

TITLE: Neck Dissection: Classification, Indications and Techniques
SOURCE: Grand Rounds Presentation, UTMB, Dept. of Otolaryngology
DATE: January 16, 2002
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Introduction

The single most prognostic factor for patients with squamous carcinomas of the upper aerodigestive tract is the status of the cervical lymph nodes. Cure rates drop to nearly half when there is involvement of regional lymph nodes.

The first conceptual approach for removing nodal metastases was made by Kocher in 1880. The classic technique of the radical neck dissection was later described by George Crile in 1906. Originally, this technique included removal of the submandibular salivary gland, internal jugular vein, greater auricular and spinal accessory nerves, as well as the digastric, stylohyoid, and sternocleidomastoid muscles. It was later popularized by Blair (1933) and Martin (1941) and the technique has remained virtually unchanged since. Martin believed in the concept that cervical lymphadenectomy for cancer was inadequate unless all the lymph-node-bearing tissues of one side of the neck were removed. This, he felt, was impossible without the removal of the spinal accessory nerve, the internal jugular vein, and the sternocleidomastoid muscle.

The 1960s and 70s marked a significant change in the attitude towards the surgical treatment of head and neck malignancies. This change was exemplified by the evolution of conservation laryngeal surgery where preservation of tissue and function was considered in the development of new surgical techniques and treatment. Similarly, this attitude began to infiltrate those developing new therapeutic modalities for the treatment of the neck. In 1953, Pietrantoni, a strong advocate of bilateral elective neck dissection, recommended sparing the spinal accessory nerves and at least one internal jugular vein. This break with surgical tradition was first limited to elective neck dissections, but was later extended to therapeutic dissections when lymph nodes were enlarged but still mobile. In 1967 Bocca and Pignataro described an operation that removed all of the lymph node groups but spared the sternocleidomastoid muscle, the spinal accessory nerve, and the internal jugular vein. Bocca, a staunch opponent of conservative nodal

stripping indicated the complete effectiveness of his surgical technique, which he described in the Semon Lecture to the Royal Society of Medicine in 1975: “a complete dissection of the lateral cervical space, anatomically confined by a fascial envelope, and itself containing the major cervical lymphatics”. He called this technique the “**functional neck dissection**”. He followed nearly 400 patients with N0-N2 treated with this technique. These patients showed no difference in survival from those patients treated with radical neck dissection. Since this time a multitude of modified techniques have evolved to more specifically address early stage neck metastases. In 1989, Medina suggested that lymphadenectomies be categorized as comprehensive, selective, or extended. Robbins *et al.* in 1991 used the term “selective” to distinguish patients who had one or more nodal groups preserved. Although these modifications have refined surgical treatment of the neck, it has also resulted in a nomenclature system that is confusing and non-uniform. In response to this confusion, in 1991 Robbins *et al.* published the Official Report of the Academy’s Committee for Head and Neck Surgery and Oncology standardizing neck dissection terminology. This terminology was adopted by the American Academy of Otolaryngology-Head and Neck Surgery and is the current terminology used by the American Joint Committee on Cancer (1997). To date there is continued debate and discussion as to the indications for these different neck dissections in treatment of the neck for various types and stages of head and neck malignancies.

Anatomy

A firm grasp of the applied and basic anatomy of the neck is paramount in providing appropriate surgical treatment to patients with head and neck cancer. Below is thorough, but by no means exhaustive, discussion of the anatomic structures that must be considered when performing a neck dissection.

Platysma Muscle

Origin and insertion. The platysma muscle is a broad sheet of muscle arising from the fascia covering the upper parts of the pectoralis major and deltoid muscles and contained in the superficial cervical fascia; its fibers cross the clavicle, and proceed obliquely upwards and medially in the side of the neck. The anterior fibers interdigitate, with the fibers of the opposite muscle below and behind the mental symphysis; succeeding fibers insert into the lower border of the body of the mandible more anteriorly while more laterally and posteriorly they cross the mandible and insert into the skin and subcutaneous tissue. Particularly in the area of the corner of the mouth the platysma interdigitates with the facial musculature.

Nerve supply. The platysma is innervated by the cervical branches of the facial nerve.

Function. The platysma muscle has four functions: (1) it wrinkles the surface of the skin of the neck in an oblique direction, and diminishes the concavity between the jaw and the side of the neck; (2) assists the facial muscles of expression in depressing the angle of the mouth; (3) increases the diameter of the neck during rapid respiration; (4) assists with venous return by increasing negative pressure in the superficial veins of the neck.

Surgical considerations. Raising skin flaps during a neck dissection is carried out in a subplatysmal plain. The purpose of this technique is to provide better blood supply to the flap. Laterally the fibers of the SCM may be confused for the platysma. The fibers of the platysma run anterosuperiorly from its origin while the fibers of the SCM run posterosuperiorly.

Sternocleidomastoid Muscle (SCM)

Origin and insertion. The SCM passes obliquely in the neck forming an “X” with respect to the more superficial fibers of the platysma muscle. It is invested in the superficial layer of the deep cervical fascia. It consists of two heads, one that originates from the medial third of the clavicle (clavicular or lateral head) and another which originates from the manubrium sterni (sternal head). These two join together and insert onto the mastoid process of the temporal bone.

Nerve supply. The SCM is innervated by the spinal accessory nerve (CN XI). The entire nerve may traverse the muscle. It also receives proprioceptive innervation by cervical spinal nerves from the cervical plexus

Blood supply. There are three sources of blood supply to the SCM: (1) the occipital artery or directly from the external carotid artery, (2) the superior thyroid artery, and (3) the transverse cervical artery

Function. When one SCM contracts, the head rotates away from the side of the contracting muscle and tilts towards the ipsilateral shoulder. Both muscles act together against gravity to draw the head forwards and help to flex the cervical part of the vertebral column. This is a common movement in feeding. If the head is fixed, they assist in elevating the thorax in forced inspiration.

Surgical considerations. (1) When raising skin flaps care should be taken to leave the superficial layer of deep cervical fascia overlying the SCM down. This will later be the dissection plain for unwrapping the SCM and will provide attachment to the contents of the posterior triangle for en bloc resection. (2) firm lateral retraction near the superior aspect of the SCM and upwards retraction on the mandible allow for good exposure in locating the spinal accessory nerve and in dissection of lymph nodes in the submuscular recess.

Omohyoid muscle

Origin and insertion. The omohyoid muscle consists of two bellies (inferior and superior). The inferior belly arises from the upper border of the scapula near the scapular notch. From there it inclines forward and slightly upwards across the lower part of the neck dividing the posterior triangle into an upper, occipital and lower, supraclavicular triangle. It passes deep to the SCM and ends in the intermediate tendon, which usually lies adjacent to the internal jugular vein, opposite the arch of the cricoid cartilage. This tendon is ensheathed by a band of deep cervical fascia, which is attached to the clavicle and first rib and is responsible for the angled appearance the inferior belly makes with the superior. The superior belly extends from the intermediate tendon and passes nearly vertically close to the lateral border of the sternohyoid

muscle and attaches to the lower border of the hyoid bone lateral to the insertion of the sternohyoid muscle.

Nerve supply. Nervous innervation to the omohyoid muscle comes from branches of the ramus superior of the ansa cervicalis (C1-C3).

Blood supply. Inferior thyroid artery

Function. The omohyoid depresses the hyoid bone after it has elevated during swallowing. It is speculated that it tenses the deep cervical fascia during deep inspiration to prevent collapsing of soft tissues.

Surgical considerations. The omohyoid may be absent in 10% of individuals. It is a useful landmark when dissecting the level IV lymph nodes. The inferior belly lies superficial to the brachial plexus, phrenic nerve and transverse cervical vessels. The superior belly lies just superficial to the internal jugular vein.

Trapezius Muscle

Origin and insertion. The trapezius is a flat sheet of muscle extending over the back of the neck and upper thorax. It originates from the medial one-third of the superior nuchal line of the occipital bone, the external occipital protuberance, the ligamentum nuchae, the seventh cervical and all the thoracic vertebral spinous processes, and the corresponding supraspinous ligaments. The upper fibers extend inferiorly and laterally, the middle fibers laterally, and the inferior fibers superiorly and laterally to join laterally and insert into the shoulder at the lateral third of the clavicle, the medial margin of the acromion and the spine of the scapula.

Nerve supply. Nervous innervation to the trapezius muscle is provided by the spinal accessory nerve.

Function. The trapezius functions to elevate and rotate the scapula forward and assists in elevating the arm above the head. It also stabilizes the shoulder when the arm is loaded.

Digastric Muscle

Origin and insertion. The digastric muscle has two bellies, anterior and posterior. The anterior belly originates from the digastric fossa of the mandible (at the symphyseal border). It extends inferiorly and lateral superficial to the mylohyoid muscle to the hyoid bone where it unites with the posterior belly via an intermediate tendon. The intermediate tendon perforates the stylohyoid muscle and is held to the side of the body and the greater cornu of the hyoid bone by a fibrous loop. The posterior belly is longer than the anterior belly. It extends posteriorly and inserts into the mastoid process

Nerve supply. The anterior belly is supplied by the mylohyoid branch of the inferior alveolar nerve (V3). The posterior belly is innervated by the facial nerve.

Function. The action of the digastric muscle is to depress the mandible and can elevate the hyoid bone. EMG studies indicate that both bellies act together and are secondary to the lateral pterygoid in mandibular depression, coming into play especially in maximal depression.

Surgical considerations. The digastric is often referred to as the “residents friend”. It is named so because many vital structures may be avoided by dissecting lateral to it. The posterior belly lies directly superficial to the branches of the external carotid artery, the hypoglossal nerve, the internal carotid artery, and the IJV. The spinal accessory nerve crosses over the IJV and immediately deep to the digastric in 70% of patients. The anterior belly is also a good landmark. Dissection of fascia and nodes just posterior to it helps in identification of the mylohyoid muscle and ensures safe dissection of the submandibular triangle.

Marginal Mandibular Nerve (ramus mandibularis)

Preserving the marginal mandibular branch of the facial nerve is important component of a neck dissection. It is most commonly injured when dissecting the level Ib lymph nodes in the submandibular triangle. The nerve extends proximally from the lower division of the facial nerve through the parotid gland and can be located at the mandibular notch about one centimeter anterior and inferior to the angle of the mandible. It lies deep to the fascia covering the submandibular gland (superficial layer of the deep cervical fascia) but superficial to the adventitia of the anterior facial vein. Preservation of the nerve may be accomplished by ligating the anterior facial vein low in the submandibular triangle and retracting it superiorly but this may result in elevation of the prevascular and retrovascular lymph nodes. This practice should therefore be restricted to non-oncologic surgery in this area. From the submandibular gland the nerve extends superiorly into the platysma muscle and depressors of the mouth. There is usually more than one branch present, which may loop inferior to the gland. Sensory branches may also travel with the marginal mandibular nerve but continue inferiorly and must be sacrificed with the neck dissection.

Spinal Accessory Nerve

The spinal root of the accessory nerve is a union of motor neurons whose cell bodies originate in the *spinal nucleus* located in the anterior grey column of the spinal cord. It may extend downwards as low as the fifth cervical segment. They emerge from the spinal cord on its surface midway between the ventral and dorsal nerve roots of the upper cervical nerves and from there join to form one trunk which travels superiorly through the foramen magnum, behind the vertebral artery. It then exits the skull via the jugular foramen. In approximately 70% of cases the nerve passes lateral and posterior to the internal jugular vein (IJV). In 30% of cases it passes medial to the vein and in rare cases (3-5 %) the nerve splits the IJ. The nerve then crosses the transverse process of the atlas and is, itself, crossed by the occipital artery. It descends obliquely through the level 2 lymph nodes medial to the styloid process, the stylohyoid muscle, and the posterior belly of the digastric. It then penetrates the deep surface of the SCM giving off a branch to it. It exits the posterior aspect of the SCM deep to Erb’s point (point where the greater auricular nerve wraps around and crosses the SCM) and traverses the posterior triangle (Level V) lying on the levator scapulae, from which it is separated by the prevertebral layer of deep

cervical fascia. Approximately 5 cm above the clavicle, the accessory nerve disappears under the anterior border of the trapezius.

Brachial Plexus and Phrenic nerve

The brachial plexus is formed by the union of the ventral rami of the lower four cervical nerves and the greater part of the ventral ramus of the first thoracic nerve (C5-8 and T1). In the neck it lies in the inferior aspect of the posterior triangle in the angle between the clavicle and the lower part of the posterior border of the SCM. It enters the posterior triangle between the anterior and middle scalene muscles along with the subclavian artery which lies anterior and inferior to it. The plexus is crossed by the supraclavicular nerves, the nerve to the subclavius, the inferior belly of the omohyoid, the external jugular vein and the transverse cervical artery.

The phrenic nerve provides the sole innervation to diaphragm. It is comprised of fibers from cervical roots 3-5. It runs obliquely toward the midline along the anterior surface of the anterior scalene muscle and is covered by prevertebral fascia. The vagus nerve and the sympathetic trunk should not be confused for the phrenic nerve. The vagus lies anterior to the phrenic in the posterior aspect of the carotid sheath and the sympathetic trunk lies medial and posterior to the carotid sheath. Neither crosses over the anterior scalene. When transecting cervical rootlets as is routine in neck dissections, it is important to cut distal to their contributions to the phrenic. This can be accomplished by identifying the cervical nerves as they exit the plexus, and then transect them high on the specimen.

Hypoglossal Nerve

The hypoglossal nerve is the motor nerve of the tongue. Its cell bodies originate in the *hypoglossal nucleus* in the medulla oblongata. The nerve exits the skull via the hypoglossal canal of the occipital bone. As it exits the canal it lies deep to the IJV, the internal carotid artery, and CN IX, X, and XI. It passes laterally and inferiorly behind the internal carotid artery and the glossopharyngeal and vagus nerves to gain the interval between the artery and the IJV. At this point, it is surrounded by numerous veins forming a venous plexus called the *ranine veins*. It then makes a half-spiral turn round the inferior ganglion of the vagus, to which it is united by connective tissue. It then descends almost vertically becoming more superficial below the posterior belly of the digastric. It loops round the inferior sternocleidomastoid branch of the occipital artery and crosses the loop of the lingual artery a little above the tip of the greater cornu of the hyoid bone. It is crossed here by the facial vein. It extends upwards along the hyoglossus muscle and into the genioglossus traveling in its substance as far as the tip of the tongue.

The hypoglossal nerve is most commonly injured during inappropriate dissection of the floor of the submandibular triangle where it lies just deep to the submandibular duct. It may also be injured by inadvertent clamping while controlling bleeding veins in the plexus posterior and inferior to the posterior belly of the digastric muscle.

Thoracic Duct

The thoracic duct conveys the greater part of the lymph back into the circulating blood. It drains lymph from the entire body except for the right side of the head and neck, the right upper extremity, right lung, right heart, and part of the convex surface of the liver. The duct proper begins at the upper end of the cisterna chyli near the lower thorax through the aortic opening of the diaphragm. It then ascends through the posterior mediastinum with the aorta on its left and azygos vein on its right. The duct begins to course toward the left and enters the superior mediastinum, and ascends to the thoracic inlet along the left side of the esophagus. As the duct passes into the neck it lies anterior to the vertebral artery and vein, the sympathetic trunk and the thyrocervical trunk. It is separated from the phrenic nerve by the prevertebral fascia. Finally it descends in front of the first part of the left subclavian artery and ends by opening into the junction of the left subclavian and internal jugular vein. It may enter the distal IJV as well. It may be a single large duct or break up into a variable number of smaller vessels just prior to its termination.

It is important to remember that there is a smaller lymphatic duct in the right neck. It descends along the medial border of the anterior scalene and ends by opening into the junction of the right subclavian and internal jugular veins.

The preferred method to prevent chyle leak is the en bloc ligation of the lymphatic pedicle in which the lymphatic ducts lie. This should be done only after the carotid artery, vagus, phrenic, and IJV are identified. A leak may be difficult to detect, as chyle is not milky colored in the fasting individual. Microscopic examination may be of benefit if a leak is suspected. Having the anesthesiologist perform the Valsalva maneuver on the patient at this time may increase the flow of chyle from a leaking duct facilitating its discovery.

Lymph Node Levels/Nodal regions

For ease and uniformity of description, nodal regions have been subdivided into levels with corresponding clinical descriptions. This system was established by the Sloan-Kettering Memorial Group and is as follows:

Level I: Lymph node groups – submental and submandibular

Level Ia*: Submental triangle

Boundaries – anterior bellies of the digastric muscle and the hyoid bone

Level Ib*: Submandibular triangle

Boundaries – body of the mandible, anterior and posterior belly of the digastric muscle

Note: includes the submandibular gland, pre- and postglandular lymph nodes and pre- and postvascular (relative to facial vein and artery) lymph nodes

Note: does not include perifacial lymph nodes

Level II: Lymph node groups – upper jugular

- Boundaries – 1) anterior – lateral border of the sternohyoid muscle
2) posterior – posterior border of the sternocleidomastoid muscle
3) superior – skull base
4) inferior – level of the hyoid bone (clinical landmark) or carotid bifurcation (surgical landmark)

Level IIa* and **IIb*** are arbitrarily designated anatomically by splitting level II with the spinal accessory nerve.

Level III: Lymph node groups – middle jugular

- Boundaries – 1) anterior – lateral border of the sternohyoid muscle
2) posterior – posterior border of the sternocleidomastoid muscle
3) superior – hyoid bone (clinical landmark) or carotid bifurcation (surgical landmark)
4) inferior – cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark)

Level IV: Lymph node groups – lower jugular

- Boundaries – 1) anterior – lateral border of the sternohyoid muscle
2) posterior – posterior border of the sternocleidomastoid muscle
3) superior – cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark)
4) inferior – clavicle

Level IVa* denotes the lymph nodes that lie along the internal jugular vein but immediately deep to the sternal head of the SCM. **Level IVb*** denotes the lymph nodes that lie deep to the clavicular head of the SCM

Level V: Lymph node groups – posterior triangle

- Boundaries – 1) anterior – posterior border of the sternocleidomastoid muscle
2) posterior – anterior border of the trapezius muscle
3) inferior - clavicle

Level Va* denotes those lymphatic structures in the upper part of level V that follow the spinal accessory nerve. **Level Vb*** refers to those nodes that lie along the transverse cervical artery. Anatomically, the division between these two subzones is the inferior belly of the omohyoid muscle.

Level VI: Lymph node groups – [prelaryngeal (Delphian), pretracheal, paratracheal, and precricoid (Delphian) lymph nodes] - also known as the anterior compartment

- Boundaries – 1) lateral – carotid sheath
2) superior – hyoid bone
3) inferior – suprasternal notch

Level VII: Lymph node groups – Upper mediastinal

- Boundaries – 1) lateral – carotid arteries
- 2) superior – suprasternal notch
- 3) inferior – aortic arch

Supraclavicular zone or fossa: relevant to nasopharyngeal carcinoma

- Boundaries – 1) superior margin of the sternal end of the clavicle
- 2) superior margin of the lateral end of the clavicle
- 3) the point where the neck meets the shoulder

* Note: The subzones Ia, Ib, IIa, IIb, IVa, IVb, Va, and Vb were not part of the original description of the levels of the neck. They have been suggested by Suen and Goepfert (1987) to further subdivide areas of differing lymphatic drainage within certain levels. Depending on the site of the primary tumor, these subzones may have biological significance and can guide decision-making in determining which nodal levels should be addressed surgically. For example, level Ia is more likely to contain metastatic disease associated with primary lesions arising in the, lower lip, floor of mouth, and ventral tongue, whereas lesions arising from other oral cavity subsites are more likely to spread directly to level Ib, II, and III. Level II is divided into subzones anatomically by the spinal accessory nerve, however, subzones Level IIa and IIb have biologic implications as well. Primary lesions from the oropharynx and nasopharynx are more likely to involve level IIb. Therefore it is important to mobilize the spinal accessory nerve and remove the fibrofatty components containing lymph nodes from this compartment. Obviously level IIb should also be dissected when there are clinically positive lymph nodes in level IIa however, it may not be necessary to dissect level IIb when performing elective neck dissections for carcinomas arising from the oral cavity, larynx, and hypopharynx. Similarly Level IV may be subdivided into subzones. Clinically positive lymphadenopathy in Level IVa may signify a higher risk of spread to level VI whereas lymph nodes in Level IVb may be more likely to spread to level V. Level Va denotes those lymphatic structures coursing along with the spinal accessory nerve as it exits the posterior border of the SCM and enters the anterior border of the trapezius muscle. Tumors arising in the oropharynx, nasopharynx, and cutaneous structures of the posterior scalp and neck are more likely to involve these lymph nodes. Level Vb refers to those lymph nodes lying along the transverse cervical artery and are anatomically separated from Level Va by the inferior belly of the omohyoid muscle. These notes have a high risk of involvement in metastatic thyroid cancers.

Staging

The “N” or nodal classification for cervical metastasis is consistent for all mucosal sites except the nasopharynx. Thyroid and nasopharyngeal carcinomas have unique nodal classifications that are based upon tumor behavior and prognosis. The staging systems for cervical metastases have been established by the American Joint Committee on Cancer most recently updated in 1997. These systems are based on the best possible estimate of the extent of disease before first treatment. Clinical information including physical exam and imaging modalities are used to contribute to this estimate.

Regional Lymph Nodes (N)

Lip, oral cavity, oropharynx, hypopharynx, larynx, trachea, paranasal sinuses, major salivary glands,

NX Regional lymph nodes cannot be assessed

N0 No regional lymph node metastasis

N1 Single ipsilateral lymph node 3-6 cm

N2

N2a Single ipsilateral lymph node 3-6 cm

N2b Multiple ipsilateral nodes \leq 6 cm

N2c Bilateral lymph nodes \leq 6 cm

N3 Any node $>$ 6 cm

Nasopharynx

NX nodes cannot be assessed

N0 no regional lymph node metastasis

N1 Unilateral metastasis in lymph nodes $<$ 6 cm above the supraclavicular fossa

N2 Bilateral metastasis in lymph nodes $<$ 6 cm above the supraclavicular fossa

N3 Metastasis in a lymph node(s)

N3a $>$ 6 cm

N3b extension to the supraclavicular fossa

Thyroid

NX Regional lymph nodes cannot be assessed

N0 No regional lymph node metastasis

N1 Regional lymph node metastasis

N1a Metastasis in ipsilateral cervical lymph node(s)

N1b Metastasis in bilateral, midline, or contralateral cervical or mediastinal lymph node(s)

Classification

In 1991, the Committee for Head and Neck Surgery and Oncology of the American Academy of Otolaryngology/Head and Neck Surgery developed a system for the classification of neck dissections. Other individual authors prior to and since this time have proposed other classification systems, however, the Academy's system remains the most widely accepted and has been endorsed by the American Society for Head and Neck Surgery. It is based on the following concepts:

- 1) Radical neck dissection is the standard basic procedure for cervical lymphadenectomy against which all other modifications are compared.

- 2) Modifications of the radical neck dissection which include the preservation of any non-lymphatic structures are referred to as modified radical neck dissection (MRND)
- 3) Any neck dissection that preserves one or more groups or levels of lymph nodes is referred to as a selective neck dissection.
- 4) An extended neck dissection refers to the removal of additional lymph node groups or non-lymphatic structures relative to the radical neck dissection.

The following are the four major types and subtypes of neck dissections proposed by the Academy:

- 1) Radical neck dissection (RND)
- 2) Modified radical neck dissection (MRND)
- 3) Selective neck dissection (SND):
 - a. supra-omohyoid type
 - b. lateral type
 - c. posterolateral type
 - d. anterior compartment type
- 4) Extended radical neck dissection

In 1989 Medina suggested that the term “comprehensive neck dissection” be used whenever all the lymph nodes contained in levels I through V have been removed. The radical neck dissection and the modified radical neck dissection would, therefore, be included under this title. He then recommended three subtypes of modified radical neck dissection. This additional nomenclature has the disadvantage of adding further complexity to the classification system, however it may be more conducive to consider adding such refinements to the Academy’s system now that most head and neck surgeons are familiar with its structure and concepts.

Medina’s classification is as follows:

- 1) Comprehensive neck dissection
 - Radical neck dissection
 - Modified radical neck dissection
 - Type I (XI preserved)
 - Type II (XI, IJV preserved)
 - Type III (XI, IJV, and SCM preserved)
- 2) Selective neck dissection (a-d as above)

In 1994, Spiro suggested changes to the Academy’s classification of neck dissections. He recommended that the term “radical neck dissection” be used for any neck dissection in which four or more lymph node levels are removed, and that the term “modified radical neck dissection” be included under the heading of RND. Additionally they included two other types of neck dissection: selective and limited. He believed that his system more accurately reflected the time and effort involved and provided a “more equitable basis for reimbursement”. The following table describes Spiro’s “three-tiered” classification:

- Radical** (4 or 5 node levels resected)
 Conventional radical neck dissection

- Modified radical neck dissection
- Extended radical neck dissection
- Modified and extended radical neck dissection
- Selective** (3 node levels resected)
 - Supraomohyoid neck dissection
 - Jugular dissection (Levels II-IV)
 - Any other 3 node levels resected
- Limited** (no more than 2 node levels resected)
 - Paratracheal node dissection
 - Mediastinal node dissection
 - Any other 1 or 2 node levels resected

The Academies system for classification of neck dissection as compared to others has the advantage of being simple, logical, based on historical terminology, and most importantly, represents a consensus of opinions by the two organizations at the time it was developed. Therefore, it has become the most widely accepted and utilized system throughout the world. It is not perfect, however. Not all neck dissections fit perfectly into the classification. Thus, there will be continued discussion and debate concerning the nomenclature used in these situations.

Radical neck dissection

Definition

The radical neck dissection is the gold standard for oncologic treatment of lymph node metastasis in the neck. It involves removal of all lymphatics from levels I-V. In addition, removal of nonlymphatic structures including the spinal accessory nerve, the sternocleidomastoid muscle and the internal jugular vein is carried out. It does not include removal of the postauricular and suboccipital nodes, periparotid nodes except for a few nodes located in the tail of the parotid gland, the perifacial and buccinator nodes, the retropharyngeal nodes, and the paratracheal nodes.

Indications

Decision to perform a radical neck dissection is not always straight forward, and often is determined at the time of surgery. A RND is indicated in patients with extensive cervical lymph node metastasis and/or extension beyond the capsule with invasion into the spinal accessory nerve, IJV, and SCM. Many surgeons will elect to perform a RND if there is extensive disease surrounding the spinal accessory nerve without gross evidence of invasion. Others would elect to perform a MRND. The bottom line is the one should not risk inadequate oncologic resection for the sake of preserving these any of these nonlymphatic structures.

Modified Radical Neck Dissection

Definition

Modified radical neck dissection involves excision of the same lymph node bearing tissues from one side of the neck as is performed in a RND with the preservation of one or more nonlymphatic structure including the spinal accessory nerve, the IJV, or the SCM. As mentioned before, Medina subclassifies the MRND into **Types I-III** (see Medina's classifications above). MRND is analogous to the "**functional neck dissection**" described by Bocca, however they differ in that Bocca originally did not remove the submandibular gland.

Indications

MRND is indicated in patients with gross nodal metastasis to the neck that does not directly infiltrate or adhere to the non-lymphatic structures previously mentioned. Bilateral MRND is indicated when there is contralateral nodal involvement with the above mentioned specifications. In these cases it is important to plan ahead if sacrifice of both IJVs is anticipated because bilateral resection results in massive edema and cases of blindness (ischemic optic neuropathy), stroke, and death have been reported. Preservation of the IJV in MRND results in IJV patency rates of 86-99% excluding patients with compression of the IJV by tumor recurrence. If decision to preserve IJVs is decided on, care should be taken to avoid endothelial damage by atraumatic handling, by tying instead of cauterizing tributaries of the IJV, and by avoiding desiccation. If both veins are involved with tumor, the therapeutic options include staging the second neck dissection, or to proceed with bilateral IJV resection with, or without reconstruction. The IJV may reconstructed in several different ways. Interposition grafts with spiraled saphenous vein is the preferred method. In addition, a segment of the contralateral (resected) IJV, polytetrafluoroethylene (PTFE), or the external jugular vein may be used.

Rationale

Modifications of the classic RND aim to reduce postsurgical neck pain and shoulder dysfunction encountered when the spinal accessory is resected without compromising adequate oncologic treatment. The earliest studies as mentioned previously by Bocca found no difference in those patients treated with MRND vs RND. Many subsequent studies have supported this finding. Anderson and colleagues (1994) found the actuarial 5-year survival and neck failure rates for RND were 63% and 12% respectively compared to 71% and 12% for MRND Type I. These results were not statistically different when controlled for pathologic N stage, presence of extracapsular spread, and pathologic presence of nodes along the spinal accessory nerve. Additionally, there was no difference in the pattern of neck failure.

Sacrifice of the SCM and IJV is less debilitating. SCM preservation, however, improves cosmetic appearance and protects the carotid artery if adjuvant radiotherapy is employed. The oncologic safety of preserving the SCM has been established by pathologic studies. In one study Calero (1983) found no evidence of SCM invasion in a series of 98 RNDs for oral cancer, despite 73 having pathologic metastases. More recently, Jaehne (1996) looked at of 101 RNDs performed for N+ disease and found that only 12% of cases had SCM invasion. This higher incidence may reflect the trend toward more conservative surgery with RND reserved for cases where there is obvious invasion of nonlymphatic structures. Preserving the IJV becomes more

significant in patients requiring bilateral neck dissections. MRND type II is rarely planned, as it is uncommon for metastatic disease to invade the SCM and not the IJV so when gross invasion of the SCM is not seen preservation of both the SCM and IJV should be considered. MRND Type III evolved from work by Suarez (1963) who observed in autopsy and surgical specimens of the larynx and hypopharynx that the lymph nodes were in fibrofatty tissue, and even when near blood vessels but did not share the same adventitia.

Selective Neck Dissection: Supraomohyoid Type (Level I-III)

Definition

The supraomohyoid neck dissection (SOHND) is the most commonly performed selective neck dissection for the treatment of the N0 neck. It involves the en bloc removal of cervical lymph node groups I-III. The posterior limit of this 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.

Indications

SOHND is indicated in patients with primary tumors arising from the oral cavity without clinical or radiologic evidence of cervical metastasis but who have a high probability of occult lymphatic disease. The oral cavity includes the area between the vermilion border of the lips and the junction of the of the hard and soft palate superiorly and the circumvallate papillae of the tongue inferiorly. Subsites in the oral cavity include the lips, buccal mucosa, upper and lower alveolar ridges, retromolar trigone, hard palate, and anterior two thirds of the tongue, and floor of mouth. Medina recommends SOHND in patients with staged T2-T4N0 or TXN1 when the palpable node is less than 3 cm, clearly mobile, and located in levels I or II.

Bilateral SOHND is indicated in patients who have carcinomas of the anterior tongue or oral tongue and floor of mouth that approach or cross the midline.

SOHND is indicated along with parotidectomy in patients with squamous cell carcinoma, Merkel cell carcinoma, or selected stage I melanomas (thickness between 1.5 and 3.99mm) in the cheek and zygomatic regions of the face.

Rationale

The expectant management of patients with oral cavity tumors and N0 necks has been condemned because of the high incidence of occult nodal metastasis and poor salvage rates. One exception is carcinoma of the lower alveolar ridge, which has a low probability of neck metastasis. Byers does not advocate elective neck dissections in carcinomas of the buccal mucosa no matter what T stage. His series was comprised of ten patients all of whom had elective neck dissections from which no metastatic disease was found. In all patients who are candidates for any selective neck dissection, the decision to proceed with surgery versus

radiation is based on the characteristics of the primary tumor, the skill and experience of the physicians involved, and the patient's wishes and general health.

The basis for which the SOHND was developed for treatment of the N0 neck in patients with oral cavity carcinomas was established by Lindberg's study in 1972 where he looked at the distribution of lymph node metastasis in head and neck squamous cell carcinomas. He showed that the subdigastric and midjugular nodes were the most likely affected lymphatics. In the absence of involvement of the first echelon node groups (submandibular, subdigastric, and midjugular) oral cavity carcinomas rarely spread to the lower jugular or posterior triangle lymph nodes. In 2001, Hoffman reviewed 5 of the largest series of oral cavity and calculated the mean percent occurrence of oral cavity tumors in all levels of the neck. Many of these studies included N+ necks. The results are as follows: Level I – 30.1%, Level II – 35.7%, Level III – 22.8%, Level IV – 9.1%, and Level V – 2.2%. When factoring in only N0 necks, the occurrence of occult nodal metastases in both Level IV and Level V was less than 3%. This finding supports the use of the SOHND in treatment of patients with N0 necks with oral cavity carcinoma.

Perineural spread to the cervical plexus is a potential source of regional recurrence. The cervical plexus is sacrificed in a radical and in modified radical neck dissections but preserved, at least in part, in selective neck dissections. In a study of 30 RND specimens, 25 were found to have extracapsular spread, but only one had histologic invasion of the cervical plexus; further supporting the oncologic safety of the selective neck dissection

Selective Neck Dissection: Lateral Type (Levels II-IV)

Definition

The lateral type neck dissection refers to the en bloc removal of the jugular lymph nodes including Levels II-IV.

Indications

The primary indications for the lateral type neck dissection include removal of nodal disease associated with carcinomas arising in the oropharynx, hypopharynx, and larynx.

The boundaries of the oropharynx are: anteriorly at the junction of the hard and soft palate and circumvallate papillae of the tongue base, superiorly at an imaginary line drawn from the hard palate to the posterior oropharyngeal wall, and inferiorly at the pharyngoepiglottic folds. Structures contained in the oropharynx are the tonsils, tonsillar fossa, tonsillar pillars, tongue base and a portion of the posterior pharyngeal wall.

The hypopharynx extends from the hyoid bone superiorly to the cricoid cartilage inferiorly and includes three subsites: the pyriform sinus, the postcricoid region, and the posterior hypopharyngeal wall.

The supraglottic larynx is bounded superiorly by the valleculae and extends inferiorly to the apex of the ventricle. It includes the epiglottis, the aryepiglottic folds, arytenoids, false vocal cords, and the superior aspect of the ventricle.

The boundaries of the larynx include the apex of the ventricle superiorly to a horizontal plane passing 1 cm below this point and includes the true vocal cords and the anterior and posterior commissures.

Rationale

Oropharynx

Oropharyngeal carcinoma has a high likelihood of metastasizing to the jugular lymph nodes in levels II-IV regardless of the size of the tumor. Overall, the risk of metastasis to these areas 30%-35%. Hoffman's review revealed that Level I was involved in 10.3 % and Level V in 7% of patients with oropharyngeal carcinoma. Again, further substantiating the low risk of tumor metastasis to these areas was supported by the fact that some of the studies reviewed included N+ necks. When only N0 necks were considered, these percentages dropped to less than 5%.

Because these tumors are in difficult locations to access surgically, often radiation will be chosen for the primary treatment modality. In these cases, it is reasonable to treat the neck or both necks if indicated with radiation.

Hypopharynx

Hypopharyngeal carcinomas are aggressive tumors that have rich lymphatics that tend to drain bilaterally. There is occult metastasis involved in 30% to 35% of patients most commonly to the subdiaphragic, upper and middle jugular lymph nodes. Retropharyngeal and paratracheal nodes are also at risk for harboring metastases. Often the primary tumor has extensive submucosal spread. Patients with bulky or extensive primary tumors (T3 or T4) will require combined radiation and surgical treatment. These patients usually undergo surgical treatment of the primary with bilateral neck dissection and adjuvant radiotherapy. Unilateral neck dissection with radiation to the other neck is also a consideration. T1 and T2 lesions may either be treated primarily with wide local excision or radiotherapy with good control rates. In 1994, Johnson *et al.* reviewed 169 patients with carcinoma of the hypopharynx. They separated these patients by location within the hypopharynx: medial pyriform (MP) or lateral pyriform (LP). Patients with MP carcinomas and N0 necks treated with ipsilateral were found to have 14% failure rate in the contralateral neck compared to 5% in patients with LP carcinomas. They, therefore, advocate bilateral neck dissection or radiotherapy in patients with MP tumors and unilateral treatment of the neck in patients with LP tumors.

Supraglottic larynx

Of all subsites in the larynx, the supraglottis has the highest incidence of nodal metastasis. Approximately 30% of patients will have occult metastases most commonly to levels

II-IV with greater than 20% involvement of the contralateral side. Shah and coworkers (1990) found that only 6% and 1% of patients who had a radical neck dissection for clinically N0 disease had metastatic cancer in levels I and V respectively. Based on these finds bilateral selective II-IV neck dissections are advocated in patients with supraglottic carcinomas with N0 necks. Again, radiation therapy is also an option in these patients and decision making depends on multiple factors.

Glottic larynx

Glottic carcinomas metastasis late because of the sparse lymphatics and the anatomic barriers to lymphatic spread such as the conus elasticus. T1 and T2 carcinomas of the glottic larynx have less than 5% and 2% to 7% metastatic rate respectively. Expectant management of the neck in these patients is therefore accepted.

In two separate studies done by Byers (1988) and Candela (1990) found that recurrent T2 lesions have a much higher rate of metastasis (20%-22%). Therefore, ipsilateral neck dissection of levels II-IV is advocated in these patients with N0 necks. Patients with T3 and T4 have a 10% to 20% and up to 40% rate of occult nodal metastasis respectively. Because of this data and the fact that salvage rates in these patients is so dismal (70% die of disease) ipsilateral neck dissection of levels II-VI is advocated.

Selective Neck Dissection: Posterolateral Type (Levels II-IV, suboccipital and postauricular)

Definition

The posterolateral type neck dissection involves the en bloc excision of lymph bearing tissues in Levels II-IV and additional node groups including the suboccipital and postauricular nodes

Indications

This type of neck dissection is primarily used to treat the neck in patients with cutaneous malignancies (primarily squamous cell carcinoma, melanoma, and other skin tumors with metastatic potential, such as the Merkel cell carcinomas) and soft tissue sarcomas.

Selective Neck Dissection: Anterior Compartment Type (Level VI)

Definition

The anterior compartment neck dissection involves the en bloc removal of lymph structures in Level VI. The lymph node groups excised are the perithyroidal nodes, pretracheal, precricoid (Delphian), and paratracheal nodes located along each recurrent laryngeal nerve. The

superior limit of the dissection is the hyoid bone and the inferior extent is the suprasternal notch. Laterally the dissection is carried out to the carotid sheath.

Indications

The anterior neck dissection is performed in the following situations: (1) selected cases of differentiated thyroid carcinoma, (2) parathyroid carcinoma (3) subglottic carcinoma (4) glottic carcinomas with subglottic extension, (5) cervical esophagus. Robbins (1998) also recommends this neck dissection in some patients with hypopharyngeal carcinoma as paratracheal nodes are at high risk for occult disease in these tumors.

Rationale

Extended Neck Dissection

Definition

Extended neck dissection refers to any of the above listed dissections involving the removal of additional lymphatic groups or nonlymphatic structures (vascular, neural, or muscular) beyond what is normally included in that procedure.

Indications

Extended neck dissections are usually performed when MRND or RND is planned for N+ necks. The decision to extend the neck dissection may either be made preoperatively based on findings on CT or MR or intraoperatively based on findings of tumor invasion of surrounding structures. The most significant example is when cervical disease involves the carotid artery. Some authors feel that resection of the carotid artery is futile because of the poor prognosis of these patients and the significant risk incurred by undergoing this procedure. Others advocate resection with or without reconstruction determined by preoperative tolerance to carotid artery balloon occlusion.

Other examples where extended neck dissections are indicated include performing level VI neck dissection for carcinoma involving the subglottis and removal of retropharyngeal lymph nodes in one or both sides when the primary tumor originates in the pharyngeal walls.

Controversies

Treatment of the neck in patients with head and neck malignancies is can be challenging and is certainly fraught with controversy. Over the past century, advances in surgical technique, diagnostic equipment, and radiotherapy have helped improve the treatment of these tumors, however, the finding of metastatic disease to the neck, particularly in squamous carcinomas of the upper aerodigestive tract, continues to portend a dismal prognosis.

The current classification of neck dissections has met worldwide acceptance, however, it is not perfect for every situation. As the field progresses, the existing classification will likely change to better unify terminology used by physicians who treat head and neck cancer.

Debate and controversy continue to exist in the following areas:

- 1) Treatment of level IV in patients with N0 necks and carcinoma of the oral tongue
- 2) Supraomohyoid neck dissection: diagnostic or therapeutic?
- 3) Management of advanced cervical metastases (N2 and N3) after organ preservation therapy
- 4) Sentinel node localization in head and neck squamous carcinoma
- 5) The role of elective and therapeutic neck dissections in thyroid cancer
- 6) Management of the necks in patients with superficial extension of glottic tumors to the supraglottis
- 7) Management of carotid artery with involvement in cervical metastases

Finding solutions and consensus in these areas will be the challenge of the years to come.

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