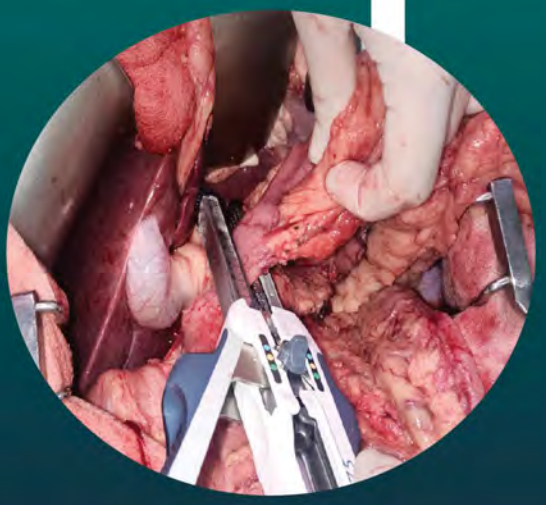
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ATLAS OF OPERATIVE SURGICAL ONCOLOGY



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4

CHAPTER

Neck Dissection

Shivakumar Thiagarajan, Gouri Pantvaidya, Devendra Chaukar

INTRODUCTION

Cervical node metastasis is the most important prognostic factor affecting survival in head and neck squamous cell carcinoma (HNSCC).[1] Appropriate management of neck nodes hence becomes a very important step in the multimodal treatment of head and neck cancers. A systematic description of radical neck dissection (RND) was first given by George W Crile in 1906. The morbidity associated with RND led to the development of lesser morbid variations, like modified radical or functional neck dissection, with comparable oncological safety.[2] Modified radical neck dissection was first described by Oswaldo Suarez which was popularized by Ettore Bocca.[2] The American Head and Neck Society (AHNS) and the American Academy of Otolaryngology Head and Neck Surgery (AAO-HNS) standardized the terminologies in 1991, which were subsequently modified in 2002 (Table 1).[3,4] The cervical lymph nodes have been grouped into six levels (Fig. 1).[5]

PREOPERATIVE EVALUATION

- A through history and clinical examination assessing the primary site and the associated nodal disease is required. The levels of the palpable node(s) should be noted, along with its mobility in relation to the underlying structures like the sternocleidomastoid muscle (SCM), carotid artery, and the prevertebral muscles.

TABLE 1: Details of structures removed and/or preserved in the various types of neck dissection

Type of neck dissection	*Nodal levels removed*	*Additional structures removed*	*Structures preserved*
Radical neck dissection	Levels I–V	SCM, SAN, and IJV	None
Extended radical neck dissection	Levels I–V	• Additional levels of nodes, e.g. retropharyngeal, parapharyngeal, superior mediastinal, periparotid, postauricular or suboccipital, • Additional structures (e.g. external carotid artery, hypoglossal nerve, vagus nerve)	None
Modified neck dissection	Levels I–V	Structures sacrificed to be mentioned in parentheses (IJV/SAN/SCM)	Atleast one non-lymphatic structure to be preserved (IJV, SAN, SCM)
Selective neck dissection	Mention the levels of nodes removed	None	Usually preserved unless involved

Abbreviations: SCM, sternocleidomastoid muscle; SAN, spinal accessory nerve; IJV, internal jugular vein

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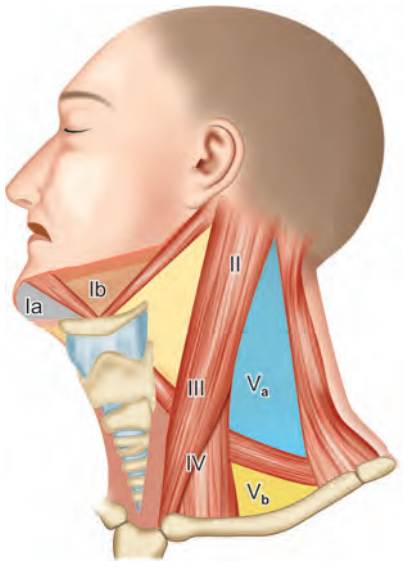


Fig. 1: Levels (I-V) of neck nodes

- *Fine-needle aspiration cytology* (FNAC) of the positive node may help in deciding the extent of neck dissection to be performed.
- Radiological evaluation for the resectability of the primary and the nodal disease as applicable should be done. The most common imaging modality used is a contrast-enhanced computed tomography scan (CECT).

INDICATIONS

Indication and Types of Neck Dissection in an N+ Neck

Modified Radical Neck Dissection

- Clinically palpable metastatic nodal disease. Depending upon the involvement of the adjacent structures like the spinal accessory nerve (SAN), the internal jugular vein (IJV) or the sternocleidomastoid (SCM), one or more of them may have to be sacrificed
- The structure sacrificed needs to be mentioned along with the procedure
- For example, if SCM and SAN are preserved, then the nomenclature of a modified radical neck dissection (MND) would be, "MND (IJV-sacrificed)". The older terminology of MND I, II, and III is no longer used.

Radical Neck Dissection

- This procedure is performed only for advanced nodal disease (N3 node, fungating node) which involves all the three non-lymphatic structures (SAN, SCM, IJV)
- Nodal disease with gross extracapsular spread.

Indications and Type of Neck Dissections in an N0 Neck

Selective Neck Dissection

A selective neck dissection (SND) is performed for clinico-radiological node negative patients. The type of SND will depend upon the propensity of the primary disease to metastasize to certain nodal levels (Table 2).

CONTRAINDICATIONS

- Radiologically, if the nodal mass is encircling the common carotid artery for anything more than 180 degrees
- Infiltration into the prevertebral muscles or into the skull base
- Infiltration of the disease into the parapharyngeal space or into the deep lobe of the parotid
- Untreatable primary or presence of distant metastasis
- If the patient is found unfit for a general anesthesia due to comorbid conditions.

SURGICAL STEPS

Anesthesia

- General anesthesia

Antibiotic Prophylaxis

- Single dose preoperatively at the time of induction.

Position

- Keep the patient in a supine position with the neck extended in a 30 degree reverse Trendelenburg position, with the head turned away from the primary surgeon
- A transparent drape is used in the head end. This helps to visualize the endotracheal tube at all times (Fig. 2).

TABLE 2: Nodal levels commonly involved in different head and neck cancers

Primary	*Nodal levels commonly involved*
Oral cavity	Level I,II,III
Larynx and hypopharynx	Levels II,III,IV, and level VI*
Oropharynx	Levels II,III,IV
Thyroid	Levels VI and level II–IV
Skin malignancies	II–V, postauricular, suboccipital

*In particular for subglottic extension of disease or a hypopharyngeal primary

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Incisions

- The incision has to be planned at the watershed line of the blood supply for optimum access and proper wound healing
- The blood supply of the cervical skin is derived from the facial artery superiorly and the transverse cervical artery inferiorly. The occipital and postauricular artery supply the flap posteriorly and the superior thyroid artery supplies it anteriorly
- Planning the incision for the neck dissection is very crucial and is based on the following:
  - Type of neck dissection to be done
  - Primary to be addressed
  - Extent of skin to be resected in relation to the primary and/or node (especially in oral cancers)
  - The reconstruction planned after the excision of the primary
  - Previous treatment received including previous surgery and radiotherapy or chemoradiotherapy.

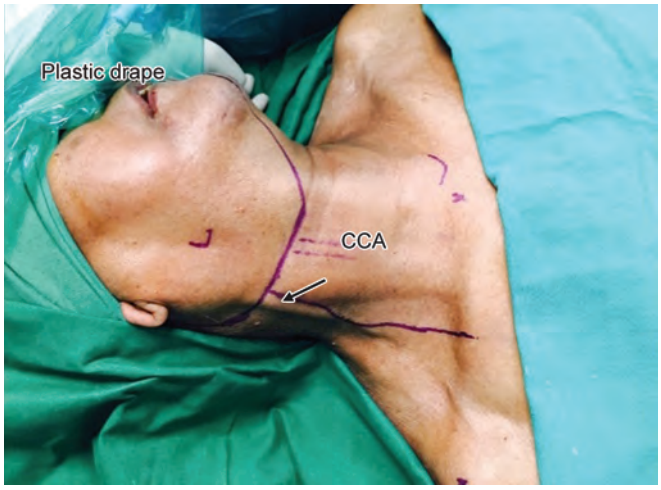


Fig. 2: The modified Schobinger's incision for a comprehensive neck dissection. Common carotid artery (CCA), the arrow is pointing towards the external jugular vein (EJV). Note the plastic drape covering the endotracheal tube

Types of Incisions

Incisions for Oral Cancer

- There are a variety of incisions that have been described for the purpose of neck dissection (Fig. 3)
- The incision which is most often used is a curvilinear skin crease incision two finger breadth below the mandible. This incision should suffice if only a SND is to be done
- This incision can be extended from the mastoid process towards the hyoid, and superiorly to the chin depending upon the nodal disease. The same incision can be

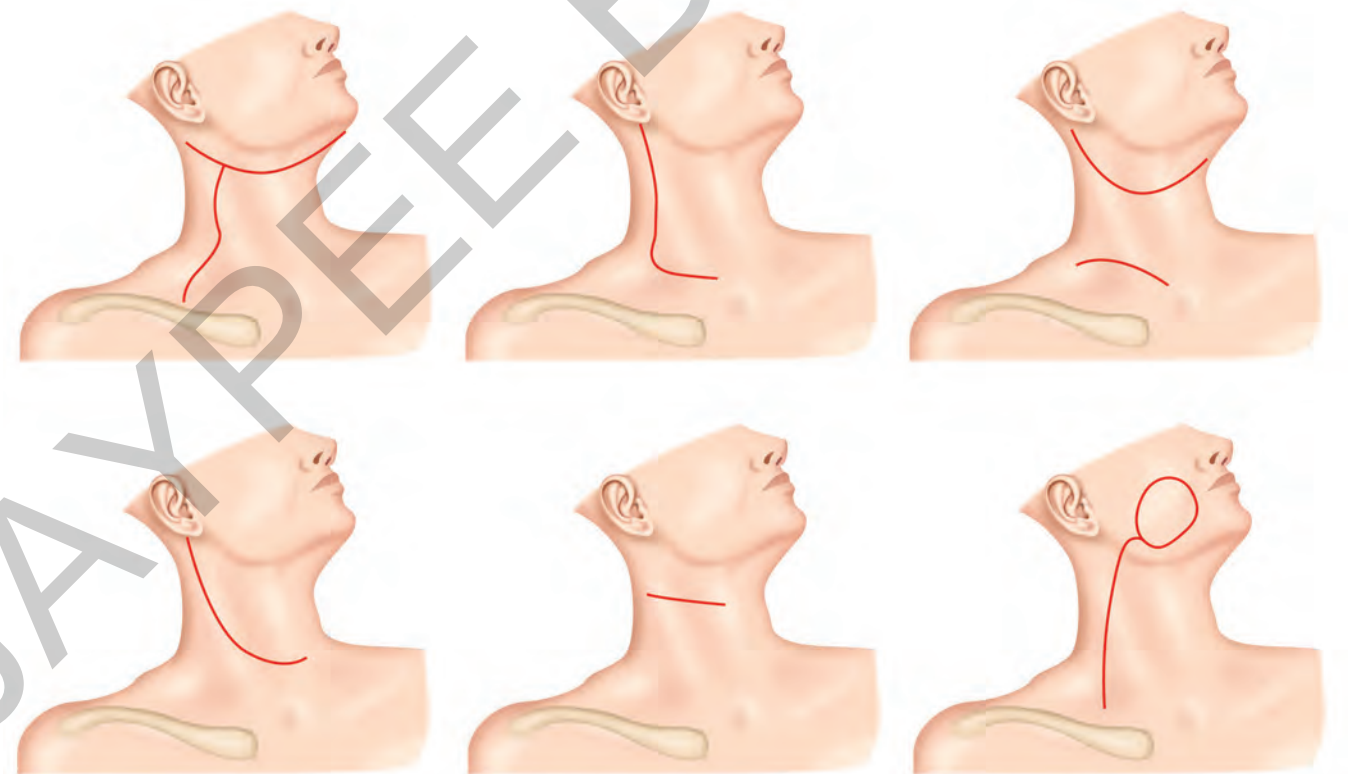


Fig. 3: Various types of incisions that can be used for neck dissections

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converted to a midline lip split for resection of an oral cancer (Fig. 2)
- The incision can also be extended across the midline into the opposite side (Visor incision) if the contralateral neck needs to be addressed
- To perform a MND, a vertical limb is added to the horizontal curvilinear incision described above. This vertical limb starts about 1.5 cm behind the carotid artery pulsation felt in the neck. (modified Schobinger's incision) (Fig. 2)
- Acute angulation of the vertical limb with the horizontal limb must be avoided, to prevent neck flap necrosis, which may subsequently expose major structures underneath (Fig. 2)
- The vertical limb goes down to the midclavicular line in a "lazy S" fashion to prevent scaring and contracture subsequently. The incision should stop around 1.5–2 cm above the clavicle
- Trifurcations or incisions parallel to the carotid artery are best avoided
- A McFee incision avoids some of the potential problems of a tripointer and is a better option in a postirradiated neck
- If skin is to be excised for resection of the primary, a single vertical incision in a lazy S-shaped fashion can be considered.

Incisions for Neck Dissection in Other Head and Neck Cancers

- Neck dissection done during total thyroidectomy can be completed with the same horizontal skin crease incision, extending it laterally till the trapezius on either side or towards the mastoid, if required
- Similarly, for neck dissections done during a laryngectomy, this can be completed with the laryngectomy incision itself (modified Gluck-Sorenson incision)
- A hockey-stick incision is used in patients with cervical metastasis of unknown origin or for a salvage neck dissection after organ preservation protocols for laryngeal and hypopharyngeal cancers. This incision is also used for patients with scalp tumors requiring a posterolateral neck dissection
- For addressing the neck during a parotidectomy, the modified Blair incision is extended into the neck skin crease.

Surgical Steps

Step 1

- The skin is infiltrated with adrenaline solution in saline or 2% lignocaine both in 1:2,00,000 concentration (to minimize skin bleeding)
- The horizontal skin incision is taken. The skin and the platysma are cut at the same level for better wound approximation and subsequent healing. Identify the external jugular vein (EJV) and the greater auricular nerve over the SCM. Care has to be taken to prevent posterior extension of this incision to prevent injury to the EJV and the greater auricular nerve
- The skin flap is then raised superiorly in the subplatysmal plane (Fig. 4), till the lower border of the mandible. The flap is raised towards the midline till the visualization of the opposite anterior belly of digastric muscle
- The neck flap in the submental region is deficient of platysma in the midline. This has to be kept in mind in order to maintain a proper plane and to avoid button-holing the neck flap. The platysma is also deficient posteriorly where the posterior skin flap is raised-off the sternocleidomastoid
- The vertical limb is now incised and the lower anterior skin flap is raised till anterior jugular vein is exposed. Care has to be taken not to raise the flap beyond the strap muscles anteriorly (Fig. 5)
- The posterior neck flap is raised by giving adequate traction and countertraction until the trapezius muscle is exposed. While raising the posterior flap the cautery must be used parallel to the skin flap to avoid button-holing (Fig. 6)
- The trapezius is exposed all along in the posterior triangle up to its apex superiorly in relation to the posterior border of sternocleidomastoid (Fig. 5)
- Once the skin flaps have been raised, the following landmarks should be kept exposed prior to initiating the neck dissection. Superiorly the mandible, inferiorly the clavicle, posteriorly the trapezius, and anteriorly the opposite belly of digastric muscle (Fig. 5).



Fig. 4: Raising the upper neck flap in the subplatysmal plane

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Step 2

- Level IA clearance is done by removing fibrofatty tissue between both the anterior bellies of the digastric muscles and the hyoid bone inferiorly. The apex of this dissection is at the lower border of the mandible. All the fat in this triangle needs to be cleared exposing the mylohyoid muscle.

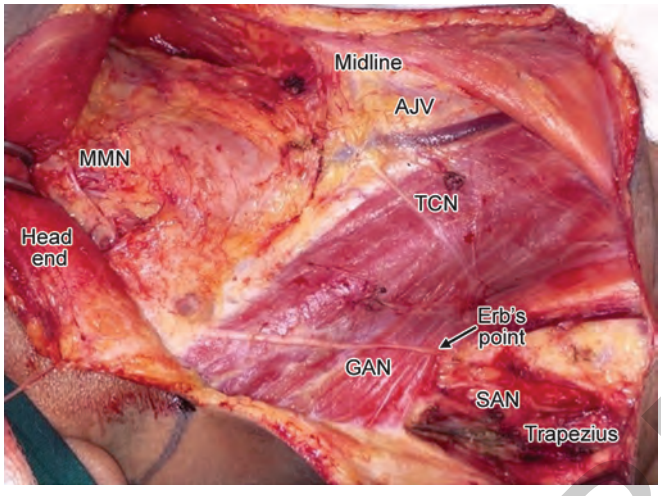


Fig. 5: Landmarks displayed after raising all the skin flaps
Abbreviations: MMN, marginal mandibular nerve; GAN, greater auricular nerve; TCN, transverse cutaneous nerve; SAN, spinal accessory nerve; AJV, anterior jugular vein

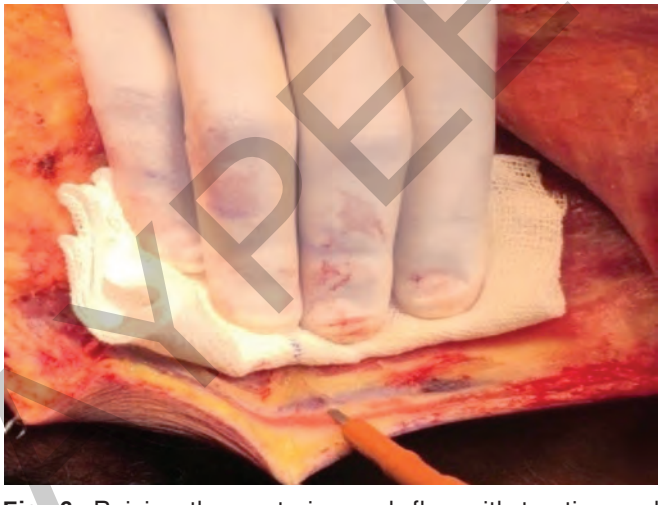


Fig. 6: Raising the posterior neck flap with traction and countertraction. Note that the cautery is used parallel to the skin flap

Step 3

- Before beginning level IB clearance, the marginal mandibular nerve (MMN) must be identified and preserved. The surface marking to identify the MMN is 1.5 cm below and in front of the angle of the mandible. The fascia over the facial artery and vein is incised using a scalpel, to identify the nerve (Fig. 7). Identify the nerve using blunt dissection, as it crosses the facial vessels. After identification, the nerve is traced both anteriorly toward its entry into the neck flap and posteriorly into the parotid tissue. Avoid excessive handling of the MMN during this step
- After identifying and preserving the MMN, the facial artery and the vein are cut and ligated over the mandible
- For level IB clearance, the fibrofatty tissue between the anterior belly of digastric and the mylohyoid muscles is cleared. While doing this, the branches of submental vessels entering the mylohyoid muscle will be encountered and these vessels must be cauterized well. The superficial part of the submandibular gland is mobilized over the mylohyoid muscle
- The mylohyoid muscle is then retracted to expose the deep part of the submandibular gland along with the hypoglossal nerve, the Wharton's duct and the lingual nerve with its attachment to the gland (Fig. 8). The duct is divided and the gland released from the ganglion taking care not to injure the lingual or the hypoglossal nerves
- The gland is then mobilized from all the surrounding soft tissue. The facial artery and vein are once again

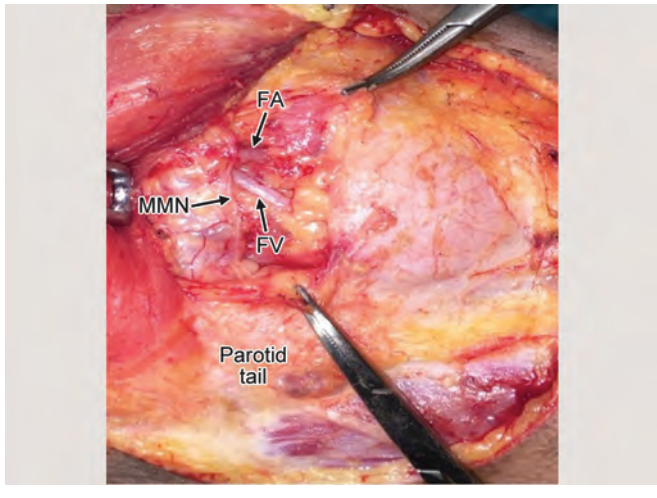


Fig. 7: Marginal mandibular nerve in relation to the facial artery (FA) and vein (FV)

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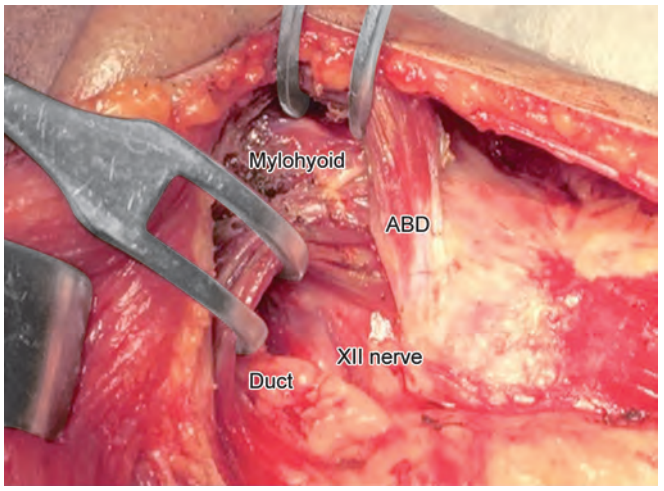


Fig. 8: Submandibular gland duct and the hypoglossal nerve being displayed after retracting the mylohyoid muscle
Abbreviation: ABD, anterior belly of digastric

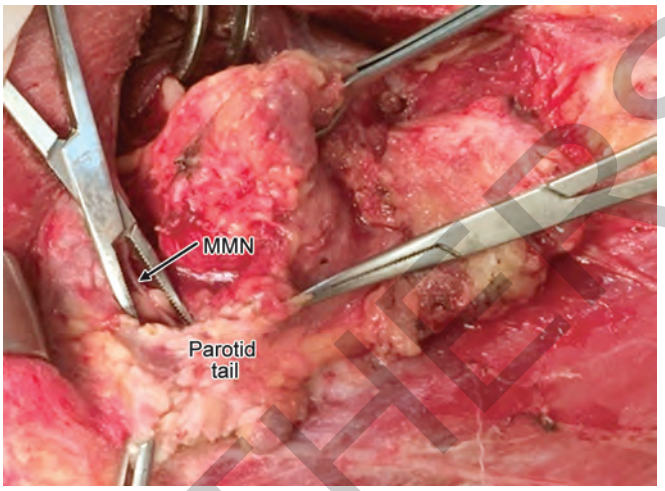


Fig. 9: The tail of the parotid being cut below the level of the marginal mandibular nerve (MMN)

identified posterior to the common tendon of the digastric muscle and securely ligated. This completes level IB dissection.

Step 4

- After completion of dissection of level IA and IB, dissection is carried out to remove levels II–IV along the IJV
- The posterior belly of the digastric muscle is identified as the first step of this dissection. It is then traced posteriorly towards the SCM
- The tail of the parotid is encountered during this mobilization and the part below the mandible may be cut or retracted. Care has to be taken to avoid injury to the MMN during this step. The retromandibular vein which is encountered as the tail is cut is also securely ligated (Fig. 9).

Step 5

- Next, the fascia over the posterior belly of digastric muscles along its entire length is divided and exposed. Retraction of this muscle helps us to identify the IJV, SAN, and external carotid artery (ECA), which lie just beneath the digastric muscle
- Identify the hypoglossal nerves (XII) in the carotid triangle at the level of the greater horn of the hyoid (Fig. 10). The veins that accompany the nerve need to be ligated to visualize the nerve
- Prior to starting the level IIA dissection, it is important to identify the SAN as it enters the SCM. The nerve is identified by using blunt dissection along the course of the nerve. The nerve is accompanied by blood vessels which are a useful guide to finding the nerve. However, excessive dissection in this area can lead to bleeding from these vessels. Care has to be taken to use only bipolar cautery for hemostasis to avoid thermal injury to the SAN. The nerve is then traced anteriorly and this leads to the IJV. Blunt dissection is done along the upper end of IJV to mobilize the level IIA fibrofatty tissue. At this point the transverse process of C2 is identified (upper limit of level II clearance). All fibrofatty tissue over IJV and lateral to it is cleared as part of level IIA clearance
- If the IJV needs to be sacrificed it is mobilized all around and prepared for ligation after identifying the vagus nerve

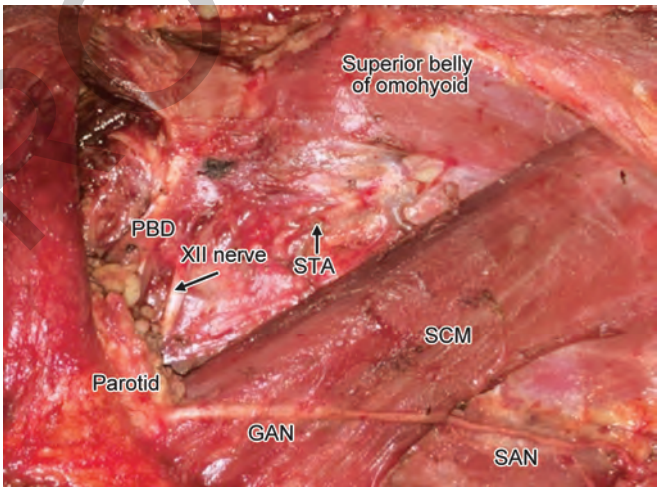


Fig. 10: The hypoglossal (XII) nerve and the STA (superior thyroid artery) in the carotid triangle
Abbreviations: PBD, posterior belly of digastric; GAN, greater auricular nerve; SAN, spinal accessory nerve

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- In elderly patients, the internal carotid artery (ICA) may be very prominent (due to atherosclerotic changes) and could be easily mistaken for a node. Care has to be taken to palpate the vessel for pulsations prior to removal of fibrofatty tissue in this area to avoid damage to a looped-ICA
- While performing dissection in this level the carotid bulb could be handled which may cause bradycardia and hypotension. The anesthetist should be informed of any such handling.

Step 6

- The SCM is then cut as high as possible close to the mastoid exposing the splenius capitis muscle. Care should be taken to prevent injury to the SAN as it enters the SCM
- The SAN is then identified in level V region about 1–1.5 cm posterosuperior to the Erb's point (Fig. 5). It is then traced anteriorly through the SCM into the Level II region by splitting the SCM in the process
- It must be noted that the SAN passes through the SCM, unlike the cervical plexus that passes deep to the muscle
- The branch to the SCM is then divided and the SAN is taken aside to complete level IIB clearance. If the SAN passes through a large nodal mass at level II, it should be sacrificed
- The contents of Level IIA and IIB are then dissected-off the deep muscles of the neck. The branches of the cervical plexus which come into view are divided and the SAN is transposed posteriorly away from the dissecting field.

Step 7

- Subsequently, the SAN is traced along its entire length in the posterior triangle till its entry deep to the trapezius muscle (Fig. 5). Dissection deep to the trapezius is avoided. The nerve is accompanied by venae comitantes which are preserved if possible. All hemostasis in this area should once again be done using the bipolar cautery to avoid thermal injury to the nerve
- Level V clearance is now initiated by clearing the fibrofatty tissue in this region
- The clavicular and the sternal head of the SCM are cut inferiorly about 0.5–1 cm above the clavicle to avoid damage to the periosteum of the clavicle. The IJV is visualized once the muscle is cut
- The lower end of EJV is identified and ligated. The inferior belly of the omohyoid muscle is then cut
- As the fibrofatty tissue is raised, the supraclavicular nerves are transected and a plane is developed thereby visualizing the transverse cervical vessels
- All attempts should be made to preserve the transverse cervical vessels
- After saving the transverse cervical vessels, its ascending branch has to be ligated. Bleeding from an unsecured ascending branch is one of the most common causes of bleeding in the postoperative period
- The fibrofatty tissue is then held with a Babcock's forceps and raised from the floor of the neck, avoiding breach of the prevertebral fascia to prevent damage to the brachial plexus which lies beneath (Fig. 11)
- The level V clearance must be done on either side of the SAN which is lifted-off the levator scapulae muscle mobilizing it towards the carotid sheath.

Step 8

- After completion of level V dissection, the level III and IV dissection commences
- The fibrofatty tissue should be cleared above the prevertebral fascia to avoid damage to the phrenic nerve at level IV (Fig. 11)
- The chyle duct will be encountered during level IV dissection. The chyle duct may be single duct or at times a leash of ducts may be seen. The chyle duct is more constantly seen on the left side in comparison to the right
- To avoid chyle leak serial clipping of fibrofatty tissue close to the IJV must done to avoid a postoperative leak
- If the IJV is to be ligated then at this point it is well-mobilized all around identifying and separating the common carotid artery (CCA) and vagus nerve.

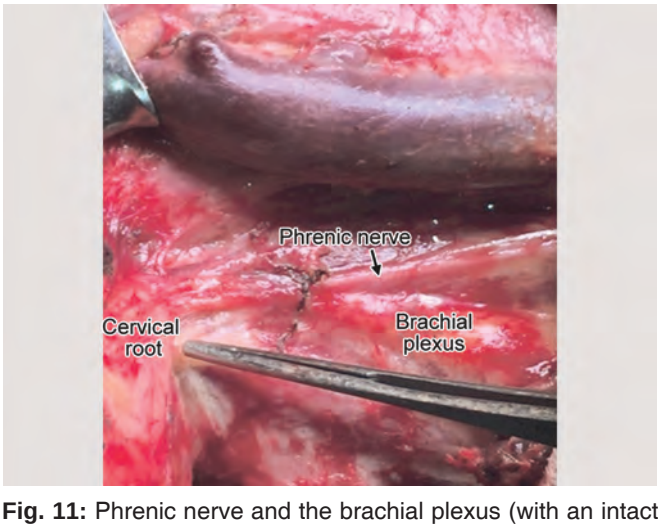


Fig. 11: Phrenic nerve and the brachial plexus (with an intact prevertebral fascia over it). The forcep is pointing towards the cervical root contribution to the phrenic nerve

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Step 9

- Level III clearance is also done reflecting the fibrofatty tissue medially onto the carotid sheath
- With proper traction the entire specimen (level II/III/IV) is mobilized towards the carotid sheath. The cervical nerve roots that are encountered during this mobilization can be cut away from the phrenic nerve
- The contents of the carotid sheath come into vision and the entire level II–IV fibrofatty tissue is stripped of the IJV with sharp dissection. As the content is mobilized over the IJV, small tributaries that are seen are securely ligated
- The superior belly of the omohyoid is cut close to the hyoid while clearing the contents medial to the IJV
- Then the specimen is mobilized over the strap muscles and removed
- The nodal levels are marked in the specimen before sending it for the histopathological reporting
  At the end of the surgery a valsalva maneuver is to be performed in all patients undergoing neck dissections requiring level IV clearance to check for an undetected chyle leak.

Selective Neck Dissection

- Selective neck dissection (I–III) is the most commonly performed SND
- A single transverse skin crease incision two finger breadths below the mandible should suffice (Fig. 3)
- While performing SND level IA and IB clearance is done as described in surgical steps 2 and 3
- The fascia over the SCM is dissected of its surface. Subsequently the SCM is mobilized laterally away from the carotid sheath. Care should be taken to stay close to the SCM to avoid injury to the contents of the carotid sheath
- As this is being done the perforator vessels which are seen entering the SCM have to be cauterized well to avoid troublesome bleeding from the muscle (Fig. 12).
- The SCM is mobilized till its posterior border, as the cervical rootlets come into vision (Fig. 13). The EJV will be encountered beyond this, and is liable to be injured.
- As this is being done the SAN will be encountered at the junction of the upper one-fifths and the lower four-fifths of the SCM. The sentinel vessels that accompany the SAN acts as a useful landmark for its identification. The SAN travels from lateral to medial to enter the skull base lateral to the IJV (most common)
- Steps as described in surgical step 5 are performed for level II clearance. Fibrofatty tissue anteroinferior to SAN is considered as Level IIA and posterosuperior to it as level IIB (Fig. 14).
- Level III clearance is done till the crossing of the tendon of the omohyoid muscle over the IJV, as described in surgical step 9 (Fig. 13).

Closure

- The wound is closed in two layers (platysma and skin) after confirming hemostasis and ruling out an inadvertent chyle duct injury
- This is done by placing the patient in Trendelenburg position and by asking the anesthetist to raise the intrathoracic pressure. If any chyle leak is noticed it should be controlled
- Once a chyle leak is controlled drains must not be placed overlying this region (to avoid the continuous negative

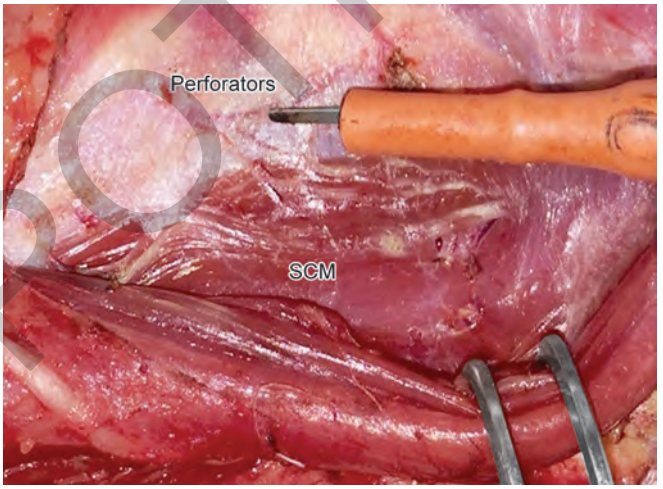


Fig. 12: The perforator vessels entering the SCM (pointed by the cautery)

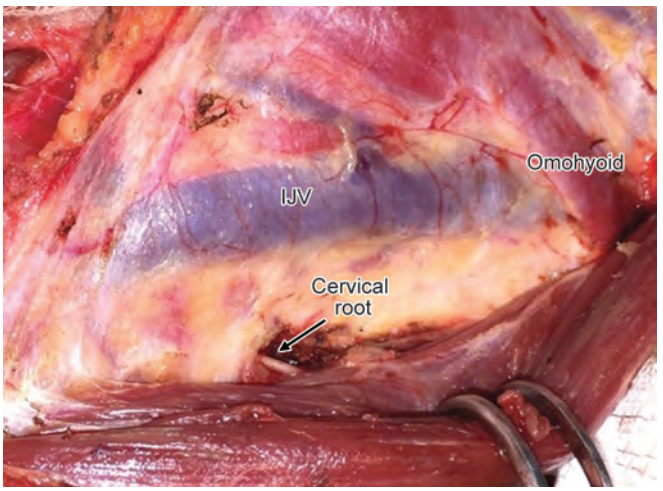


Fig. 13: Cervical root is displayed to demonstrate the plane of performing the selective neck dissection. Also note the omohyoid muscle which forms the lower limit of level III
Abbreviation: IJV, internal jugular vein

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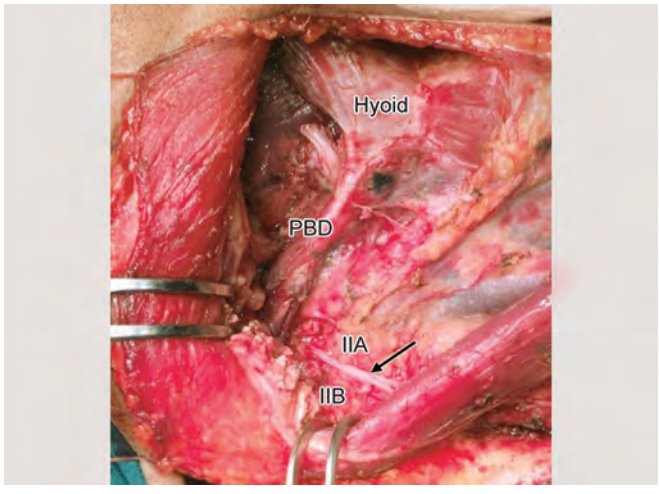


Fig. 14: Level II divided by the spinal accessory nerve (SAN) into IIA and IIB

pressure acting on it and promoting the chyle leak in the postoperative period).

POSTOPERATIVE CONCERNS

- Ensure that the suction drains are functioning and not clotted
- If the drains are not holding then this is most commonly due to improper skin closure which needs to be identified and corrected
- If tracheostomy is done then this could communicate with the neck wound, especially if the anterior flap is raised too medially, and the drains may not function
- Functioning suction drains are essential to avoid hematoma or collection below the neck flap which could cause wound complications.

COMPLICATIONS

Some of the commonly encountered complications of neck dissection are as follows:

- *Chyle Leak:* Milk-like fluid in the drains would indicate a chyle leak. Fat-free diet (especially milk and milk product) has to be started. Management of the chyle leak depends upon the output and duration of the leak. Most chyle leaks respond to conservative management with diet modifications and pressure dressings
- *Hemorrhage:* Postoperative bleeding is a common complication after neck dissection. It is recognized either by an excessive drain output or the presence of a collection below the neck flaps. This raises the neck flap drawing suspicion to a postoperative bleed. Most postoperative bleeds require a re-exploration and securing of the bleeding vessel
- *Wound complications:* Infection, dehiscence (especially in postirradiated neck), neck flap necrosis
- *Shoulder dysfunction:* This is one of the most common complication after a neck dissection. It has a significant impact on the quality of life in patients undergoing neck dissections
- *Cosmetic deformity:* Hollowness in the neck is due to the absence of SCM, hypertrophic scar and keloid formation.

SUMMARY

Neck dissection has undergone a sea change from radical neck dissection which was initially described to the more conservative procedures like the modified and selective neck dissection. These are oncologically safe procedures which reduce the morbidity in addition to improving the quality of life of the patients. The non-lymphatic structures (IJV, SAN, SCM) are removed only when they are involved by the tumor. Management of the neck is an integral part in the treatment of head and neck cancer. In an N+ neck, radical or modified neck dissection is done depending on the involvement of the non-lymphatic structures. In an N0 neck selective neck dissection is performed addressing the nodal stations that are at highest risk based on the location of the primary tumor, whenever the incidence of occult nodal metastasis is significant.

KEY POINTS

- Avoid raising very thin skin flaps. Stay in a subplatysmal plane
- Avoid excess handling of the marginal mandibular nerve. Use bipolar cautery or pressure to control bleeding around the nerve
- Avoid excess traction on the SAN to prevent traction injury. Use sharp dissection along the SAN and avoid thermal injury
- Do not breach the prevertebral fascia in the neck to avoid damage to the phrenic nerve and the brachial plexus
- Do not look for chyle duct during level IV clearance. Perform a serial clipping or ligation of all structures while dissecting level IV
- Do not leave any fibrofatty tissue anterior to the carotid sheath as these may harbor small lymph nodes.

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