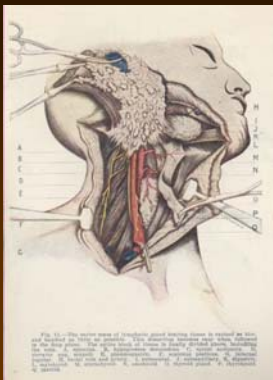
A Pathologist's Guide to Neck Dissection

North American Society for Head and Neck Pathology Companion Meeting 2006

Sigrid Wayne, M.D.
Department of Pathology
University of Iowa

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%



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

Neck Dissections

- Anatomy
- Types of dissection
- Orientation
- Staging

Neck Dissections

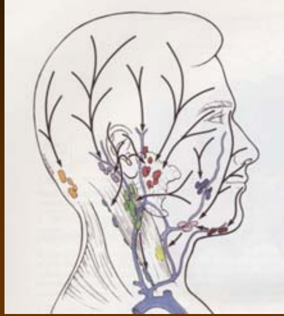
- Anatomy
- Types of dissection
- Orientation
- Staging

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

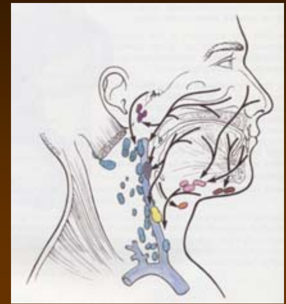
Superficial lymph node system

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



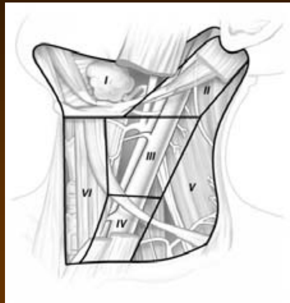
Deep lymph node system

- 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



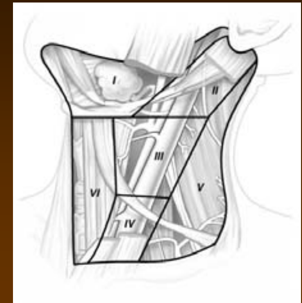
Surgical level system

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



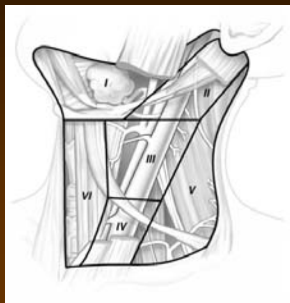
Level I

- Submental and submandibular nodes
- Boundaries
  - Submental and submandibular triangles
- Sites drained
  - Oral cavity, lower lip, anterior nasal cavity, submandibular gland, soft tissue of midface

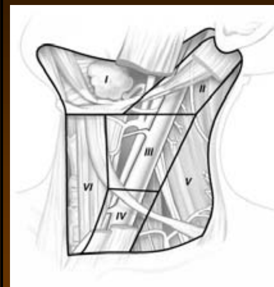


Level II

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

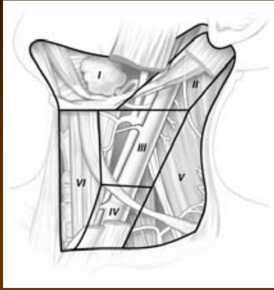


Level III



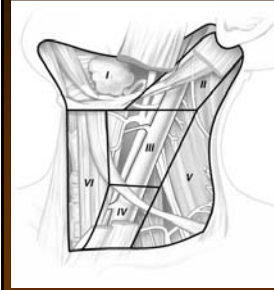
- Mid jugular nodes
- Boundaries
  - Superior: inferior body of hyoid
  - Inferior: inferior border of cricoid cartilage
  - Anterior: lateral border of sternohyoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Oral cavity, nasopharynx, oropharynx, hypopharynx, larynx

Level IV



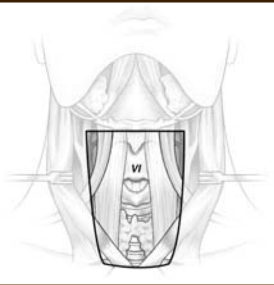
- Lower jugular nodes
- Boundaries
  - Superior: inferior border of cricoid cartilage
  - Inferior: clavicle
  - Anterior: lateral border of sternohyoid muscle
  - Posterior: posterior border of sternocleidomastoid muscle
- Sites drained
  - Hypopharynx, larynx, cervical esophagus, thyroid gland

Level V



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

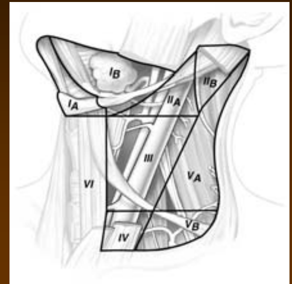
Level VI



- 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

American Academy of Otolaryngology-Head and Neck Surgery modification (1991)

- 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

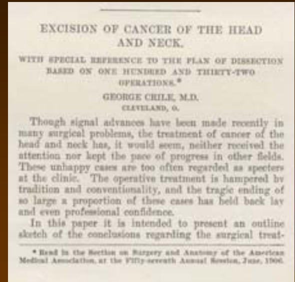


Neck Dissections

- 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



EXCISION OF CANCER OF THE HEAD AND NECK.

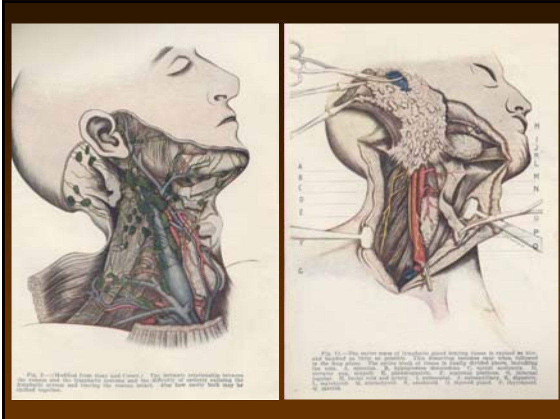
WITH SPECIAL REFERENCE TO THE PLAN OF DISSECTION BASED ON ONE HUNDRED AND THIRTY-TWO OPERATIONS.*

GEORGE CRILE, M.D.
CLEVELAND, O.

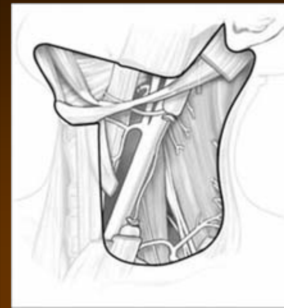
Though signal advances have been made recently in many surgical problems, the treatment of cancer of the head and neck has, it would seem, neither received the attention nor kept the pace of progress in other fields. These unhappy cases are too often regarded as specters at the clinic. The operative treatment is hampered by tradition and conventionality, and the tragic ending of so large a proportion of these cases has held back lay and even professional confidence.

In this paper it is intended to present an outline sketch of the conclusions regarding the surgical treat-

* Read in the Section on Surgery and Anatomy of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.



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

NODAL GROUP	IPSILATERAL (%)	CONTRALATERAL (%)
I	70	5
II	54	6
III	14	0
IV	6	1
V	3	0
Supraclavicular	1	0

Frequency of cervical nodal metastases in supraglottic carcinoma

NODAL GROUP	IPSILATERAL (%)	CONTRALATERAL (%)
I	2	0
II	67	21
III	48	10
IV	15	5
V	9	4
Supraclavicular	3	

Proliferation of conservation neck dissections in 1980's

- Proliferation of nonstandardized, institution and surgeon specific eponyms and terms for types of neck dissection
- 1991: American Academy of Otolaryngology-Head and Neck Surgery issued a standardized classification of neck dissections
  - Updated in 2001

Extended neck dissection

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

Radical neck dissection (RND)
Standard basic procedure for cervical lymphadenectomy

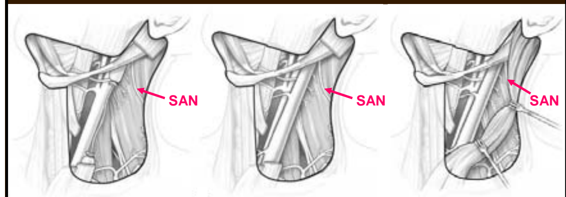
Preservation of one or more nonlymphatic structures that are removed in RND

Preservation of one or more lymph node groups 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

Type II: Preservation of spinal accessory nerve and internal jugular vein

Type III: Preservation of spinal accessory nerve, internal jugular vein, and sternocleidomastoid muscle

- Excision of levels I – V
- Preservation of spinal accessory nerve (SAN) without or without internal jugular vein and sternocleidomastoid muscle

Which type of neck dissection to choose?

- Factors considered
  - Site of primary
  - Clincal status of neck (physical exam, radiologic studies)
    - Clinically negative = N_0
    - Clinically positive = N+
  - 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 (N_1)

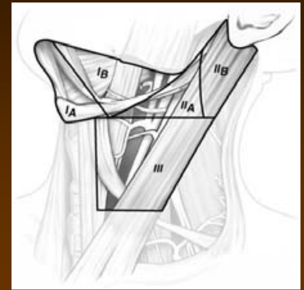
The clinically N_0 neck: *Elective neck dissection*

- 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

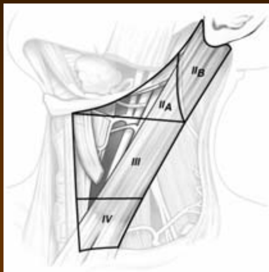
Nodal Group	Ipsilateral (%)	Contralateral (%)
I	70	5
II	54	6
III	14	0
IV	6	1
V	3	0
Supraclavicular	1	0

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 (IIa, III, IV)
  - Bilateral for supraglottis

Primary site: *Thyroid gland*

- Papillary or follicular carcinoma
  - N_0 (Controversial): No neck dissection or selective neck dissection (VI)
  - N+: Selective neck dissection of involved levels
- Medullary carcinoma
  - N_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+ neck
  - Modified radical neck dissection
  - Selective neck dissection (I-III) or (I-IV)
- N_0 neck
  - Selective neck dissection (I-III) if:
    - High grade
    - T3/T4
    - Extraglandular spread
    - Age > 54 years
    - Lymphatic invasion

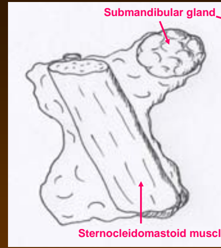
Neck Dissections

- Anatomy
- Types of dissection
- Orientation
- Staging

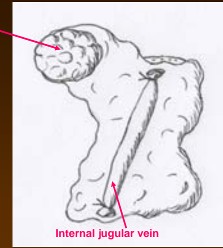
Orienting the neck dissection

- 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…?

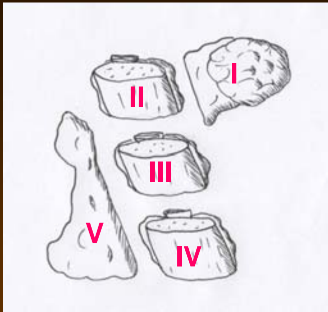
Right radical neck dissection: View of superficial surface



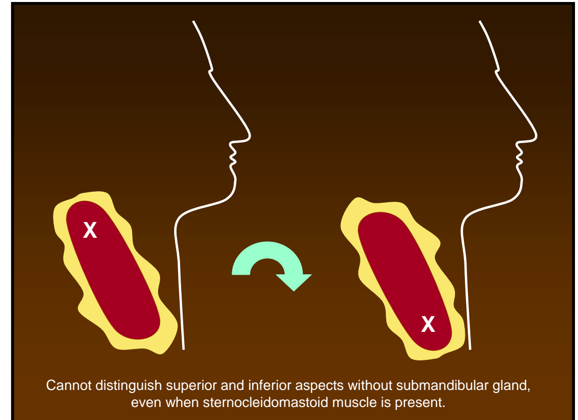
Right radical neck dissection: View of deep surface



- 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 V: 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.

- Check clinic notes and radiology reports to correlate location of any grossly positive nodes
- Ask the surgeon to orient the specimen

How many nodes?

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

Mean number of nodes by procedure

Lymphography (I-V)	RND (I-V)	MRND (I-V)	SND (I-III)	SND (II-IV)
42	22 - 31	26 - 31	10 - 20	19 - 30

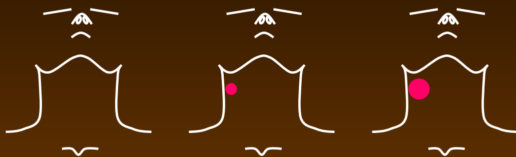
- Approximately 3-8 lymph nodes per level
- Prior radiotherapy can reduce yield by up to 50%

Neck Dissections

- Anatomy
- Types of dissection
- Orientation
- Staging

TMN Staging

American Joint Committee on Cancer 2002



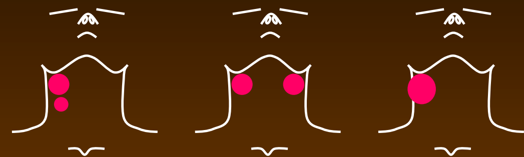
N_0
No regional lymph node metastases

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

TMN Staging

American Joint Committee on Cancer 2002



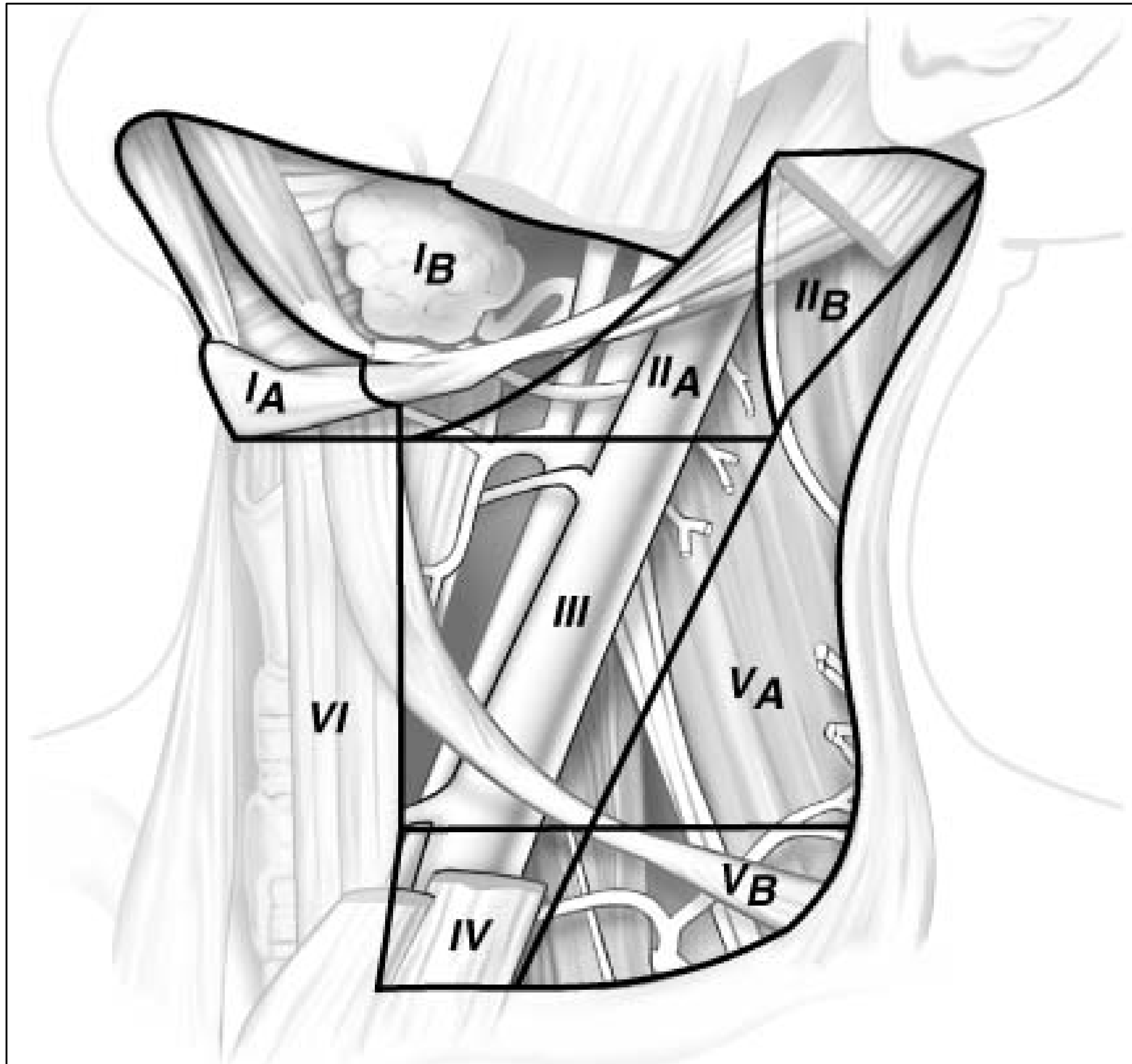
N_{2b}
Metastasis in multiple ipsilateral nodes, <6 cm in greatest dimension

N_{2c}
Metastasis in bilateral or contralateral nodes, <6 cm in greatest dimension

N_3
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?



Cummings, CW. Cummings: Otolaryngology: Head and Neck Surgery, 4th ed. Mosby, Inc: 2005

Summary of anatomic boundaries of neck levels

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

Robbins KT et al. The use and misuse of neck dissection for head and neck cancer. *J Am Coll Surg*, 193(1)91-102,2001

Summary of sites drained by nodal group and level

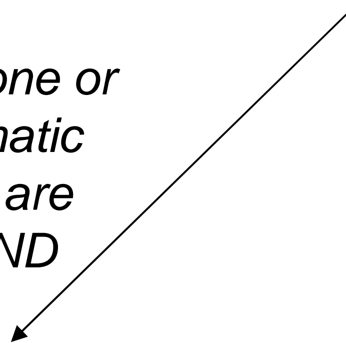
LEVEL	NODAL GROUPS	SITES DRAINED
IA	Submental	Floor of mouth, anterior oral tongue, anterior mandibular alveolar ridge, lower lip
IB	Submandibular	Oral cavity, anterior nasal cavity, soft tissue of midface, submandibular gland
II (A+B)	Upper jugular	Oral cavity, nasal cavity, nasopharynx, oropharynx,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

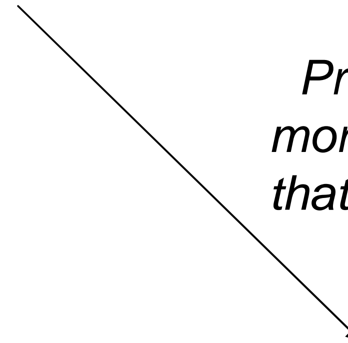
Extended neck dissection

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

Radical neck dissection (RND)

Standard basic procedure for cervical lymphadenectomy





Preservation of one or more nonlymphatic structures that are removed in RND

Preservation of one or more lymph node groups that are removed in RND

Modified radical neck dissection (MRND)

Selective neck dissection (SND)

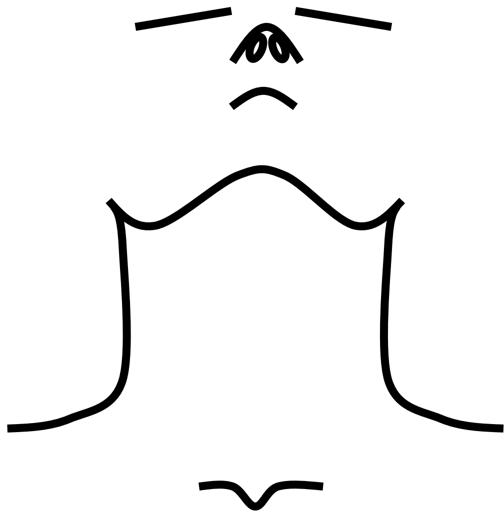
Classification of neck dissection

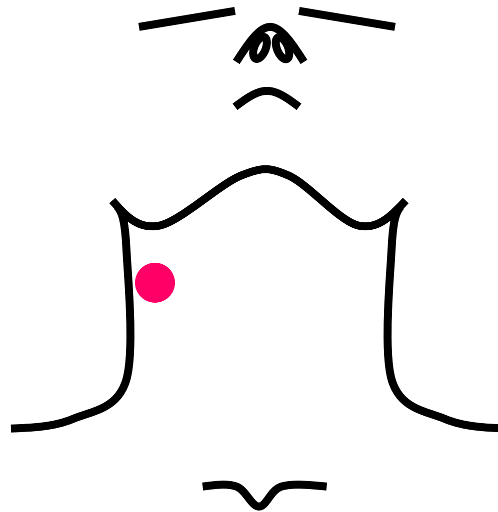
1991 Classification	2001 Classification	Lymph node levels removed	Other structures removed
Radical neck dissection (RND)	Radical neck dissection (RND)	I-V	SAN, SCM, IJV
Modified radical neck dissection (MRND)	Modified radical neck dissection (MRND)	I-V	Type 1: SCM, IJV Type 2: SCM Type 3: None
Selective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

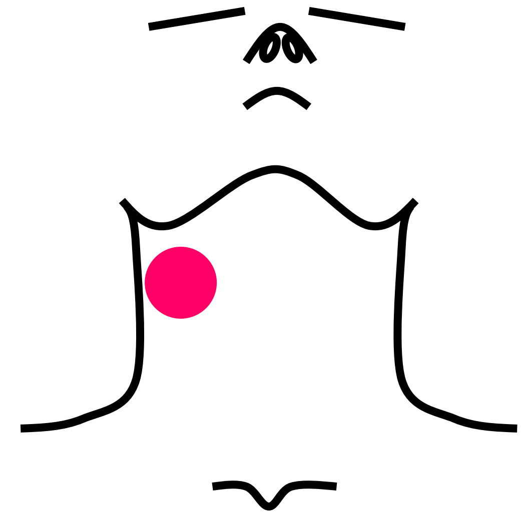
SAN = Spinal accessory nerve; **SCM** = Sternocleidomastoid muscle; **IJV** = Internal jugular vein

TMN Staging

American Joint Committee on Cancer 2002







N_0

No regional lymph node metastases

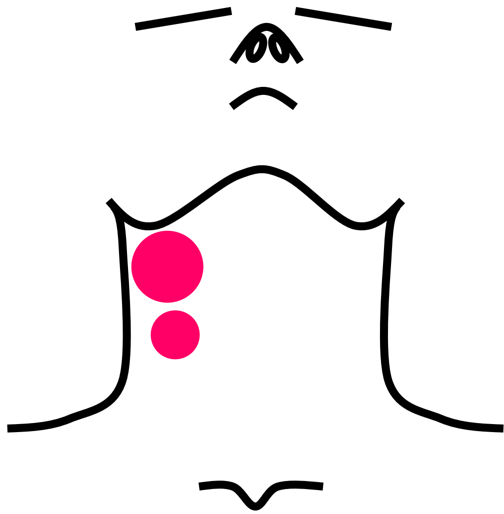
N_1

Metastasis in single ipsilateral node, 3 cm or less in greatest dimension

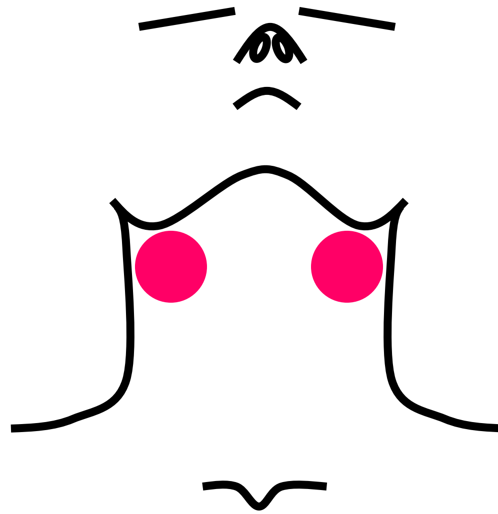
N_{2a}

Metastasis in single ipsilateral node, >3 cm but <6 cm in greatest dimension

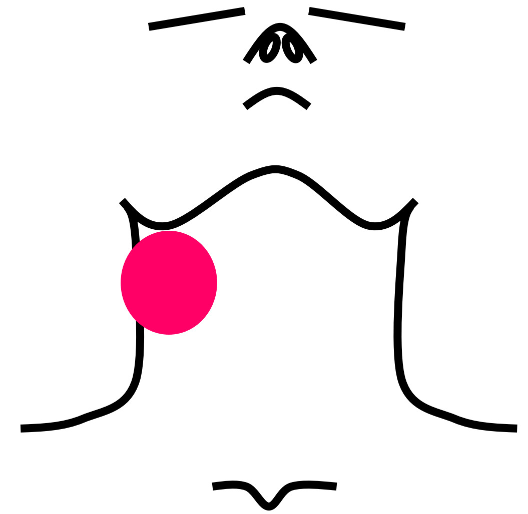
TMN Staging
American Joint Committee on Cancer 2002



N_{2b}
Metastasis in multiple ipsilateral nodes, <6 cm in greatest dimension



N_{2c}
Metastasis in bilateral or contralateral nodes, <6 cm in greatest dimension



N_3
Metastasis in lymph node >6 cm in greatest dimension

LITERATURE CITED

1. Crile G. Excision of cancer of head and neck. With special reference to the plan of dissection based on 132 patients. JAMA. 47:1780-1786, 1906.

2. Agur, A.M.R. Grant's Atlas of Anatomy, 9th ed. Williams and Wilkins:1991.

3. Cummings, CW. Cummings: Otolaryngology: Head and Neck Surgery, 4th ed. Mosby, Inc: 2005.

4. Shah JP et al. Neck dissection: current status and future possibilities. *Clin Bull* 11:25, 1981.

5. Robbins KT et al. Standardizing neck dissection terminology. *Arch Otolaryngol* 117:601, 1991.

6. Robbins KT et al. The use and misuse of neck dissection for head and neck cancer. J Am Coll Surg, 193(1)91-102,2001

7. Werning J. Modified Radical Neck Dissection. medicine.com, 2004.

8. Rouviere H. Lymphatics of the head and neck. Tobias MJ, trans. Ann Arbor, Mich: Edwards Brothers: 1938.

9. Ward GE, Robben JO. A composite operation for radical neck dissection and removal of cancer of the mouth. *Cancer* 4:98, 1951.

10. Suarez O. El problema de las metastasis linfáticas y alejadas del cancer de laringe e hipofaringe. Rev Otorhinolaringol 23:83, 1963.

11. Lindberg R. Distribution of cervical lymph node metastases from squamous cell carcinoma of the upper respiratory and digestive tracts. Cancer 29:1446, 1972.

12. Shah JP. Patterns of lymph node metastases from squamous carcinomas of the upper aerodigestive tract. Am J Surg 160:405, 1990.

13. Byers, RM, et al, Rationale for elective modified neck dissection. Head and Neck Surgery 1988; 10:160-167

14. Lindberg J et al. Treatment of cervical lymph node metastases from primary lesions of the oropharynx, supraglottic laryx, and hypopharynx. Am J Roentgen Rad Ther Nucl Med. 102:132-137, 1968.

15. Shah J and Anderson PE. Impact of patterns of nodal metastases on modifications of neck dissections. Ann Surg Oncol. 1:521-532, 1994.

16. Mukherji SK et al. Cervical nodal metastases in squamous cell carcinoma of the head and neck: what to expect. Head & Neck. 23(11)995-1005, 2001.

17. Robbins KT et al. Neck dissection classification update: revisions proposed by the American Head and Neck Society and the American Academy of Otolaryngology – Head and Neck Surgery. Arch Otolaryngol Head Neck Surg. 128:751-758, 2002.

18. Chummun S et al. Surgical education: neck dissection. Br Assoc Plast Surg 57:610-623, 2004.
Ferlito A et al. Current considerations in neck dissection. Acta Otolaryngol. 122:323-329, 2002.

19. Ferlito A et al. Is the standard radical neck dissection no longer standard? Acta Otolaryngol. 122:792-795, 2002.

20. Shaha AR. Neck dissection: an operation in evolution. Wor J Surg Onc. 3:22, 2005.

21. Gold DR et al. Management of the neck in salivary gland carcinoma. Otolaryngol Clin N Am. 38:99-105, 2005.

22. Hurban RH et al. Surgical Pathology Dissection: an illustrated guide. Springer-Verlag New York, Inc, 1996.

23. Greene FL et al, eds. American Joint Committee on Cancer: Cancer staging manual, 6th ed. Springer-Verlag, 2002.

24. Fisch UP and Sigel ME. Cervical lymphatic system as visualized by lymphography. Annals Oto Rhino Laryngol. 73:869-882, 1964.

25. Agrama MT et al. Node counts in neck dissection: are they useful in outcomes research? Otolaryngol Head Neck Surg. 124:433-435, 2001.

26. Friedman M et al. Quantification of lymph nodes in selective neck dissection. Laryngoscope. 109:368-370, 1999.

27. Bhattacharyya N. The effects of more conservative neck dissection and radiotherapy on nodal yields from the neck. Arch Otolaryngol Head Neck Surg. 124:412-416, 1998.