessory nerve to digastric muscle Lift accessory nerve Free posterior corner Watch internal jugular vein and 11th nerve
Pass posterior corner under accessory nerve Cut deep fascia to omohyoid muscle Identify, trace cervical nerves Protect plexus and phrenic nerve Identify carotid sheath
Unwrap fascia from internal jugular vein Go slow Identify, ligate branches of internal jugular vein Elevate, clamp, ligate lymphatic pedicle Watch for vagus, phrenic nerves
Follow omohyoid muscle, carotid artery, internal jugular vein Preserve superior thyroid artery and hypoglossal nerve Divide ranine veins Label specimen—then: Resect specimen