

# Central Neck Dissection

Mohamad Sidani, Salem I. Noureldine, José Gabriel Paixão

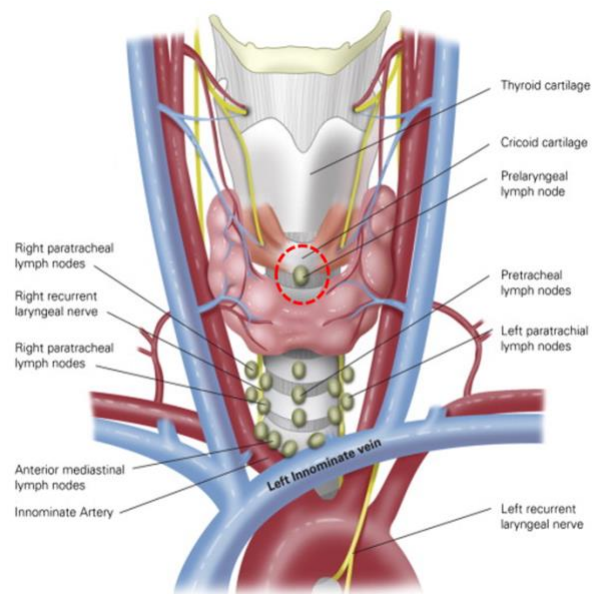
## Introduction:

Central neck dissection is one of the pillars of treatment of thyroid cancer with lymphatic spread. The central neck compartment lymph nodes, also known as Level 6 and 7 nodes, are the most common (80%,) and first site of lymphatic spread of thyroid cancer.

Regional lymph node metastases from differentiated thyroid cancer are present in the majority of patients with papillary thyroid cancer and medullary thyroid cancer, and in a smaller proportion of patients with other differentiated thyroid cancers such as Follicular thyroid cancer and Hürthle cell carcinoma. The presence of lymph node metastasis primarily affects most patients not through survival but by increasing the risk of subsequent nodal recurrence.

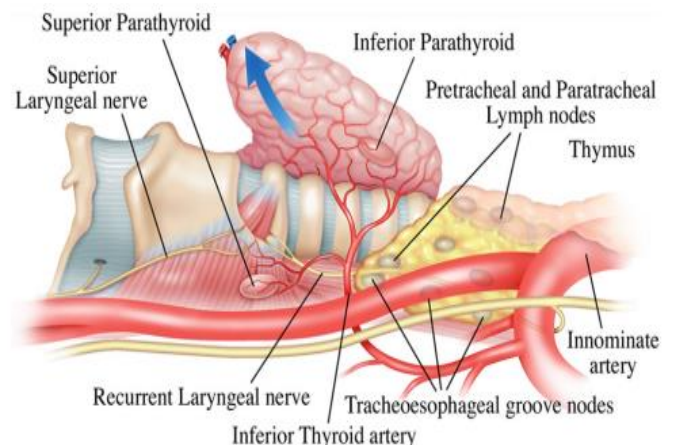
The central neck is the gateway of the cervical lymphatic system and the “Delphian node” is the gatekeeper. It is located in the pre-cricoid or pre-laryngeal region. In addition to the Delphian node there are several other lymph node basins within the central neck: the pre-tracheal and the left and right para-tracheal lymph nodes.

Metastases to the retropharyngeal or retroesophageal nodes are less common than to the more anterior lymphatics. Paralaryngopharyngeal lymph node involvement is rare, as the bulk of central lymph nodes are located inferior to the pharynx. Mediastinal lymph nodes located caudal to the brachiocephalic vein and adjacent to the tracheal bifurcation are rarely involved in patients with existing central compartment lymph node metastases.



*Central compartment borders: Hyoid bone (superior), superior border of innominate vein (inferior), common carotid arteries (lateral). This space contains prelaryngeal, pretracheal and right and left paratracheal lymph nodes. The Delphian node is circled in Red. McHenry CR, et al., used with permission. <https://doi.org/10.1016/j.suc.2014.02.003>*

Lastly, as the esophagus curves more to the left side of the neck, it creates a large empty space on the right posterior aspect of the trachea. This space will harbor numerous right paratracheal nodes that will be hidden deep to the right recurrent laryngeal nerve. These lymph nodes are commonly missed and hence are the most common site of thyroid cancer recurrence in the central neck.



*Right paratracheal lymph nodes are located deep to the right recurrent laryngeal nerve and are common site of cancer recurrence. Friedman et al., used with permission. <https://doi.org/10.1016/j.otot.2011.04.001>*

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To remove both the anterior and posterior lymph node compartments in this right paratracheal space, the right RLN needs to be transposed. The posterior compartment lymphatic tissue is then mobilized anteriorly and drawn under the nerve towards the lymph nodes that are caudal to the inferior thyroid artery.

The anatomical borders of the central neck compartment are defined superiorly by the hyoid bone and inferiorly to the innominate artery on the right and the corresponding axial plane on the left. The compartment is bordered by the medial aspect of carotid sheath laterally. Its deep boundary is the prevertebral fascia.

<b>Border</b>	<b>Surgical Anatomic landmark</b>
<i>Superior</i>	Horizontal line at the inferior border of the cricoid and RLN insertion point
<i>Inferior</i>	The plane on level with the innominate artery
<i>Posterior</i>	Prevertebral fascia
<i>Anterior</i>	Sternothyroid muscle
<i>Lateral</i>	Common carotid artery
<i>Medial*</i>	Medial edge of contralateral strap muscles

\*In cases of unilateral central compartment neck dissection

A comprehensive neck dissection implies comprehensive removal of the pretracheal and prelaryngeal lymph nodes, along with at least one paratracheal nodal basin. This operation can be unilateral or bilateral depending on whether one or both paratracheal regions are dissected.

Focal “berry picking” of only involved LNs without a compartmental dissection leads to higher rates of recurrence and should not be done. The specific regions and nodal packets dissected as part of the comprehensive neck dissection should be clearly identified in the operative report. In addition, the indication for dissection should be defined as therapeutic or elective/prophylactic. A therapeutic dissection involves removal of clinically or radiographically apparent nodal metastases (cN1.) Conversely, prophylactic or elective neck dissection is the removal of clinically uninvolved nodes (cN0.)

Indications for therapeutic central neck dissection are:

1. cN1 disease for differentiated thyroid cancer (Papillary, Follicular or Hurthle cell carcinoma)
  - a. Clinically palpable lymph nodes in the central neck compartment
  - b. Obvious central compartment node involvement of neck ultrasound
  - c. Biopsy proven central compartment node involvement (Fine Needle Aspiration is preferred.)
2. Medullary thyroid cancer even in the absence of any clinical evidence of lymph node involvement.
3. Central neck recurrence of thyroid cancer (if not already done in prior operations)

The indications below for prophylactic central neck dissection remain a topic of debate:

1. Older or very young patients (as they have a higher risk of at least microscopic lymph node involvement)
2. T3 or T4 differentiated thyroid cancer without clinical evidence of central or lateral LN involvement (ie. extrathyroidal extension or invasion to surrounding structures and organs)
3. Unfavorable histology (i.e tall-cell variant, diffuse sclerosing variant, or solid variant)
4. Ipsilateral clinically apparent lateral neck disease (cN1b) is present and is being targeted with lateral neck dissection

Most commonly a central neck dissection is performed at the time of total thyroidectomy. The thyroidectomy is performed first. Most surgeons will remove the thyroid specimen first and then remove the central neck nodes as one or 2 other specimens.

In general, the steps of a central neck dissection are:

- Dissection of the soft tissue anterior and medial to the common carotid artery from superior to inferior towards its insertion into the innominate artery or aortic arch
- Dissection of the recurrent laryngeal nerve circumferentially all along its course distally from its insertion point into the cricothyroid muscle to the most visible caudal portion



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- Separation of the soft tissue with the nodal basins en-bloc (preferably) from the trachea and esophagus and the underlying prevertebral fascia while making sure to identify and preserve the vascular pedicle to the inferior parathyroid glands, which are specifically placed at risk during this operation

## Steps:

1. The patient is positioned supine with both arms padded and tucked and a shoulder roll placed under the shoulder blades as to extend the neck as much as possible with the head well supported. The “beach-chair” position should be used for additional extension if needed. Place sequential compression devices (if available) and consider administering a dose of preoperative antibiotics such as cefazolin.



*Patient in Semi-Fowler, also called “Beach Chair” position. Raising the head and torso like this decreases venous distention and bleeding. The surgeon must be cautious to avoid venous air embolism: in case of any injury to large veins, air can enter the venous system.*

2. Using a nerve monitor during this operation gives the following advantages:
  - a. Its ability to map and localize the RLN and the external branch of the superior laryngeal nerve
  - b. Its ability to aid in dissection once the nerves are identified
  - c. In demonstration of mechanism and site of nerve injury

- d. Prognostication of postoperative nerve function allowing for intraoperative surgical decision changes to obviate bilateral nerve paralysis.

If you plan on using a nerve monitor, the patient should not be paralyzed. If paralysis must be used for induction, you should favor a short-acting paralytic such as succinylcholine. If any other agent is used consider reversal of the paralytic agent to achieve 4 twitches of equal magnitude on “Train Of Four” monitoring using a peripheral nerve stimulator, prior to incision.

In the more likely even that you do not have a nerve monitor, you must be meticulous about identifying the recurrent laryngeal nerve during the thyroidectomy and dissecting it carefully throughout the operation.



*Close-up of the endotracheal tube used with the nerve monitoring system with electrodes above the cuff that contact the vocal folds. These complete an electrical circuit, making an alerting sound, when the nerve monitor probe is touched to the recurrent laryngeal nerve in the neck. Source: Duran-Poveda MC et al, DOI: 10.5005/jp-journals-10002-1091*

3. If a nerve monitor is used, ensure the anesthesiologist uses a fiberoptic scope to intubate if possible, in order to confirm that the sensors on the endotracheal tube are spanning above and below the vocal cords.
4. Ask for an esophageal temperature probe or an orogastric tube, as this assists in palpating the esophagus and finding the nerve more easily in the tracheoesophageal groove.

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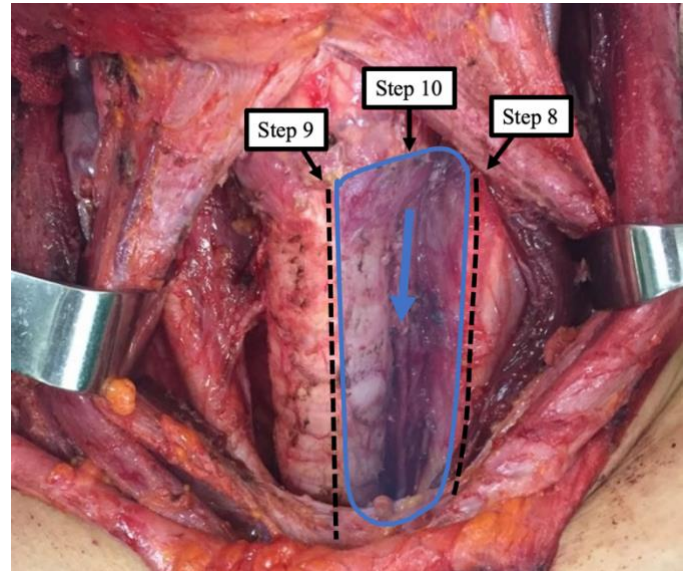
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5. At this point proceed with the thyroidectomy portion of the procedure (See Chapter.)
6. Once the thyroid is completely removed, re-identify the recurrent laryngeal nerves bilaterally, and identify the parathyroid glands that were seen during the thyroidectomy. Assess their viability and associated vascular pedicles. The inferior parathyroid glands may be reflected away with their vascular pedicle allowing for paratracheal dissection and inferior parathyroid gland preservation. If after dissection, the parathyroid gland appears nonviable and dusky, or there is interference with appropriate compartmental dissection, auto-transplant it. Cut it into small 1-2 mm pieces and then insert the pieces into several “pockets” of the ipsilateral sternocleidomastoid muscle. Loosely close the “pocket” to keep the pieces inside.
7. Plan to start your central neck dissection on the side of the proven thyroid cancer first.
8. Start your dissection by entering the avascular plane directly anterior/medial to the common carotid artery and develop that plane inferiorly down to the innominate artery. This can be done with a sealing energy device or bluntly. If an energy-sealing device is not available, use a bipolar rather than a monopolar diathermy.
9. Next expose the anterior surface of the trachea at the level of the thyroid cartilage and dissect pre-laryngeal and pre-tracheal tissue off of the tracheal rings using blunt dissection, if not already performed during thyroidectomy. Avoid using diathermy in this step, inadvertent entry into the trachea can cause a fire. Continue developing this plane all the way down until you reach the superior aspect of the innominate vein inferiorly.
10. Next re-identify the recurrent laryngeal nerve and gently develop a plane over the nerve along its entire tract, proceeding cranially from its insertion into the cricothyroid muscle to the most caudal visible aspect of the nerve in your field of dissection.

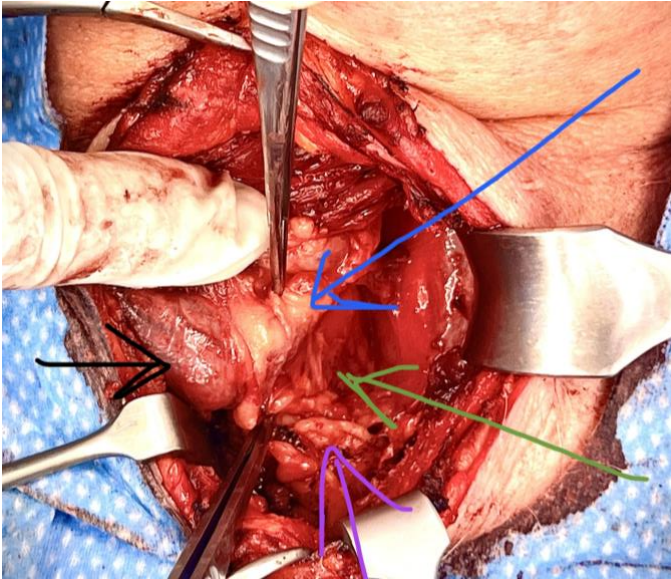


*Steps 8-10, shown schematically on the left side on a neck after completed dissection, patient's head is upwards in this picture. In Step 8, a plane is opened along the peri-adventitial plane of the left common carotid artery. In Step 9, a plane is opened along the laryngeal and pre-tracheal tissue lateral to the midline of the trachea. In Step 10, tissue is elevated in between these two boundaries along the recurrent laryngeal nerve, proceeding from where the nerve inserts into the larynx in a caudal direction. Dissection is from cranial to caudal and lateral to medial, as described below.*

11. Dissect the soft tissue containing lymph nodes from the medial aspect of the carotid sheath moving from lateral to medial. Next transpose the nerve more laterally and proceed by excising all the soft tissue and lymph nodes medial and deep to the nerve. Continue this until you reach the trachea medially and the esophagus posteriorly. This should allow you to fully separate the central neck tissue and lymph nodes en bloc.

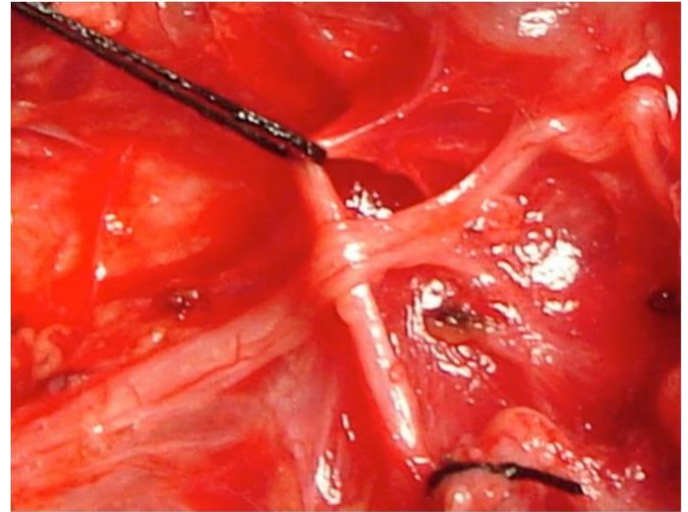
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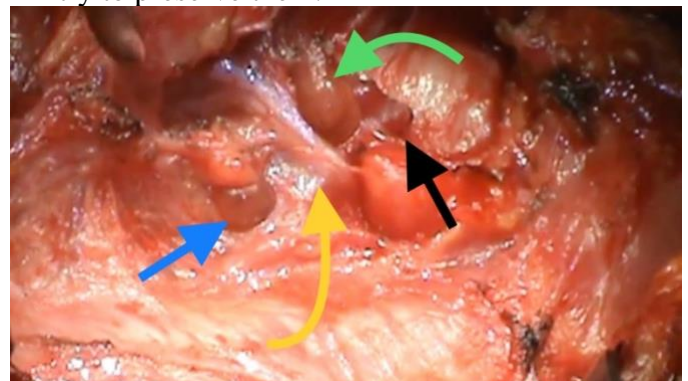
Lateral view of the left central neck dissection, patient's head is upwards in this picture. In this case, the central neck lymph node packet (Purple arrow) is being dissected as described, away from the left recurrent laryngeal nerve (Green arrow.) The left inferior parathyroid gland (Blue arrow) is seen and preserved. Note that in this case, the central node dissection is occurring prior to removal of the left thyroid lobe (Black arrow.) This is acceptable, but not described in this text.

12. Continue dissecting this soft tissue/nodal bundle from the anterior and lateral aspect of the recurrent nerve down towards the innominate artery if possible.
13. Be aware that the recurrent nerve can occasionally course anterior to the inferior thyroid artery, and sometimes it can bifurcate very proximal (more inferior) into an anteromedial motor branch and a posterolateral sensory branch.



Photograph showing the relationship between the recurrent laryngeal nerve and the inferior thyroid artery (artery retracted by a Black suture). The artery may have a single or multiple branches, which may pass anterior or posterior to the nerve, or both. As the inferior thyroid artery is the blood supply of both the superior and inferior parathyroid glands, this relationship is especially Important. Source: Chintamani <https://doi.org/10.1007/s12262-017-1691-2>

14. Prior to completely separating the soft tissue/nodal bundle near the inferior thyroid artery, makes sure you re-identify the parathyroid glands and their respective vascular pedicles and try to preserve them.

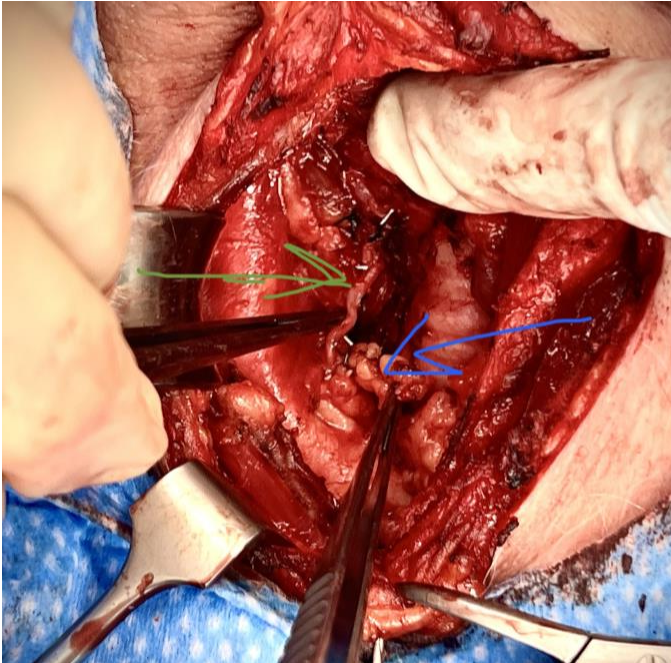


Right sided tracheoesophageal groove after thyroidectomy, before neck dissection. The head is to the left of this picture. A pathologic lymph node is seen (Black arrow.) The right recurrent laryngeal nerve (Yellow arrow) is shown, with the expected anatomic relationship to the parathyroid glands. The superior parathyroid gland (Blue arrow) is dorsal/posterior to the nerve and the inferior parathyroid gland (Green arrow) is ventral/anterior to the nerve. Note that the pathologic lymph node is darker than the parathyroid glands, and "kidney bean" in shape compared to the parathyroid glands.

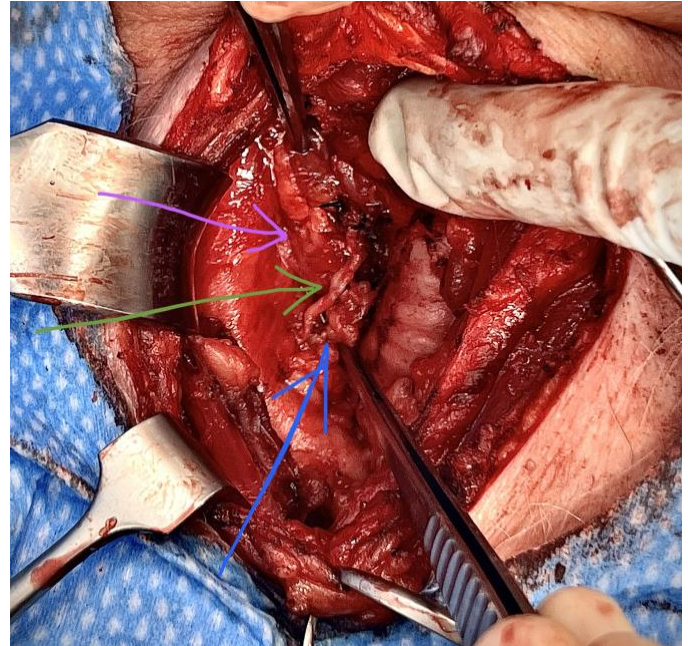
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15. Do not forget to examine on the right side the space deep to the inferior thyroid artery and recurrent nerve as it can harbor several lymph nodes. This is actually the most common location of central neck recurrence in thyroid cancer, as discussed in the Introduction.



*Lateral view of the right central neck, head is upwards in this picture and midline is on the right side of the photo. The Blue arrow shows the deep level 6 cervical lymph node packet (that is not present on the left side.) These nodes are located deep to the right recurrent laryngeal nerve (Green arrow) and anterior to the esophagus (though they have been mobilized anterior to the nerve in this photo.) These nodes are a common area of tumor recurrence as they can be easily missed.*

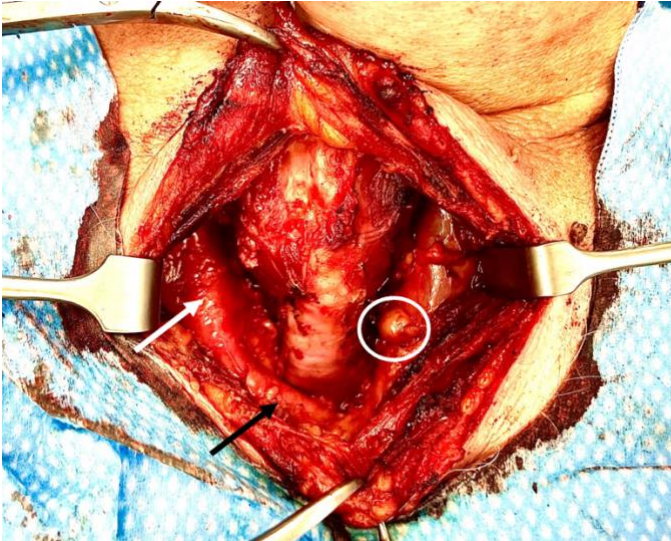


*Another view of the same patient, right central neck, head is upwards in this picture. The Blue arrow shows the deep level 6 cervical lymph node packet, located deep to the right recurrent laryngeal nerve (Green arrow) and anterior to the esophagus (Purple arrow.)*

16. Examine the specimen after removal for any parathyroid tissue. In resource-rich settings, surgeons confirm the tissue in question is indeed parathyroid tissue using frozen section before auto-transplanting, to avoid implanting a lymph node containing cancer. If you do not have frozen section capabilities, follow the principles described above to preserve as many viable well vascularized parathyroid glands in-situ as possible.

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Completed central neck dissection shows the inferior boundary of dissection, the innominate artery (Black arrow) and the right lateral boundary of dissection, the common carotid artery (White arrow.) A preserved parathyroid gland (White circle) is also seen.

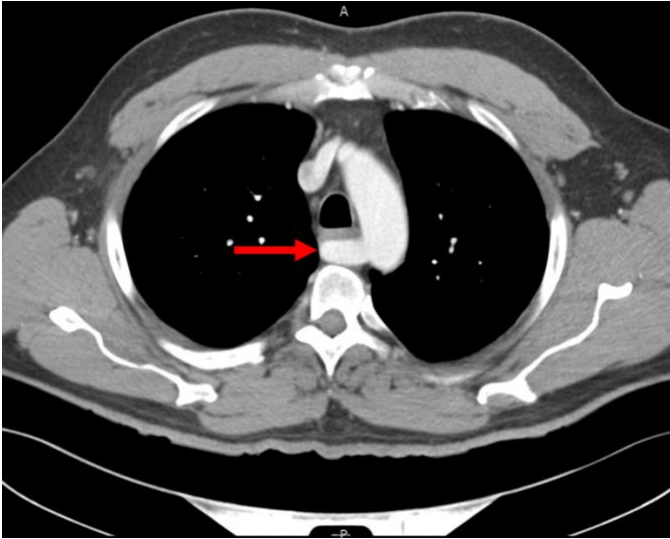
17. At the end re-assess the recurrent nerve by following its course entirely. Assess its function if you are using a nerve monitor.
18. Obtain meticulous hemostasis. Avoid using the “pinch buzz” technique (i.e. holding tissue, including possibly near the nerve, and touching the forceps with the monopolar diathermy.) Sometimes gentle pressure and irrigation with sterile water is all that is needed. Use ties or clips instead of an energy device. Any bleeding along the trachea can be stopped with mindful use of the bipolar diathermy. If there is slow oozing adjacent to the recurrent laryngeal nerve, it is better to leave this rather than pursue a “scorched earth” tactic with the diathermy. Pulsatile bleeding adjacent to the nerve, on the other hand, is a branch of the inferior thyroid artery and must be controlled with a carefully applied vascular clip or clamp and ligature.
19. Irrigate with sterile water and ask the anesthetist to perform a Valsalva maneuver (up to 30 mmHg) to check for any bleeding. Lastly consider placing a topical hemostatic agent along the bed of dissection (Gel foam cut into small squares soaked in thrombin, or surgical nitrocellulose.)
20. Close the wound in multiple layers like you would for a thyroidectomy. Usually leaving a drain is not required in central neck dissections, unless a large substernal goiter requiring extensive dissection was concomitantly removed. This decision is surgeon dependent, and outcomes are not different with or without a drain.
21. Administer oral calcium carbonate 1500mg three times per day for the first two weeks after surgery and then wean this amount as the patient tolerates. Be mindful of hypocalcemia symptoms, including perioral numbness, cramping in the hands, and laryngospasm.

## Pitfalls

- Try to set your self up for success by optimizing your neck extension, and by placing an esophageal temperature probe to help locate the esophagus, and therefore the tracheoesophageal groove, early during dissection.
- It is helpful to know the different anatomical trajectories of the recurrent nerve on the right the left side. On the right the nerve is more anterior and oblique in its course, and on the left the nerve is deeper, more medial and more vertical as its coursing in the tracheoesophageal groove.
- Be aware of the rare non-recurrent right laryngeal nerve (it is exceedingly rare to encounter a non-recurrent laryngeal nerve on the left.) This is commonly associated with aberrant right common carotid and right subclavian artery anatomy. One way to predict that is using intraoperative ultrasound, if available, pre- incision. If you see that the right subclavian artery and right common carotid artery do not merge at the base of the neck, it is highly likely you have a non-recurrent nerve. If you have preoperative cross-sectional imaging (CT scan,) an aberrant right subclavian artery with a retroesophageal course is highly predictive of a right non-recurrent laryngeal nerve.

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*Aberrant right subclavian artery with a retroesophageal course (Red arrow) in a patient that was found to have a right non-recurrent laryngeal nerve.*

- Use of a nerve monitor can help you assess not only the location and structural integrity of the nerve but its function as well. It can occasionally help guide the decision to proceed to the contralateral side and subsequently avoid bilateral recurrent nerve injury and airway compromise. Always know that a nerve injury comes in different shapes and forms, ranging from a grasping injury, to a traction injury, to a partial or complete transection. A non-transection injury is potentially one that a patient can recover from. A nerve monitor can help identify those injuries, as a nerve will structurally look intact in those cases.
- If you realize that one nerve was injured, consider abandoning any dissection (whether thyroidectomy or central neck dissection) on the contralateral side during the same operation, as you can always come back to “fight another day.” Usually, you can wait 6 weeks and re-assess the function of nerve and vocal cords in clinic, using either ultrasound or flexible laryngoscopy, prior to planning a completion thyroidectomy or central neck dissection.
- Realize that a nerve monitor will not prevent an injury; it will only help identifying and recognizing it earlier.

- Postoperative hypocalcemia can occur after even the most meticulous surgical technique. In most cases the parathyroid glands are not permanently damaged; they are “stunned” from the adjacent dissection. You may need to supplement calcium at high doses after surgery, including intravenously. Once the patient is stable clinically with oral calcium supplementation only, it is safe to discharge them on this dosage, maintain it for two weeks, and then taper the dosage as an outpatient under close supervision.

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