TITLE: Neck Dissection and Sentinel Lymph Node Biopsy
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History

Aside from distant metastases, cervical nodal metastases are the worst prognostic indicator for survival in patients with head and neck carcinoma. Presence of nodal metastases decreases survival by fifty percent. Surgical therapy for cervical metastases has evolved over the past two centuries. In the early 19th century, the presence of nodal metastases indicated incurable disease. As surgical technique improved into the late 19th and early 20th century, surgeons began to advocate treatment of nodal mets. Kocher advocated wide margin lymphadenectomy and also recommended that the submandibular triangle always be dissected in patients with lingual cancer. The first published account of en bloc tumor and lymph node resection along with non-lymphatic structures was performed by Jawdynski in 1888. [1]

In 1905 and 1906 Crile's description of en bloc lymphadenectomy became the standard operation for the majority of the 20th century. This operation removed the submandibular salivary gland, internal jugular vein, greater auricular and spinal accessory nerves, as well as the digastric, stylohyoid, and sternocleidomastoid muscles. In 1926 Bartlett and Callander advocated preservation of non-lymphatic structures (XI, internal jugular vein (IJV), sternocleidomastoid (SCM), platysma, stylohyoid, digastric), citing similar rates of recurrence when compared to more inclusive or radical procedures. Blair and Brown maintained that lymphadenectomy could not be complete without sparing the accessory nerve in 1933. In 1951, Martin et al reviewed 1450 cases of en bloc lymphadenectomy. He concluded that complete cervical lymphadenectomy was impossible without concomitant removal of the IJV, SCM and XI. Martin's refinement of Crile's 1906 operation became the template for the modern radical neck dissection.

As Martin advocated radical neck dissection (RND) in the US, Suarez advocated a more conservative neck dissection in Europe in 1952. He believed preservation of the SCM,

omohyoid, submandibular gland, IJV and XI were possible with similar survival rates but he also noted the importance of leaving structures to protect the carotid artery. Bocca and Pignataro later described the functional neck dissection (FND) in which the IJV, SCM and XI are preserved if possible. Bocca later established the oncologic safety of the FND when compared to the RND in 1975. The functional neck dissection is the same as the modified radical neck dissection (MRND).

Management of the N_0 neck has been debated since the 19th century. In 1885, Butlin questioned radical neck dissection for N_0 disease. Solis-Cohen recommended lymphadenectomy in N_0 patients with laryngeal carcinomas in 1901. Until the late 20th century, RND was the primary surgical therapy for nodal mets. With the advent of the FND, the frequency of RND has decreased but still remains the gold standard to which all other therapies are compared to. In the 1960's, MD Anderson physicians began to advocate selective removal of high risk nodal basins depending on the primary tumor site. In the last thirty years, the trend towards more conservative surgical therapy has been accompanied by improved efficacy of radiation therapy. Currently, surgical therapy for clinically positive nodal metastases will consist of a modified radical neck dissection or radical neck dissection depending on the involvement of tumor with any non-lymphatic structures. In general selective neck dissections are performed more as staging procedures for patients with N_0 disease.

Anatomy

Since cervical anatomy is complex, there are many ways to divide the neck into different triangles and zones. The lymphatics in the head and neck are extensive and there can be up to 300 lymph nodes in specimens depending on the patient's age. A more detailed description of pertinent cervical anatomy can be found in prior ground rounds. Evaluation of nodal drainage patterns and primary tumor locations by the Sloan-Kettering Memorial Group has helped standardize the nomenclature in regard to cervical nodal basins. The cervical nodes are divided into six groups which have been further divided into subgroups. A brief outline of the boundaries and regions which drain primarily into each level follows:

Level I: Submental and submandibular nodes
    Level Ia*: Submental triangle
- Boundaries
  - Anterior bellies of the digastric muscle
  - Hyoid bone
- Primary drainage
  - Chin
  - Lower lip
  - Anterior floor of mouth
  - Mandibular incisors
  - Tip of tongue

    Level Ib*: Submandibular triangle
- Boundaries
  - Body of the mandible
  - Anterior and posterior belly of the digastric muscle
- Primary drainage

- o Oral Cavity
- o Floor of mouth
- o Oral tongue
- o Nasal cavity (anterior)
- o Face

Level II: Upper jugular nodes
- Boundaries
  - o Anterior – lateral border of the sternohyoid muscle, posterior digastric and stylohyoid
  - o Posterior – posterior border of the sternocleidomastoid muscle
  - o Superior – skull base
  - o Inferior – level of the hyoid bone (clinical landmark) or carotid bifurcation (surgical landmark)
- Primary drainage
  - o Oral Cavity
  - o Nasal Cavity
  - o Nasopharynx
  - o Oropharynx
  - o Larynx
  - o Hypopharynx
  - o Parotid

Level IIa – anterior to XI

Level IIb – (Submuscular recess) - posterior to XI
- – More likely to drain pharyngeal lesions than oral cavity or laryngeal lesions.

Level III: Middle jugular nodes
- Boundaries
  - o Anterior – lateral border of the sternohyoid muscle
  - o Posterior – posterior border of the sternocleidomastoid muscles
  - o Superior – hyoid bone (clinical landmark) or carotid bifurcation (surgical landmark)
  - o Inferior – cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark)
- Primary drainage
  - o Oral cavity
  - o Nasopharynx
  - o Oropharynx
  - o Hypopharynx
  - o Larynx

Level IV: Lower jugular nodes
- o Boundaries
  - o Anterior – lateral border of the sternohyoid muscle
  - o Posterior – posterior border of the sternocleidomastoid muscles

- o Superior – cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark)
- o Inferior – clavicle
  - o Primary drainage
    - o Hypopharynx
    - o Larynx
    - o Thyroid
    - o Cervical esophagus

Level V: Posterior triangle
- o Boundaries
  - o Anterior – posterior border of the sternocleidomastoid muscle
  - o Posterior – anterior border of the trapezius muscle
  - o Inferior – clavicle
- o Primary drainage
  - o Nasopharynx
  - o Oropharynx
  - o Posterior neck and scalp

Level Va - lymphatic structures that follow the spinal accessory nerve.
Level Vb – lymphatic structures that lie along the transverse cervical artery

Level VI: Anterior compartment (Prelaryngeal (Delphian), pretracheal, paratracheal, and precricoid (Delphian) nodes)
- o Boundaries
  - o Lateral – carotid sheath
  - o Superior – hyoid bone
  - o Inferior – suprasternal notch
- o Primary drainage
  - o Thyroid
  - o Larynx (glottic and subglottic)
  - o Pyriform sinus apex
  - o Cervical esophagus

The following table is a summary of the nodal drainage patterns from different primary sites.

Face and Scalp	Anterior	Facial, Ib
	Lateral	Parotid
	Posterior	Occipital, V
Eyelids	Medial	Ib
	Lateral	Parotid, II
Chin		Ia, Ib, II
External Ear	Anterior	Parotid, II
	Posterior	Post auricular, II, V
Middle Ear		Parotid, II
Floor of mouth	Anterior	Ia, Ib, IIa > IIb
	Lower incisors	Ia, Ib, IIa > IIb
	Lateral	Ib, IIa > IIb, III
	Teeth except incisors	Ib, IIa > IIb, III
Nasal Cavity	Anterior	Ib
	Posterior	Retropharyngeal, II, V
Nasopharynx		Retropharyngeal, II, III, V
Oropharynx		IIb > IIa, III, IV, V
Larynx	Supraglottic	IIa > IIb, III, IV
	Subglottic	VI, IV
Cervical esophagus		IV, VI
Thyroid		VI, IV, V, Mediastinal
Tongue	Tip	Ia, Ib, IIa > IIb, III, IV
	Lateral	Ib, IIa > IIb, III, IV

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. 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 noses 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 order to communicate effectively between institutions and compare data related to surgical procedures, a classification scheme for neck dissections has been endorsed by the American Society for Head and Neck Surgery. The nomenclature uses the radical neck dissection as the standard which all other modifications are compared to. Preservation of any combination of the IJV, SCM or XI is a modified radical neck dissection (MRND). Preservation of lymphatic groups normally removed in a RND is a selective neck dissection. An extended neck dissection removes any structure or additional lymph node groups normally preserved in a RND.

Radical Neck Dissection

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 non-lymphatic 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.

Modified Radical Neck Dissection

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 non-lymphatic structure including the spinal accessory nerve, the IJV, or the SCM.

Selective Neck Dissection

There are several types of selective neck dissection. They focus on removing the highest risk nodal groups depending on the site of the primary tumor. The Supraomohyoid neck dissection (SOHND) removes levels I-III and is performed in patients with oral cavity primaries, Merkel cell carcinoma, some melanoma of the face and SCCA of the parotid. Bilateral SOHND are considered with anterior oral cavity and cutaneous lesions along with lateral lesions that approach or cross the midline. The lateral neck dissection removes levels II-IV. It is performed for patients with oropharyngeal, hypopharyngeal or laryngeal primaries. The posterolateral neck dissection removes levels II-IV, suboccipital and postauricular nodes. It is performed primarily for patients with cutaneous lesions on the posterior scalp or neck. Then anterior neck dissection removes the anterior compartment (level VI) and is indicated in some types of differentiated thyroid carcinoma, parathyroid carcinoma, subglottic carcinoma, and lesions of the cervical esophagus.

Extended Neck Dissection

The extended neck dissection removes any lymphatic or non-lymphatic structure that is usually preserved in a RND or MRND. Examples include removal of parapharyngeal nodes along with a pharyngectomy specimen. Removal of the carotid artery with reconstruction may be attempted in some circumstances. Preoperative balloon occlusion may be performed to determine if the patient can tolerate carotid ligation without reconstruction.

Sentinel Lymph Node Biopsy

The role of sentinel lymph node biopsy in head and neck carcinoma is still being established. It has been effective in the treatment of melanoma of the head and neck but its role in the treatment of squamous cell carcinoma of the oral cavity or pharynx is still being developed.

The central tenet of sentinel lymph node biopsy is that a primary tumor will spread via lymphatics to a primary node. Examination of the primary node for tumor then directs the need

for further surgical management of the nodal basins. The evolution of the sentinel node concept began in 1955 when the concept of the first echelon node was introduced. Gould coined the term "sentinel node" in 1960 and the first successful sentinel node biopsy was performed in 1977 in a patient with penile cancer. The concept was revived by Morton in 1992 and applied to N_0 melanoma. Since then, it has become the standard for treatment of N_0 melanoma and breast cancer.

Application of sentinel node biopsy to the head and neck has not been as feasible as its application to the trunk and extremities. O'Brien delineated four drawbacks to its application to the head and neck:

1. It is difficult to visualize lymphatic channels using lymphoscintigraphy because of proximity to the injection site.
2. The radiotracer travels fast in the lymphatic vessels.
3. If more than one node is visible, it can be difficult to distinguish first echelon nodes from second-echelon nodes.
4. The SLN may be small and not easily accessible (eg, in the parotid gland).

Sentinel lymph node biopsy (SLNB) has been successfully performed in patients with cutaneous malignancies of the head and neck. Since 1996 several investigators have displayed the feasibility of SLNB in squamous cell carcinoma of the pharynx and oral cavity. The first reported use was in the hypopharynx. Since then more investigators have focused on N_0 disease for patients with oral cavity SCCA. There are multiple small case series that display the feasibility of SLNB in these patients although no there are no standardized techniques between institutions. All the series compare the efficacy of pre op lymphoscintigraphy, intraoperative localization with the gamma probe with or without blue dye and the results of final pathology for the completed neck dissection specimens.

Pre operative techniques for SLNB include injection with a radiotracer. The tracer has to be able to be taken up by the lymphatics but large enough to remain in them to make detection possible. Technetium is the most commonly used radiotracer. It is injected submucosally in quadrants surrounding the tumor one day prior to surgery. The total dose injected does not affect the ability to locate sentinel nodes on lymphoscintigraphy according to a recent meta-analysis. The use of local anesthetic is debated because some investigators feel it may affect tracer uptake. Spillage of the tracer should be avoided in the oral cavity at time of injection.

About 45 – 60 minutes following tracer injection the patient should undergo dynamic lymphoscintigraphy followed by static lymphoscintigraphy. Typically a sentinel node can be seen within fifteen minutes during the dynamic imaging. AP, lateral and oblique static images help confirm the dynamic imaging and delayed static images reveal sentinel nodes when the dynamic images are non-revealing. Using a cobalt pencil to mark landmarks like the mandible, chin, cricoid and sternal notch also aid in localizing the node.

Not all investigators use blue dye to help locate sentinel nodes. Those that do use it inject the dye about 20 minutes prior to surgery. Intraoperative gamma probes are used in conjunction with the dye to localize the sentinel nodes. A distant site on the patient is scanned to record the background levels. Then the operative bed is inspected with the probe and high signal nodes

removed. Once removed, the node is probed away from the patient and then the counts are compared to the wound bed. If there is a significant drop after the node is excised, then it is sent to pathology for fine cut frozen section. All other nodes that have counts of 10% or more of the original node are also removed. Depending on the site of the primary, a lead malleable may be useful in shielding the tracer counts from floor of mouth tumors and nodes in level I. Sometimes it is useful to excise the primary tumor to remove any interfering signals. Overall, sentinel nodes are able to be located in more than 90% of cases but this success is highly user dependent. A European survey found that surgeons with less than ten cases only had a 56% success rate in finding sentinel nodes. When sentinel nodes are located, there are usually 2-3 nodes present and occult malignancy has been reported to be as high as 46%. Overall there is about a 10% false negative rate which was associated with larger primary tumors (T3) and could be due to gross nodal involvement rather than microscopic tumor metastases.

Complications for SLNB are reported to be less than one percent. All of the complications have been reported in cutaneous malignancy primaries. Almost all complications are related to limited incisions and subsequent facial nerve damage.

Trials are ongoing to evaluate the efficacy of sentinel node biopsy in N_0 oral SCCA when compared to watchful waiting or elective treatment of the neck with surgery or radiation.

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