Neck Dissections: Classifications, Indications, and Techniques

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Introduction

• Status of the cervical lymph nodes important prognostic factor in SCCA of the upper aerodigestive tract
Introduction

• Cure rates drop in half when there is regional lymph node involvement
Evolution of the neck dissection

• 1880 – Kocher proposed removing nodal metastases
• 1906 – George Crile described the classic radical neck dissection (RND)
• 1933 and 1941 – Blair and Martin popularized the RND
• 1953 – Pietrantoni recommended sparing the spinal accessory nerves
Evolution of the neck dissection

- 1967 - Bocca and Pignataro described the “functional neck dissection” (FND)
- 1975 – Bocca established oncologic safety of the FND compared to the RND
Evolution of the neck dissection

• 1991 – Official Report of the Academy’s Committee for Head and Neck Surgery and Oncology standardizing neck dissection terminology
Fascial layers of the neck

- Superficial cervical fascia
- Deep cervical fascia
  - Superficial layer
    - SCM, strap muscles, trapezius
  - Middle or Visceral Layer
    - Thyroid
    - Trachea
    - Esophagus
  - Deep layer (also prevertebral fascia)
    - Vertebral muscles
    - Phrenic nerve
Platysma

• Origin – fascia overlying the pectoralis major and deltoid muscle

• Insertion – 1) depression muscles of the corner of the mouth, 2) the mandible, and 3) the SMAS layer of the face

• Function – 1) wrinkles the neck, 2) depresses the corner of the mouth, 3) increases the diameter of the neck, 4) assists in venous return
**Platysma**

- **Surgical considerations**
  - Increases blood supply to skin flaps
  - Absent in the midline of the neck
  - Fibers run in an opposite direction to the SCM
Sternocleidomastoid Muscle (SCM)

- **Origin** – 1) medial third of the clavicle (clavicular head)
  2) manubrium (sternal head)
- **Insertion** – mastoid process
- **Nerve supply** – spinal accessory nerve (CN XI)
- **Blood supply** – 1) occipital a. or direct from ECA
  2) superior thyroid a.
  3) transverse cervical a.
SCM

- **Function** – turns head toward opposite side and tilts head toward the ipsilateral shoulder
- **Surgical considerations**
  - Leave overlying fascia (superficial layer of deep cervical fascia down)
  - Lateral retraction exposes the submuscular recess
- External Jugular v.
- Greater auricular n.
- Spinal accessory n.
Omohyoid muscle

- Origin – upper border of the scapula
- Insertion – 1) via the intermediate tendon onto the clavicle and first rib
  2) hyoid bone lateral to the sternohyoid muscle
- Blood supply – Inferior thyroid a.
- Function – 1) depress the hyoid
  2) tense the deep cervical fascia
Omohyoid

- Surgical considerations
  - Absent in 10% of individuals
  - Landmark demarcating level III from IV
  - Inferior belly lies superficial to
    - The brachial plexus
    - Phrenic nerve
    - Transverse cervical vessels
  - Superior belly lies superficial to
    - IJV
Trapezius muscle

- **Origin** – 1) medial 1/3 of the sup. Nuchal line
  2) external occipital protuberance
  3) ligamentum nuchae
  4) spinous process of C7 and T1-T12

- **Insertion** – 1) lateral 1/3 of the clavicle
  2) acromion process
  3) spine of the scapula

- **Function** – elevate and rotate the scapula and stabilize the shoulder
Trapezius
Trapezius

- Surgical considerations
  - Posterior limit of Level V neck dissection
  - Denervation results in shoulder drop and winged scapula
Digastric muscle

- **Origin** – digastric fossa of the mandible (at the symphyseal border)
- **Insertion** – 1) hyoid bone via the intermediate tendon
  2) mastoid process
- **Function** – 1) elevate the hyoid bone
  2) depress the mandible (assists lateral pterygoid)
Digastric

- Surgical considerations
  - “Residents friend”
  - Posterior belly is superficial to:
    - ECA
    - Hypoglossal nerve
    - ICA
    - IJV
  - Anterior belly
    - Landmark for identification of mylohyoid for dissection of the submandibular triangle
9-21 POSTERIOR BELLY OF DIGASTRIC
Marginal Mandibular Nerve

- Should be preserved in neck dissections
- Most commonly injured at dissection level Ib
- Can be found:
  - 1 cm anterior and inferior to angle of mandible
  - At the mandibular notch
- Deep to fascia of the submandibular gland (superficial layer of deep cervical fascia)
- Superficial to adventitia of the facial vein
- More than one branch often present
- Travels with sensory branches that are sacrificed
Marginal Mandibular Nerve
Spinal Accessory Nerve

- Originates in the *spinal nucleus* – may extend to the fifth cervical segment
- Union of motor neurons
- Passes through two foramen
  - Foramen Magnum – enters the skull posterior to the vertebral artery
  - Jugular Foramen – exits the skull with CN IX, X and the IJV
Spinal Accessory Nerve

- CN XI – Relationship with the IJV
Spinal Accessory Nerve

- Crosses the IJV
- Crosses lateral to the transverse process of the atlas
- Occipital artery crosses the nerve
- Descends obliquely in level II (forms Level IIa and IIb)
Spinal Accessory Nerve

- Penetrates the deep surface of the SCM
- Exits posterior surface of SCM deep to Erb’s point
- Traverses the posterior triangle ensheathed by the superficial cervical fascia and lies on the levator scapulae
- Enters the trapezius approx. 5 cm above the clavicle
Phrenic Nerve

• Sole nerve supply to the diaphragm
• Supplied by nerve roots C3-5
• Runs obliquely toward midline on the anterior surface of anterior scalene
• Covered by prevertebral fascia
• Lies posterior and lateral to the carotid sheath
• Lateral neck
  – Phrenic n.
  – Brachial plexus
  – Lateral neck musculature
Phrenic Nerve
Hypoglossal nerve

- Motor nerve to the tongue
- Cell bodies are in the *Hypoglossal nucleus* of the Medulla oblongata
- Exits the skull via the hypoglossal canal
- Lies deep to the IJV, ICA, CN IX, X, and XI
- Curves 90 degrees and passes between the IJV and ICA
  - Surrounded by venous plexus (*ranine veins*)
- Extends upward along hyoglossus muscle and into the genioglossus to the tip of the tongue
Hypoglossal Nerve

• Iatrogenic injury
  – Most common site - floor of the submandibular triangle, just deep to the duct
  – Ranine veins
Hypoglossal Nerve
Thoracic duct

- Conveys lymph from the entire body back to the blood
  - Exceptions:
    - Right side of head and neck, RUE, right lung right heart and portion of the liver
  - Begins at the cisterna chyli
  - Enters posterior mediastinum between the azygous vein and thoracic aorta
  - Courses to the left into the neck anterior to the vertebral artery and vein
  - Enters the junction of the left subclavian and the IJV
Thoracic duct
Thoracic Duct
Staging of the Neck
Staging of the neck

• “N” classification – AJCC (1997)
• Consistent for all mucosal sites except the nasopharynx
• Thyroid and nasopharynx have different staging based on tumor behavior and prognosis
• Based on extent of disease prior to first treatment
Staging of the neck

- **NX**: Regional lymph nodes cannot be assessed
- **N0**: No regional lymph node metastasis
- **N1**: Metastasis in a single ipsilateral lymph node, $\leq 3$
- **N2a**: Metastasis in a single ipsilateral lymph node 3 to 6 cm
Staging of the Neck

- **N2b**: Metastasis in multiple ipsilateral lymph nodes, none more than 6 cm
- **N2c**: Metastasis in bilateral or contralateral nodes $\leq 6$ cm
- **N3**: Metastasis in a lymph node more than 6 cm in greatest dimension
Lymph Node Levels/Nodal Regions
Lymph node levels/Nodal regions

- Developed by Memorial Sloan-Kettering Cancer Center
- Ease and uniformity in describing regional nodal involvement in cancer of the head and neck
FIG. 1. Schematic diagram indicating the location of the lymph node levels in the neck as described in the text.
• Level I: Submental and submandibular triangles
Lymph node levels/Nodal regions

- Levels II, III, IV: nodes associated with IJV within fibroadipose tissue (posterior border of SCM and lateral border of sternohyoid)
Lymph node levels/Nodal regions

• Level II: Upper third jugular chain, jugulodigastric, and upper posterior cervical nodes
  – Boundaries - hyoid bone (clinical landmark) or carotid bifurcation (surgical landmark)
Lymph node levels/Nodal regions

• Level III: Middle jugular nodes
  – Boundaries - Inferior border of level II to cricothyroid notch (clinical landmark) or omohyoid muscle (surgical landmark)

• Level IV: Lower jugular nodes
  – Boundaries inferior border of level III to clavicle.
Lymph node levels/Nodal regions

• Level V: Posterior triangle of neck
  – Boundaries - posterior border of SCM, clavicle, and anterior border of trapezius
Lymph node levels/Nodal regions

• Level VI: Anterior compartment structures (hyoid, suprasternal notch, medial border of carotid sheath)
## Lymph Node Subzones

<table>
<thead>
<tr>
<th>Level</th>
<th>Lymph Node Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia</td>
<td>Submental nodes</td>
</tr>
<tr>
<td>Ib</td>
<td>Submandibular nodes</td>
</tr>
<tr>
<td>IIa</td>
<td>Upper jugular, anterior to IX</td>
</tr>
<tr>
<td>IIb</td>
<td>Upper jugular, posterior to IX (submuscular recess)</td>
</tr>
<tr>
<td>III</td>
<td>Middle jugular nodes</td>
</tr>
<tr>
<td>IVa</td>
<td>Lower jugular nodes (behind clavicular head of sternocleidomastoid muscle)</td>
</tr>
<tr>
<td>IVb</td>
<td>Lower jugular nodes (behind sternal head of sternocleidomastoid muscle)</td>
</tr>
<tr>
<td>Va</td>
<td>Posterior triangle nodes (spinal accessory group)</td>
</tr>
<tr>
<td>Vb</td>
<td>Posterior triangle nodes (transverse cervical artery group, supraclavicular group)</td>
</tr>
<tr>
<td>VI</td>
<td>Anterior (central) compartment lymph nodes (paratracheal, perithyroidal, Delphian)</td>
</tr>
</tbody>
</table>
Subzones of Levels I-V
Rationale for subzones

• Suggested by Suen and Goepfert (1997)
• Biologic significance for lymphatic drainage depending on site of tumor
  – Level I subzones
    • Lower lip, FOM, ventral tongue – Ia
    • Other oral cavity subsites – Ib, II, and III
Rationale for Subzones

– Level II subzones
  • Oropharynx and nasopharynx – IIb
    – XI should be mobilized
  • Oral cavity, larynx and hypopharynx – may not be necessary to dissect IIb if level IIa is not involved

– Level IV subzones
  • Level IVa nodes – increased risk in Level VI
  • Level IVb nodes – increased risk in Level V
Rationale for Subzones

- Level V subzones
  - Oropharynx, nasopharynx, and cutaneous – Va
  - Thyroid - Vb
Classification of Neck Dissections
Classification of Neck Dissections

- Standardized until 1991
- Academy’s Committee for Head and Neck Surgery and Oncology publicized standard classification system
Classification of Neck Dissections

• Academy’s classification
  – Based on 4 concepts
  • 1) RND is the standard basic procedure for cervical lymphadenectomy against which all other modifications are compared
  • 2) Modifications of the RND which include preservation of any non-lymphatic structures are referred to as modified radical neck dissection (MRND)
Classification of Neck Dissections

- Academy’s classification
  - 3) Any neck dissection that preserves one or more groups or levels of lymph nodes is referred to as a selective neck dissection (SND)
  - 4) An extended neck dissection refers to the removal of additional lymph node groups or non-lymphatic structures relative to the RND
Classification of Neck Dissections

• Academy’s classification
  – 1) Radical neck dissection (RND)
  – 2) Modified radical neck dissection (MRND)
  – 3) Selective neck dissection (SND)
    • Supra-omohyoid type
    • Lateral type
    • Posterolateral type
    • Anterior compartment type
  – 4) Extended radical neck dissection
Classification of Neck Dissections

• Medina classification (1989)
  – 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)
  – Selective neck dissection (previously described)
Classification of Neck Dissections

- Spiro’s 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)
    - SOHND
    - 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
Radical Neck Dissection

• Definition
  – All lymph nodes in Levels I-V including spinal accessory nerve (SAN), SCM, and IJV
FIGURE 7-4
Extent of radical neck dissection.
Radical Neck Dissection

• Indications
  – Extensive cervical involvement or matted lymph nodes with gross extracapsular spread and invasion into the SAN, IJV, or SCM
Modified Radical Neck Dissection (MRND)

• Definition
  – Excision of same lymph node bearing regions as RND with preservation of one or more non-lymphatic structures (SAN, SCM, IJV)
  – Spared structure specifically named
  – MRND is analogous to the “functional neck dissection” described by Bocca
FIGURE 7–5
Extent of modified radical neck dissection.
Modified Radical Neck Dissection

- Three types (Medina 1989) commonly referred to not specifically named by committee.
  - Type I: Preservation of SAN
  - Type II: Preservation of SAN and IJV
  - Type III: Preservation of SAN, IJV, and SCM ("Functional neck dissection")
MRND Type II
MRND Type III
MRND Type I

• Indications
  – Clinically obvious lymph node metastases
  – SAN not involved by tumor
  – Intraoperative decision
MRND Type I

• Rationale
  – RND vs MRND Type I:
    – Actuarial 5-year survival and neck failure rates for RND (63% and 12%) not statistically different compared to MRND I (71% and 12%) (Andersen)
    – No difference in pattern of neck failure
MRND Type II

• Indications
  – Rarely planned
  – Intraoperative tumor found adherent to the SCM, but not IJV and SAN
MRND TYPE III

- **Rationale**
  - Suarez (1963) – necropsy and surgery specimens of larynx and hypopharynx – lymph nodes do not share the same adventitia as adjacent BV’s
  - Nodes not within muscular aponeurosis or glandular capsule (submandibular gland)
  - Sharpe (1981) showed 0% involvement of the SCM in 98 RND specimens despite 73 have nodal metastases
  - Survival approximates MRND Type I assuming IJV, and SCM not involved
MRND Type III

- Widely accepted in Europe
- Neck dissection of choice for N0 neck
Modified Radical Neck Dissection

• Rationale
  – Reduce postsurgical shoulder pain and shoulder dysfunction
  – Improve cosmetic outcome
  – Reduce likelihood of bilateral IJV resection
• Contralateral neck involvement
Selective Neck Dissections

• Definition
  – Cervical lymphadenectomy with preservation of one or more lymph node groups
  – Four common subtypes:
    • Supraomohyoid neck dissection
    • Posterolateral neck dissection
    • Lateral neck dissection
    • Anterior neck dissection
SELECTIVE NECK DISSECTION

• Also known as an elective neck dissection
• Rate of occult metastasis in clinically negative neck 20-30%
• Indication: primary lesion with 20% or greater risk of occult metastasis
• Studies by Fisch and Sigel (1964) demonstrated predictable routes of lymphatic spread from mucosal surfaces of the H&N
• May elect to upgrade neck intraoperatively
• Frozen section needed to confirm SCCA in suspicious node (Rassekh)
• Need for post-op XRT
SND: Supraomohyoid type

• Most commonly performed SND

• Definition
  – En bloc removal of cervical lymph node groups I-III
  – Posterior limit is the cervical plexus and posterior border of the SCM
  – Inferior limit is the omohyoid muscle overlying the IJV
FIGURE 7–6
Extent of supraomohyoid selective neck dissection.
SND: Supraomohyoid type

• Indications
  – Oral cavity carcinoma with N0 neck
    • Boundaries – Vermillion border of lips to junction of hard and soft palate, circumvallate papillae
    • Subsites - Lips, buccal mucosa, upper and lower alveolar ridges, retromolar trigone, hard palate, and anterior 2/3s of the tongue and FOM
  – Medina recommends SOHND with T2-T4NO or TXN1 (palpable node is <3cm, mobile, and in levels I or II)
SND: Supraomohyoid type

- Bilateral SOHND
  - Anterior tongue
  - Oral tongue and FOM that approach the midline
- SOHND + parotidectomy
  - Cutaneous SCCA of the cheek
  - Melanoma (Stage I – 1.5 to 3.99mm) of the cheek
- Exceptions
  - inferior alveolar ridge carcinoma
  - Byers does not advocate elective neck dissection for buccal carcinoma
- Adjuvant XRT given to patients with > 2-4 positive nodes +/- ECS.
SND: Supraomohyoid type

- Rationale
  - Expectant management of the N0 neck is not advocated
  - Based on Linberg’s study (1972)
    - Distribution of lymph node mets in H&N SCCA
    - Subdigastric and midjugular nodes mostly affected in oral cavity carcinomas
    - Rarely involved Level IV and V
SND: Supraomohyoid type

– Hoffman (2001) oral cavity – combination of 5 reviews
  • Level I – 30.1%
  • Level II – 35.7%
  • Level III – 22.8%
  • Level IV – 9.1%
  • Level V - 2.2%
SND: Lateral Type

• Definition
  – En bloc removal of the jugular lymph nodes including Levels II-IV
FIGURE 7–7
Extent of lateral selective neck dissection.
SND: Lateral Type

• Indications
  – N0 neck in carcinomas of the oropharynx, hypopharynx, supraglottis, and larynx
- Oropharynx
  - Tonsils
  - Tonsillar pillars
  - Tonsillar fossa
  - Tongue base
  - Pharyngeal wall
- Hypopharynx
  - Pyriform sinus
  - Postcricoid
  - Pharyngeal wall
- Supraglottis
  - Epiglottis
  - Aryepiglottic folds
  - FVC
  - Sup. Ventricle
- Larynx
  - Apex of ventricle to 1 cm below
SND: Lateral Type

- **Rationale** – oropharynx
  - Overall risk of occult mets is 30-35%
  - Hoffman (2001)
    - Level I – 10.3%
    - Level V – 7%
    - <5% for both Levels I and V if only N0 necks considered
SND: Lateral Type

- **Rationale – Hypopharynx**
  - Occult metastases in 30-35%
  - Johnson (1994)
    - Medial pyriform (MP) vs. lateral pyriform carcinomas (LP)
      - MP – 15% failed in the contralateral neck
      - LP – 5% failed in the contralateral neck
      - Johnson advocates bilateral SNDs for N0 MP carcinomas and ipsilateral SND for N0 LP carcinomas
  - Bilateral SND is often indicated in the majority of hypopharyngeal tumors because of extensive submucosal spread and involvement of multiple subsites
SND: Lateral Type

- **Rationale** – supraglottic
  - Highest incidence of occult nodal metastasis or any other subsite in the larynx
  - Occult nodal disease in 30%
  - >20% with contralateral occult disease
  - Shah (1990)
    - Level I – 6% involvement
    - Level V – 1% involvement
  - Bilateral SND recommended by most authors
SND: Lateral Type

- Rationale – glottic larynx
  - Sparse lymphatics – late spread
  - T1 – 5% occult metastases
  - T2 – 2% to 6% occult metastases
  - Byers (1988) and Candela (1990)
    - Recurrent T1 and T2 had higher rate of metastases
      - 20% to 22%
    - Recommend unilateral SND for these lesions
SND: Lateral Type

- T3 – 10% to 20% occult metastases
- T4 – up to 40% occult metastases
- 30% salvage rate for
- Ipsilateral SND advocated for T3 and T4 glottic carcinomas
SND: Posterolateral Type

• Definition
  – En bloc excision of lymph bearing tissues in Levels II-IV and additional node groups – suboccipital and postauricular
SND: Posterolateral Type

• Indications
  – Cutaneous malignancies
    • Melanoma
    • Squamous cell carcinoma
    • Merkel cell carcinoma
  – Soft tissue sarcomas of the scalp and neck
SND: Anterior Compartment

• Definition
  – En bloc removal of lymph structures in Level VI
    • Perithyroidal nodes
    • Pretracheal nodes
    • Precricoid nodes (Delphian)
    • Paratracheal nodes along recurrent nerves
  – Limits of the dissection are the hyoid bone, suprasternal notch and carotid sheaths
SND: Anterior Compartment

• Indications
  – Selected cases of thyroid carcinoma
  – Parathyroid carcinoma
  – Subglottic carcinoma
  – Laryngeal carcinoma with subglottic extension
  – CA of the cervical esophagus
Extended Neck Dissection

• Definition
  – Any previous dissection which includes removal of one or more additional lymph node groups and/or non-lymphatic structures.
  – Usually performed with N+ necks in MRND or RND when metastases invade structures usually preserved
Extended Neck Dissection

• Indications
  – Carotid artery invasion
  – Other examples:
    • Resection of the hypoglossal nerve resection or digastric muscle,
    • dissection of mediastinal nodes and central compartment for subglottic involvement, and
    • removal of retropharyngeal lymph nodes for tumors originating in the pharyngeal walls.
SUMMARY

- Cervical metastasis in SCCA of the upper aerodigestive tract continues to portend a poor prognosis
- Staging will help determine what type neck dissection should be performed
- Unified classification of neck nodal levels and classification of neck dissection is relatively new
- Indications for neck dissection and type of neck dissection, especially in the N0 neck, is a controversial topic
• Case 1
  - 55 y/o WM
  - Right T2 supraglottis

Name the indicated neck dissection.
• Case 2
  - 40 y/o man
  - R T2 larynx

Name appropriate neck dissection.

What if the cord is fixed?
Apron Incision
Half Apron Incision

FIGURE 7–8
Hockey-stick incision for modified radical neck dissection. The dashed line indicates the modification for a radical neck dissection.
Conley Incision
Double-Y Incision
H Incision
MacFee Incision
Y Incision
Modified Schobinger Incision
Schobinger Incision
FIGURE 7–10
Flap elevation and investing fascial incisions (dashed lines) for modified radical neck dissection.
FIGURE 7–11
Removal of submental and preglandular submandibular nodes.
FIGURE 7–12
Removal of the submandibular gland and associated lymph nodes. Note the lingual nerve ramus to the gland and the submandibular duct.
FIGURE 7-13

Elevation of the investing fascia off the sternocleidomastoideus.
FIGURE 7-14
Isolation of spinal accessory nerve and elevation of the posterosuperior portion of the specimen off the splenius capitis and levator scapulae.
FIGURE 7–15
Elevation of skin-sternocleidomastoideus flap, including the distal spinal accessory nerve. The dashed line represents the posterior and inferior extent of the dissection under the flap.
FIGURE 7–16

Elevation of specimen from the floor of the neck, revealing the brachial plexus and phrenic nerve. Cutaneous nerve branches have been transsected.
FIGURE 7–17
Skeletonization of the internal jugular vein. The anterior belly of the omohyoides has been cut and elevated superiorly with the specimen.
FIGURE 7–18
Dissection of the specimen from the carotid artery, hypoglossal nerve, and strap muscles.
**FIGURE 7–19**
Operative bed following modified radical neck dissection.
FIGURE 7–20
Resection of the sternocleidomastoid, internal jugular vein, and spinal accessory nerve superiorly for radical neck dissection.