**Purpose:** The objective of this exhibit is to promote understanding of the post-treatment imaging appearance of the various types of neck dissections and myocutaneous reconstructions used in the treatment of patients with head and neck cancer.

**Materials & Methods:** The authors illustrate the new neck dissection classification1 and the various types of surgical reconstructions utilized in a variety of patients treated for head and neck cancer. Post-surgical outcomes are correlated with characteristic findings using MRI and CT imaging techniques.

**Results:** The post-surgical neck demonstrates typical appearances for a given dissection technique with or without reconstruction. Surveillance imaging appearance was influenced by: 1) the time course of characteristic changes in soft tissue appearances, 2) the possible employment of adjunctive radiation therapy, 3) type of neck dissection, and 4) use of a myocutaneous flap.

**Conclusion:** Surgical therapy for head and neck cancer results in anatomical distortions that may obfuscate the interpretation of post-therapeutic imaging. Knowledge of the surgical techniques involved in these treatments is key in anticipating the imaging appearances and rendering correct interpretations of post-therapeutic surveillance imaging studies. These include the various types of neck dissections as well as the application of the various types of soft tissue flaps used in reconstruction. Understanding the relationship between the types of surgery performed (i.e., type of neck dissection, use of a flap, etc.) and the expected post-treatment imaging appearance is mandatory in the early detection of tumor recurrence.

**Unknown Case 1:**
**History:** Left tonsillar squamous cell cancer for which definitive treatment was received. Subsequent PET study demonstrated tumor within the left parotid gland. **What** operation has been performed and what features are present that identify it? **Is** there any evidence that adjunctive therapy has been applied?

**Unknown Case 2:**
History: Laryngeal squamous cell cancer. **What** operation has been performed? **Is** there evidence that a reconstruction step has been applied? **Is** there evidence of recurrent disease?

**Unknown Case 3:**
**History:** Squamous cell cancer right hypopharynx. **Is** there evidence of bilateral spread of disease? **What** operation has been performed? **Is** there evidence of adjunctive therapy having been applied?
Cervical lymph nodes are usually divided clinically by anatomic levels with landmarks easily identifiable on imaging. Level 1 includes the submental and submandibular group; Level 2 upper jugular group; Level 3 middle jugular group; Level 4 lower jugular group; Level 5 posterior triangle group; Level 6 anterior compartment group. Several landmarks are important to identify on cross-sectional imaging including the jugular fossa, mandibular symphysis, hyoid bone and cricoid arch, submandibular gland, sternocleidomastoid, anterior scalene, digastric, mylohyoid and trapezius muscles, as well as the carotid artery and jugular vein\(^2\).

Representative axial image displays the typically symmetric arrangement of the muscle and vascular groups that aid in identifying abnormalities. SCM=sternocleidomastoid, OH=omohyoid, LC=longus colli, ASC=anterior scalene, M/P Sc=middle and posterior scalenes, LS=levator scapulae, Trap=trapezius, ICA=internal carotid artery, IJV=internal jugular vein, CN=cranial nerve, DG=digastric, Cric=cricoid arch.

Neck dissections are classified by the structures that are removed and termed radical, modified radical with preservation of a named structure, selective, and extended. Radical neck dissection (RND) implies the excision of all ipsilateral cervical lymph node groups from clavicle to mandible and, from lateral to medial, the anterior border of the trapezius muscle to the sternohyoid muscle, hyoid bone, and contralateral anterior belly of the digastric muscle. The sternocleidomastoid muscle, spinal accessory nerve, and internal jugular vein are also removed.

Modified radical neck dissection (MRND) indicates removal all lymphatic structures normally removed in the RND but with preservation of a non-lymphatic structure such as the IJV or spinal accessory nerve. Selective neck dissection (SND) indicates preservation of one or more lymph node groups that would otherwise be removed in a RND.

Selective neck dissections\(^4\) are named in accordance with the lymph node groups that are removed as dictated by the location of the tumor. For example, SND (periparotid nodes, external jugular nodes, levels II, III, and VA) is indicated for cutaneous malignancies on the lateral face, anterior scalp, and temporal distributions. Cutaneous malignancies of the anterior face indicate SND (perifacial nodes, levels
I-III, and external jugular nodes) while those cutaneous lesions of the posterior scalp and upper neck involve SND (II-V, postauricular, suboccipital and external jugular nodes). Neck dissection for malignancies of the laryngopharyngeal distributions may involve levels II-VI and retropharyngeal nodes of various combinations while lesions of the oral cavity indicate SND (I-III). Level IV nodes are added for oral tongue cancers and bilateral SND is indicated for cancers of the ventral surface of the tongue, midline of the tongue and the floor of the mouth.

**Imaging Appearance of Neck Dissections**
- Depends on the type of surgery
- Radical neck dissections and some modified radical dissections exhibit recognizable features:
  - absent structures
  - flattened neck contour
  - presence of denervation atrophy
  - muscle atrophy
- Many selective neck dissections and some modified radical neck dissections exhibit subtle changes:
  - loss of fat planes
  - contour changes of the neck
  - skin thickening at the scar site

**Anatomy** review at the level of the carotid bifurcation (A), mandibular symphysis (B), anterior commissure (C), cricoid cartilage (D), and superior margin of the clavicles (E). Normal anatomy key: AC, arytenoid cartilage; ASM, anterior scalene muscle; CB, carotid bifurcation; CC, common carotid artery; CL, clavicle; CO, anterior commissure; CR, cricoid cartilage; EJV, external jugular vein; ES, esophagus; IJV, internal jugular vein; LC, longus colli; LS, levator scapulae; M, mandible; MSM, middle scalene muscle; MY, mylohyoid muscle; PSM, posterior scalene muscle; OM, omohyoid muscle; PL, platysma; SCM, sternocleidomastoid muscle; SG, submandibular gland; STM, infrahyoid strap muscles; TC, thyroid cartilage; TR, trapezius muscle; TVC, true vocal cord; VA, vertebral artery. Note distinct appearance and symmetry of fat planes, the absence of which may aid in determining the presence or recurrence of tumor, and the type of operation performed if patient is post-operative.

**Combined SND and MRND**: Note the absence of fat planes in the right carotid space with preservation of nonlymphatic structures but absence of the left internal jugular vein.
Radical Neck Dissection: The neck contour is flattened on the right and the sternocleidomastoid muscle and internal jugular vein are absent. The levator scapulae muscle is hypertrophied as a consequence of damage to the spinal accessory nerve and paralysis of the trapezius.

Bilateral SND I-III: Loss of fat planes between the SCM and the adjacent IJV provide the clue that the patient has undergone bilateral dissection. Since all the nonlymphatic structures are present and symmetric, one can conclude that the procedure was selective dissection.

Selective node dissection for oral cavity cancer includes levels I-III necessitating removal of the submandibular glands (A). A subtle irregular margin or “fuzziness” about the right SCM (B, arrow) is present that is not seen on the contralateral side providing an important clue to the fact that this is a unilateral selective neck dissection.

Dissections that are symmetric can make recognition of defects difficult. In this case, after bilateral MRND the symmetric absence of the SCMs could go undetected if no history was provided.

Radiation changes include thickening of skin and platysma, reticulation of subcutaneous fat, mucosal edema, loss of fat planes, atrophy or fatty replacement of radiosensitive structures, and salivary gland enhancement. Since edema and acute inflammatory responses may persist for 3-4 months, a baseline CT/MR should be performed no sooner than 6-12 weeks post-therapy. Changes that suggest tumor recurrence include new masses, increasing size of a mass within or at margins of surgical site, new nodes in an atypical location after treatment, or evidence of perineural spread. Imaging before (A) and after (B) radiation depicts some of these expected changes while tumor recurrence is detected in (D, arrow) after comparison with a baseline study (C).

Denervation hemiatrophy: Fatty infiltration of the left tongue may not only reflect damage to the hypoglossal nerve after RND but it may also alert one to the possibility of tumor recurrence along the course of the nerve.
Neck Post-Op Reconstruction (Flaps)

- Used to repair surgical defects, restore optimal function, cosmesis, protect carotid artery and other structures during external beam radiation therapy.
- Classify according to:
  - Type of tissue transferred
  - Site of origin
  - Flat versus tubed

Types of Flaps

- Based upon:
  - Type of tissue
    - Cutaneous
    - Myocutaneous
    - Osteomyocutaneous
  - Site of origin
    - Local
      - Sterno-omohyoid
      - Temporalis
    - Regional
      - Pectoralis major
      - Trapezius
    - Free
      - Radial forearm
      - Rectus abdominus
      - Iliac crest
      - Vascularized intestinal transfer

The harvest site and subsequent course of a pectoralis muscle flap is shown. The flap is advanced over the clavicle with its vascular supply. Standard MRI T2 and T1 sequences with and without gadolinium demonstrate the exuberant enhancement and typical striated appearances of the flap (orange detail). Such enhancement may be mistaken for tumor recurrence.

Wide excision of mandibular cancers may require reconstruction, in this case by a free flap harvested from the patient’s right iliac crest. Slips of striated muscle within the fatty element of the flap are clearly visible in the post-operative image taken at the level of the hyoid bone. Post-operative imaging as a baseline is routine for some practitioners as recurrence at the margins of a flap is not unusual.\textsuperscript{10,11}
Treatment for oral cancers includes at least SND I-III and may include extensive reconstruction after wide excision as in this case. A large surgical defect is created for mandibular excision, bar reconstruction, and radial forearm free flap placement with excellent cosmetic result.

Flaps may not always appear prominent or easily identifiable at imaging. A pre-operative image is on the left revealing loss of prevertebral fat planes and abnormal enhancement indicating tumor presence (A). In the course of treatment, a small radial forearm free flap was placed over a posterior pharyngeal defect. On the right is a post-operative study at the same level exhibiting a subtle band of fat and muscle along the posterior wall of the hypopharynx that is the free flap (B).

Answer Case 1:
The patient is status-post left radical neck dissection. The important stigmata of a RND include an abnormal neck contour that is usually asymmetric (A), missing IJV and SCM, as well as hypertrophy of the ipsilateral levator scapulae (C) and atrophy of the trapezius muscles (B). The skin and platysma are markedly thickened after radiation therapy (D).

Answer Case 2:
A right pectoralis myocutaneous flap and pedicle has been brought up over the clavicle (A) in order to close a pharyngeocutaneous fistula after laryngectomy. A tumor recurrence is seen in the right tonsillar fossa at the superior margin of the flap (B) near a surgical clip (C). The flap is well-delineated by fat posteriorly (D) and muscular striations anteriorly (E).

Answer Case 3:
Bilateral neck dissections were performed making symmetric comparisons difficult as some changes are subtle. The two images on the left are pre-operative while those on the right are at similar levels post-operative. On the left a selective dissection of zone II was performed while a selective dissection of zones II and III was performed on the right. The submandibular glands strongly enhance after external beam radiation therapy. No fat planes are seen between the jugular veins and the overlying SCM (A). Additionally, there is pronounced loss of fat within the carotid spaces (B). Bilateral level II lymph nodes, seen pre-operatively, are absent in the post-operative study (C).
**Summary**: Radiologic changes in the post-therapeutic neck may be subtle and the imager may therefore find it helpful to become familiar with the anticipated appearances based on the type of procedure. Such post-operative changes include the loss of fat planes, muscle atrophy, and compensatory muscle hypertrophy. Asymmetry in the axial image may hint at absent structures that would provide the clue in the determination of the type of operation, if it was not already provided. The margins of flap anastomoses are likely the most common sites of tumor recurrence\textsuperscript{10,11} and therefore warrant careful scrutiny. The muscular component of myocutaneous flaps is typically striated and enhances, a phenomenon that may be confused with tumor recurrence\textsuperscript{12}. Post therapeutic changes such as radiation exhibit time-dependent changes. Tumor recurrence may be identified in such cases when there are unexpected appearances that may be made more obvious by routine baseline and surveillance imaging. Lymph node stations of the neck have been categorized utilizing an image-based system that is consistent with the clinical classification which has been in use for some time\textsuperscript{1,2}. Selective neck dissection by stations for regional control of metastatic disease while preserving non-lymphatic structures is common in the node negative neck and may gain acceptance in some node positive necks\textsuperscript{4,5,6}. It may therefore become more common that a patient has only SND without the more radiographically obvious RND or even MRND. The fact that such procedures may result in only subtle changes at imaging impresses the need for clear communication between the radiologist and the surgeon.

**References**:


