The presence of cervical metastases is the most significant independent prognostic factor in squamous cell carcinoma of the head and neck. Decreases survival by almost 50%.

Neck Dissections

- Anatomy
- Types of dissection
- Orientation
- Staging

Lymphatics of head and neck

- Waldeyer’s internal ring
  – Adenoids, lingual and palatine tonsils, posterior pharyngeal wall lymphoid aggregates
- Superficial lymph node system
- Deep lymph node system

Neck Dissections

- Oncologic importance of cervical lymph node excision recognized in late 19th century
- Radical neck dissection first described in 1906 by George Crile

A Pathologist’s Guide to Neck Dissection

North American Society for Head and Neck Pathology
Companion Meeting 2006
Sigrid Wayne, M.D.
Department of Pathology
University of Iowa
Superficial lymph node system

- Located at junction of head and neck
- Lymph node groups
  - Occipital
  - Post-auricular
  - Parotid
  - Buccal
  - Superficial cervical
  - Submental
  - Submandibular
  - Anterior cervical

Deep lymph node system

- Located along internal jugular vein, within carotid sheath
- Lymph node groups
  - Upper jugular
  - Middle jugular
  - Lower jugular
- In general, lymph flows from superficial to deep, and from superior to inferior

Surgical level system

- Lymph nodes categorized into 6 levels
- Includes deep and some superficial nodes

Level I

- Submental and submandibular nodes
- Boundaries
  - Superior: skull base
  - Inferior: inferior body of hyoid bone
  - Anterior: stylohyoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Oral cavity, lower lip, anterior nasal cavity, submandibular gland, soft tissue of midface

Level II

- Upper jugular nodes
- Boundaries
  - Superior: skull base
  - Inferior: inferior body of hyoid bone
  - Anterior: stylohyoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Oral cavity, nasal cavity, nasopharynx, oropharynx, hypopharynx, larynx, parotid gland

Level III

- Mid jugular nodes
- Boundaries
  - Superior: inferior body of hyoid
  - Inferior: inferior border of cricoid cartilage
  - Anterior: lateral border of sternocleidomastoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Oral cavity, nasopharynx, oropharynx, hypopharynx, larynx
Level IV
- Lower jugular nodes
- Boundaries
  - Superior: inferior border of cricoid cartilage
  - Inferior: clavicle
  - Anterior: lateral border of sternohyoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Hypopharynx, larynx, cervical esophagus, thyroid gland

Level V
- Posterior triangle nodes
- Boundaries
  - Inferior: clavicle
  - Anterior: posterior border of sternocleidomastoid muscle
  - Posterior: anterior border of trapezius muscle
- Sites drained
  - Nasopharynx, oropharynx, cutaneous sites of posterior scalp and neck

Level VI
- Pre- and paratracheal, precricoid (Delphian), and perithyroidal nodes
- Boundaries
  - Superior: hyoid bone
  - Inferior: suprasternal notch
  - Lateral: common carotid artery
- Sites drained
  - Thyroid gland, glottic/subglottic larynx, apex of pyriform sinus, cervical esophagus

- Subdivided levels I, II, and V
  - Level I: submental and submandibular
  - Level II: divided by plane defined by spinal accessory nerve
  - Level V: divided by plane defined by inferior border of cricoid cartilage
- Sublevels with different biological significance than larger level

Neck Dissections
- Anatomy
- Types of dissection
- Orientation
- Staging

Neck dissection: Historical perspective
- Concept of cervical lymphadenectomy developed and reported by George Crile in 1906
- Article described resection of all cervical nodal groups
- Standard treatment for cervical metastases for over 60 years
- Basis for modern radical neck dissection
Radical neck dissection (RND)

- Resection of:
  - All lymph node groups from levels I through V
  - Spinal accessory nerve
  - Internal jugular vein
  - Sternocleidomastoid muscle

Radical neck dissection (RND)

- Complications
  - Sacrifice of spinal accessory nerve and sternocleidomastoid
  - Weakness in turning head to opposite side
  - Inability to elevate and retract shoulder
  - Difficulty elevating arm above horizontal level
  - Disfiguring
    - Shoulder droop
    - Scapular winging

Development of conservation neck dissection

- Driving force behind development of conservation neck dissection was goal of preserving spinal accessory nerve
- 1950's: Ward and Robben reported that the spinal accessory nerve could be preserved in selected patients
- 1960's: Suarez popularized “functional neck dissection”
  - Demonstrated that lymphatics contained within fascial compartments, well defined from nonlymphatic structures
  - Nonlymphatic structures could be preserved during neck dissection

Evolution of neck dissection (1960's-1980's)

- Anatomic and clinical studies by Rouviere, Lindberg, Byers, and Shah
- Conclusion: squamous cell carcinoma of the head and neck metastasizes to regional lymph nodes in a predictable distribution

Frequency of cervical nodal metastases in floor of mouth carcinoma

<table>
<thead>
<tr>
<th>NODAL GROUP</th>
<th>IPSILATERAL (%)</th>
<th>CONTRALATERAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>II</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>III</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>IV</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Frequency of cervical nodal metastases in supraglottic carcinoma

<table>
<thead>
<tr>
<th>NODAL GROUP</th>
<th>IPSILATERAL (%)</th>
<th>CONTRALATERAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>II</td>
<td>67</td>
<td>21</td>
</tr>
<tr>
<td>III</td>
<td>48</td>
<td>10</td>
</tr>
<tr>
<td>IV</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>V</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Proliferation of conservation neck dissections in 1980’s

- Proliferation of nonstandardized, institution and surgeon specific eponyms and terms for types of neck dissection
  - Updated in 2001

Extended neck dissection

- Radical neck dissection (RND): Standard basic procedure for cervical lymphadenectomy
- Preservation of one or more nonlymphatic structures that are removed in RND
- Modified radical neck dissection (MRND)
- Selective neck dissection (SND)

Modified radical neck dissection (MRND)

- Type I: Preservation of spinal accessory nerve (SAN)
- Type II: Preservation of spinal accessory nerve and internal jugular vein
- Type III: Preservation of spinal accessory nerve, internal jugular vein, and sternocleidomastoid muscle

Which type of neck dissection to choose?

- Factors considered
  - Site of primary
  - Clinical status of neck (physical exam, radiologic studies)
    - Clinically negative = N₀
    - Clinically positive = N₁
  - Previous treatment of neck
  - Patient preference
- General guidelines, but may be variations with region, institution, surgeon

The clinically N+ neck: Therapeutic neck dissection

- Radical neck dissection: Massive nodal disease with extensive soft tissue involvement
- Modified radical neck dissection: Lymph node metastases confined to nodes
- Selective neck dissection: May be used in carefully selected patients with limited nodal disease (N₁)
The clinically N\textsubscript{0} neck: 
**Elective neck dissection**

- **Staging**
- **Treatment of occult metastases**
  - Indicated when risk of metastases is > 20%
  - Factors determining risk
    - Site
    - Size
    - Thickness/depth of invasion (oral cavity)
    - Vascular/perineural invasion
- **Modified radical neck dissection**
- **Selective neck dissection**

<table>
<thead>
<tr>
<th>Node Group</th>
<th>Ipsilateral (%)</th>
<th>Contralateral (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>70</td>
<td>5</td>
</tr>
<tr>
<td>II</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>III</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>IV</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Primary site:**
- **Oral cavity**
  - Selective neck dissection (I-III)
  - Selective neck dissection (I-IV) for tongue
  - Bilateral dissections for floor of mouth and midline tongue

**Primary site:**
- **Oropharynx, hypopharynx, larynx**
  - **Oropharynx**
    - Selective neck dissection (II-IV) or (I-IV)
    - Bilateral for base of tongue
  - **Hypopharynx and larynx**
    - Selective neck dissection (II-IV) or (Ila, III, IV)
    - Bilateral for supraglottis

**Primary site:**
- **Thyroid gland**
  - Papillary or follicular carcinoma
    - N\textsubscript{0} (Controversial): No neck dissection or selective neck dissection (VI)
    - N+: Selective neck dissection of involved levels
  - Medullary carcinoma
    - N\textsubscript{0}: Selective neck dissection (VI)
    - N+ or histologically positive nodes in VI: Radical or modified radical neck dissection
    - Bilateral radical or modified radical neck dissection if bilateral primary or nodal disease

**Primary site:**
- **Major salivary gland**
  - N\textsubscript{+} neck
    - Modified radical neck dissection
    - Selective neck dissection (I-III) or (I-IV)
  - N\textsubscript{0} neck
    - Selective neck dissection (I-III) if:
      - High grade
      - T3/T4
      - Extrajugular spread
      - Age > 54 years
      - Lymphatic invasion

**Neck Dissections**
- **Anatomy**
- **Types of dissection**
- **Orientation**
- **Staging**
Orienting the neck dissection

• Boundaries of neck levels are structures that mostly remain in patient
• Options for orienting specimen
  – Surgeon cuts specimen into levels prior to sending to pathology
  – Surgeon pins specimen to orienting board
  – What to do if specimen arrives in gross room unoriented…?

• Neck dissections containing level I are easily oriented
  – Submandibular gland in level I gives anterior-superior aspect of specimen
  – Sternocleidomastoid muscle is on superficial aspect
  – Internal jugular vein is on deep aspect

• Level I: anterior to sternocleidomastoid
• Level II: posterior to sternocleidomastoid
• Levels II-IV: divide sternocleidomastoid and attached fibroadipose tissue into equal thirds

Cannot distinguish superior and inferior aspects without submandibular gland, even when sternocleidomastoid muscle is present.

How many nodes?

• Sources of variability
  – Patient
    • Anatomic variation
    • Prior radiation therapy
  – Pathologist
  – Surgical technique

• Check clinic notes and radiology reports to correlate location of any grossly positive nodes
• Ask the surgeon to orient the specimen
Mean number of nodes by procedure

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Lymphography (I-V)</th>
<th>RND (I-V)</th>
<th>MRND (I-V)</th>
<th>SND (I-III)</th>
<th>SND (II-IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>22 - 31</td>
<td>26 - 31</td>
<td>10 - 20</td>
<td>19 - 30</td>
<td></td>
</tr>
</tbody>
</table>

- Approximately 3-8 lymph nodes per level
- Prior radiotherapy can reduce yield by up to 50%

Neck Dissections

- Anatomy
- Types of dissection
- Orientation
- Staging

Neck Dissections

• Anatomy
• Types of dissection
• Orientation
• Staging

TMN Staging
American Joint Committee on Cancer 2002

- N0: No regional lymph node metastases
- N1: Metastasis in single ipsilateral node, 3 cm or less in greatest dimension
- N2a: Metastasis in single ipsilateral node, >3 cm but <6 cm in greatest dimension

TMN Staging
American Joint Committee on Cancer 2002

- N2b: Metastasis in multiple ipsilateral nodes, <6 cm in greatest dimension
- N2c: Metastasis in bilateral or contralateral nodes, <6 cm in greatest dimension
- N3: Metastasis in lymph node >6 cm in greatest dimension

Summary

• The surgical level system classifies cervical lymph nodes into 6 levels
• Neoplasms of the head and neck metastasize to regional lymph nodes in a predictable distribution according to site of primary
• Neck dissection has evolved from radical neck dissection to increasingly conservative procedures that strive to minimize functional and aesthetic complications
  - Future: Increasing role of sentinel node biopsy?
### Summary of anatomic boundaries of neck levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Superior</th>
<th>Inferior</th>
<th>Anterior (medial)</th>
<th>Posterior (lateral)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Symphysis of mandible</td>
<td>Body of hyoid</td>
<td>Anterior belly of contralateral digastric muscle</td>
<td>Anterior belly of ipsilateral digastric muscle</td>
</tr>
<tr>
<td>IB</td>
<td>Body of mandible</td>
<td>Posterior belly of digastric muscle</td>
<td>Anterior belly of digastric muscle</td>
<td>Stylohyoid muscle</td>
</tr>
<tr>
<td>IIA</td>
<td>Skull base</td>
<td>Horizontal plane defined by the inferior body of the hyoid bone</td>
<td>Stylohyoid muscle</td>
<td>Vertical plane defined by the spinal accessory nerve</td>
</tr>
<tr>
<td>IIB</td>
<td>Skull base</td>
<td>Horizontal plane defined by the inferior body of the hyoid bone</td>
<td>Vertical plane defined by the spinal accessory nerve</td>
<td>Lateral border of the sternocleidomastoid</td>
</tr>
<tr>
<td>III</td>
<td>Horizontal plane defined by inferior body of hyoid</td>
<td>Horizontal plane defined by the inferior border of the cricoid cartilage</td>
<td>Lateral border of the sternohyoid muscle</td>
<td>Lateral border of the sternocleidomastoid or sensory branches of cervical plexus</td>
</tr>
<tr>
<td>IV</td>
<td>Horizontal plane defined by the inferior border of the cricoid cartilage</td>
<td>Clavicle</td>
<td>Lateral border of the sternohyoid muscle</td>
<td>Lateral border of the sternocleidomastoid or sensory branches of cervical plexus</td>
</tr>
<tr>
<td>VA</td>
<td>Apex of the convergence of the sternocleidomastoid and trapezius muscles</td>
<td>Horizontal plane defined by the lower border of the cricoid cartilage</td>
<td>Posterior border of the sternocleidomastoid muscle or sensory branches of cervical plexus</td>
<td>Anterior border of the trapezius muscle</td>
</tr>
<tr>
<td>VB</td>
<td>Horizontal plane defined by the lower border of the cricoid cartilage</td>
<td>Clavicle</td>
<td>Posterior border of the sternocleidomastoid muscle or sensory branches of cervical plexus</td>
<td>Anterior border of the trapezius muscle</td>
</tr>
<tr>
<td>VI</td>
<td>Hyoid bone</td>
<td>Suprasternal</td>
<td>Common carotid artery</td>
<td>Common carotid artery</td>
</tr>
</tbody>
</table>

Summary of sites drained by nodal group and level

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>NODAL GROUPS</th>
<th>SITES DRAINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Submental</td>
<td>Floor of mouth, anterior oral tongue, anterior mandibular alveolar ridge, lower lip</td>
</tr>
<tr>
<td>IB</td>
<td>Submandibular</td>
<td>Oral cavity, anterior nasal cavity, soft tissue of midface, submandibular gland</td>
</tr>
<tr>
<td>II (A+B)</td>
<td>Upper jugular</td>
<td>Oral cavity, nasal cavity, nasopharynx, oropharynx, hypopharynx, larynx, parotid gland</td>
</tr>
<tr>
<td>III</td>
<td>Middle jugular</td>
<td>Oral cavity, nasopharynx, oropharynx, hypopharynx, larynx</td>
</tr>
<tr>
<td>IV</td>
<td>Lower jugular</td>
<td>Hypopharynx, thyroid, cervical esophagus, larynx</td>
</tr>
<tr>
<td>V (A+B)</td>
<td>Nodes around lower half of spinal accessory nerve and transverse cervical artery, supraclavicular nodes</td>
<td>Nasopharynx, cutaneous structures of posterior scalp and neck</td>
</tr>
<tr>
<td>VI</td>
<td>Pre- and paratracheal, precricoid (Delphian), and perithyroidal nodes</td>
<td>Thyroid gland, glottic/subglottic larynx, apex of pyriform sinus, cervical esophagus</td>
</tr>
</tbody>
</table>
Radical neck dissection (RND)
Standard basic procedure for cervical lymphadeneotomy

Extended neck dissection
Removal of additional lymph node groups or nonlymphatic structures relative to RND

Radical neck dissection (RND)

Modified radical neck dissection (MRND)
Preservation of one or more nonlymphatic structures that are removed in RND

Selective neck dissection (SND)
Preservation of one or more lymph node groups that are removed in RND
## Classification of neck dissection

<table>
<thead>
<tr>
<th>1991 Classification</th>
<th>2001 Classification</th>
<th>Lymph node levels removed</th>
<th>Other structures removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radical neck dissection (RND)</td>
<td>Radical neck dissection (RND)</td>
<td>I-V</td>
<td>SAN, SCM, IJV</td>
</tr>
<tr>
<td>Modified radical neck dissection (MRND)</td>
<td>Modified radical neck dissection (MRND)</td>
<td>I-V</td>
<td>Type 1: SCM, IJV Type 2: SCM Type 3: None</td>
</tr>
<tr>
<td>Selective neck dissection (SND)</td>
<td>Selective neck dissection (SND)</td>
<td>Specify in parentheses</td>
<td>None</td>
</tr>
<tr>
<td>Supraomohyoid (SOHND)</td>
<td>SND(I-III)</td>
<td>I-III</td>
<td>None</td>
</tr>
<tr>
<td>Lateral (LND)</td>
<td>SND(II-IV)</td>
<td>II-IV</td>
<td>None</td>
</tr>
<tr>
<td>Posterolateral (PLND)</td>
<td>SND(II-V)</td>
<td>II-V</td>
<td>None</td>
</tr>
<tr>
<td>Anterior</td>
<td>SND(VI)</td>
<td>VI</td>
<td>None</td>
</tr>
<tr>
<td>Extended neck dissection</td>
<td>Extended neck dissection</td>
<td>I-V +/- other lymph node groups (eg retropharyngeal nodes)</td>
<td>SAN, SCM, IJV +/- other nonlymphatic structures (eg skin)</td>
</tr>
</tbody>
</table>

**SAN** = Spinal accessory nerve; **SCM** = Sternocleidomastoid muscle; **IJV** = Internal jugular vein
TMN Staging
American Joint Committee on Cancer 2002

- $N_0$: No regional lymph node metastases
- $N_1$: Metastasis in single ipsilateral node, 3 cm or less in greatest dimension
- $N_{2a}$: Metastasis in single ipsilateral node, >3 cm but <6 cm in greatest dimension
N2b
Metastasis in multiple ipsilateral nodes, <6 cm in greatest dimension

N2c
Metastasis in bilateral or contralateral nodes, <6 cm in greatest dimension

N3
Metastasis in lymph node >6 cm in greatest dimension
LITERATURE CITED


