

Respiratory system
Anatomy



sheet



handout



slides

Number

4

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Larynx ... con't

Cavity of the larynx

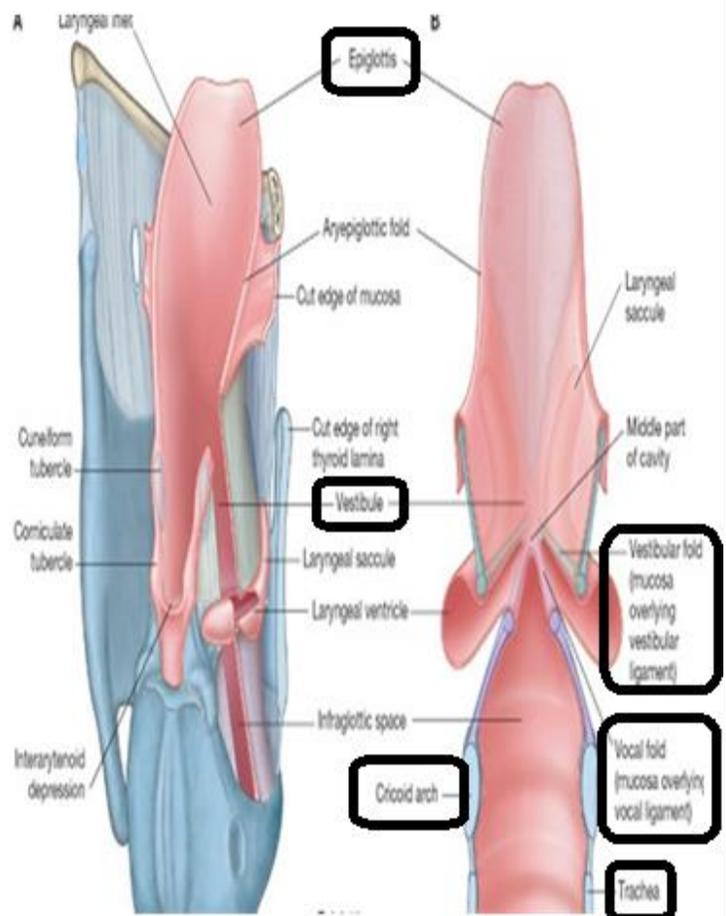
- The central cavity of the larynx is tubular in shape and is lined by mucosa
- Support is provided by the fibro-elastic membrane of larynx and by the cartilages to which it is attached.
- The superior aperture of the cavity (laryngeal inlet) opens into the anterior aspect of the pharynx just below and posterior to the tongue

laryngeal inlet

- laryngeal inlet is *oblique* and points posterosuperior
- Anterior border → is formed by mucosa covering the superior margin of the epiglottis
- Lateral borders → are formed by mucosal folds (**aryepiglottic folds**), Enclose the superior margins of the quadrangular membranes and adjacent soft tissues
Two tubercles on the more posterolateral margin side mark the positions of the underlying cuneiform and corniculate cartilages. Aryepiglottic fold contain aryepiglotticus muscle help in closure of inlet
- Posterior border → in the midline is formed by a mucosal fold that forms a depression (interarytenoid notch) between the two corniculate tubercles.

Inferior opening

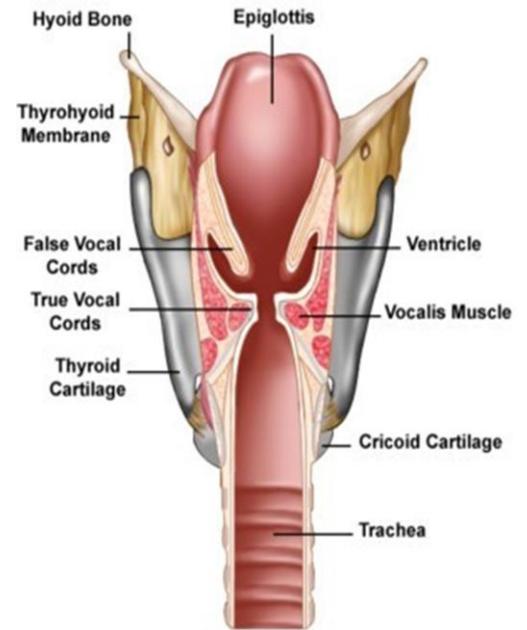
- Inferior opening of the laryngeal cavity is continuous with the lumen of the trachea
- Completely encircled by the cricoid cartilage
- *Horizontal* in position unlike the laryngeal inlet
- The inferior opening is continuously open whereas the laryngeal inlet can be closed by downward movement of the epiglottis .



The cavity of larynx the doctor repeat it 3 times (important)

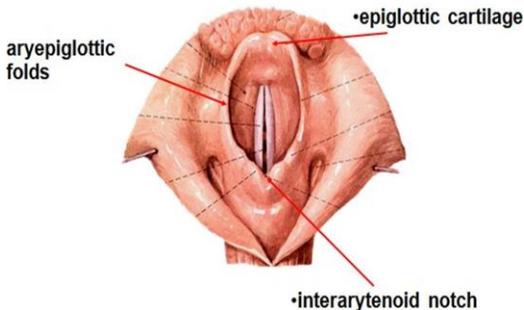
divide into three compartments:

- **Vestibule** (superior compartment) → extend from epiglottis (the inlet of the larynx) to the false vocal cord (vestibular ligament)
- **Glottic compartment** (middle compartment) → located between the false and the true cords. It contains a ventricle, called laryngeal ventricle, space extend upward to form a **sacculus** (like a pocket), this sacculus contains mucus glands that secrete mucus downward for lubrication of the true vocal cord.
- **Infra-glottic cavity** (inferior compartment) → (extend from below the true vocal cord to the trachea)



Laryngeal cavity

inlet of larynx — bounded by upper border epiglottic cartilage, aryepiglottic folds and interarytenoid notch



During anesthesia, it is a must to have a view of the area in the picture. When the patient is getting prepared for a surgery, we have to pass an endotracheal tube; from the oral cavity and it **must** pass between the true vocal cords toward the trachea. That is important to prevent adduction of the true vocal cords during operation.

Vocal Folds (true vocal cord)

characterized by:

1. **It contains vocal ligament:** upper thickening of free edge of **conus elasticus** (cricothyroid membrane), extends from vocal process to angle of thyroid, right and left vocal ligament form acute angle.
2. **Covered by mucosa:** stratified squamous non-keratinized epithelium. This part of the larynx is exposed to injury (absence of voice), and this type of epithelium can regenerate (mitosis) - the voice is back -. * Notice that the lining epithelium is different from the other parts of the larynx.
3. **Vocalis muscle (thyroarytenoid muscle):** attached on the arytenoid ligament, responsible for elongation/relaxation of the true vocal cord . note that the stretch of vocal cord done by cricothyroid muscle
4. **No submucosa:** the submucosa found in all part of RS except the vocal cord because the submucosa is exposed to fluid accumulation and edema, so if this happens it will cause adduction of the vocal cord causing suffocation.

5. No blood vessels (avascular)

It receives blood by diffusion (important for regeneration to happen). that is why it is **white** in color, while the false vocal cord (vestibular fold) is **red** in color; because it is rich in blood vessels.

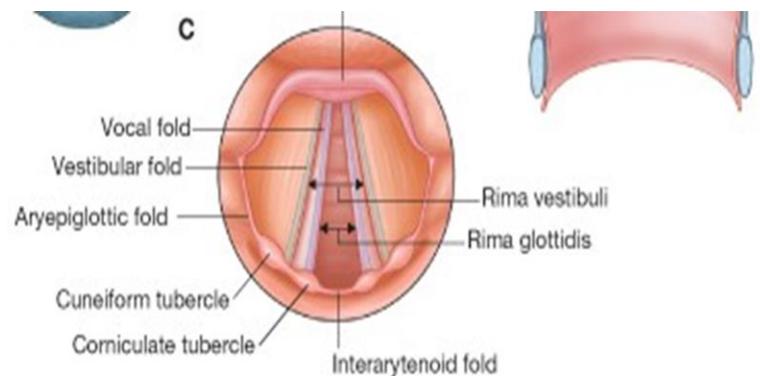
6. It has lymphatic.

7. Longer in males: cause the difference of the pitch of the voice between genders.

** note; vestibular fold formed by lower edge of quadrangular membrane, attached on lateral surface of arytenoid above the ridge. fixed not moveable, no role in phonation, but it may have role in expiration by adduction and abduction, superior to true vocal cord.

- **Rima glottides:** it is a space between the *true* vocal cords. separates the middle chamber above from the infraglottic cavity . The base of it is formed by the fold of mucosa (interarytenoid fold) at the bottom of the interarytenoid notch . **the narrowest part** of the laryngeal cavity, when abduction and adduction occur in the vocal cord there will be widening and narrowing of the Rima glottides
- **Rima vestibule:** it is a space between the *false* vocal cords. is a *triangular*-shaped opening between the two adjacent vestibular **folds** at the entrance to the middle chamber. Apex of the opening is anterior and its base is posterior.

** Both, **Rima glottides** and **Rima vestibule**, open and close due to movement of arytenoids cartilage and association membrane



Muscles of larynx

1) Intrinsic muscles

- All intrinsic muscles are innervated by the *recurrent* laryngeal branches of the vagus nerves except Cricothyroid muscles innervated by the *external* laryngeal branches of the vagus nerves
- All intrinsic muscles located *inside* the larynx except the Cricothyroid muscles located *outside*
- General function:
 - 1) Adjust tension in the vocal ligaments,
 - 2) Open and close the Rima glottides,
 - 3) Control the inner dimensions of the vestibule,
 - 4) Close the Rima vestibule

We classify all intrinsic muscles into three groups according to their actions:

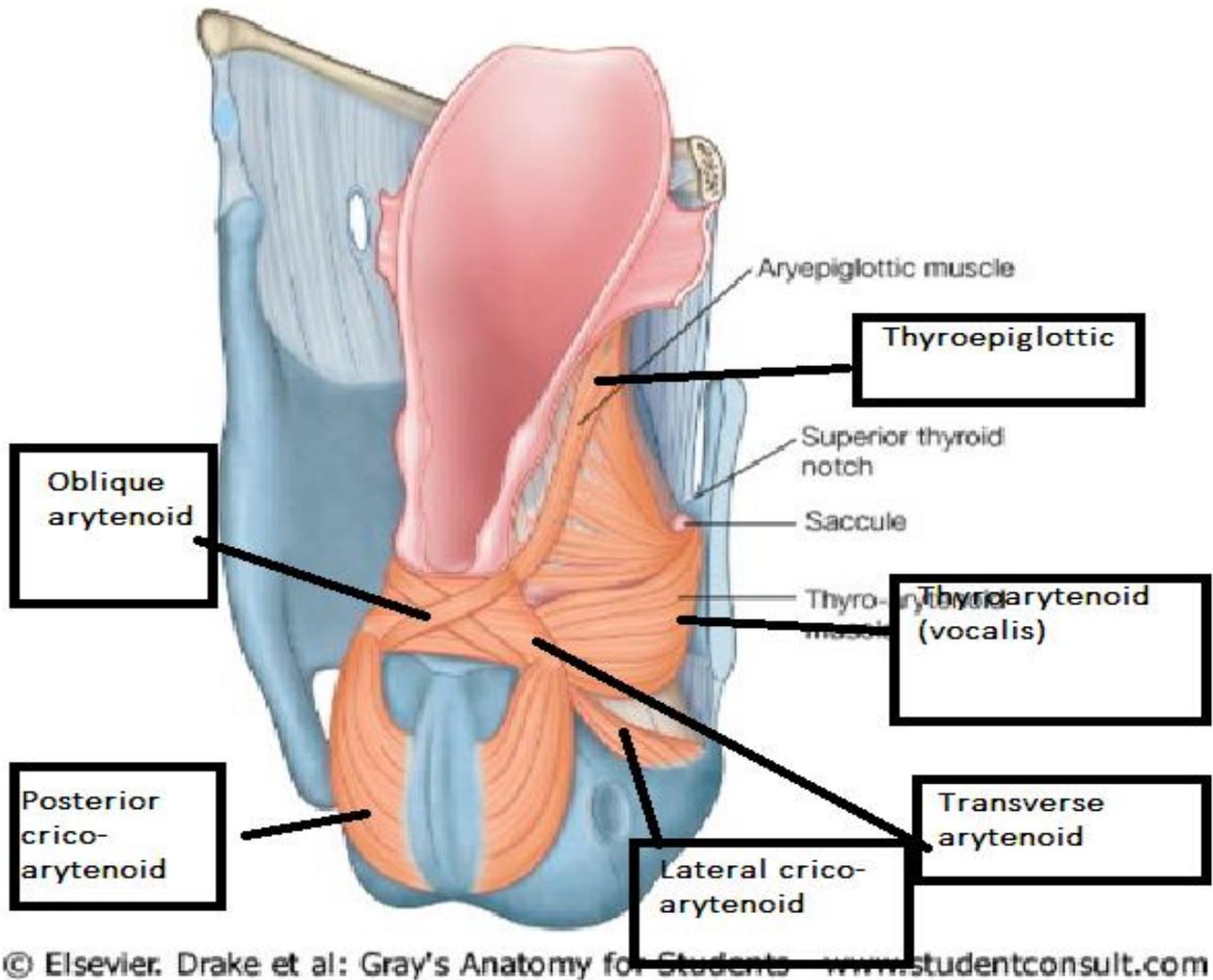
- Two muscles for shortening and elongation of the vocal cords : Cricothyroid and Thyroarytenoid (vocalis)
- Two muscles to control the inlet : Oblique arytenoid and Thyroepiglottic
- Two muscles for widening and narrowing (abduction and adduction): Lateral cricoarytenoid and Posterior cricoarytenoid

The last muscle for the posterior part of the Rima glottides (closure): Transverse arytenoid

The table below shows the origin, insertion, innervation, and action of the laryngeal muscles:

Muscles Controlling the laryngeal inlet :

muscle	origin	Insertion	Action	Notes
Oblique arytenoid	Muscular process of arytenoid cartilage	Apex of opposite arytenoid cartilage	Narrows the inlet by bringing the aryepiglottic folds together	Two oblique muscle, opposite to each other, one cross the other
Thyroepiglottic (aryepiglottic)	Medial surface of thyroid cartilage	Lateral margin of epiglottis and aryepiglottic fold	Widens the inlet by pulling the aryepiglottic folds apart	
Muscles	Controlling the	Movement of	vocal	Folds(cords):
Cricothyroid (Fan-shaped)	anterolateral surfaces of the cricoid cartilage	expand superiorly and posteriorly to thyroid cartilage	Pull the thyroid cartilage forward and rotate it down relative to the cricoid cartilage These actions Tenses vocal cords	Has two parts: 1) <i>The oblique</i> part runs in a posterior direction from the arch of the cricoid to the inferior horn of the thyroid cartilage 2) <i>The straight</i> part runs more vertically from the arch of the cricoid to the posteroinferior margin of the thyroid lamina
Thyroarytenoid (vocalis)	Inner surface of thyroid cartilage	Arytenoid cartilage	Relaxes vocal cords	
Lateral cricoarytenoid	Upper border of cricoid cartilage	runs posteriorly and superiorly Muscular process of arytenoid cartilage	Adducts the vocal cords by internally rotating arytenoid cartilage	
Posterior cricoarytenoid	Back of cricoid cartilage	and run superiorly and laterally to Muscular process of arytenoid cartilage	Abducts the vocal cords by externally rotating arytenoid cartilage	There is a right and a left posterior crico-arytenoid
Transverse arytenoid	Back and medial surface of arytenoid cartilage (base)	Back and medial surface of opposite arytenoid cartilage(base)	Closes posterior part of Rima glottides by approximating arytenoid cartilages	



2) **Extrinsic muscles**

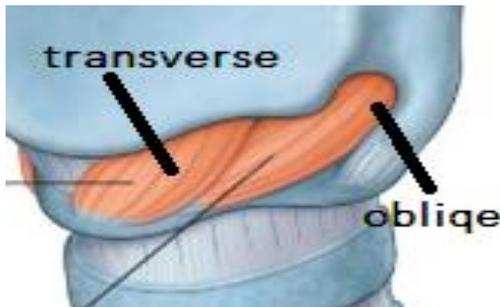
these muscles they don't affect the larynx directly, they move the larynx as one unit

Elevators of the larynx :

- Digastric muscle
- Stylohyoid
- Mylohyoid
- Geniohyoid

The larynx moves up in swallowing by these muscles assisted by:

- Stylopharngeus ,
- Salpingo-pharngeus,
- Palatopharngeus .



Depressors of the larynx :important in deglutition

- Sternothyroid
- Sternohyoid
- Omohyoid

** for closure of the inlet we need to move the larynx upward and move epiglottis downward .

Function of the larynx

1) Respiration

- During quiet respiration → the laryngeal inlet ,vestibule ,Rima vestibuli ,and Rima glottides are **open** (open valve)
- During forced inspiration → the arytenoid cartilages are **rotated laterally** ,mainly by the action of the **posterior crico-arytenoid muscles** . As a result ,the vocal folds are abducted ,and the **Rima glottides widens** into a rhomboid shape ,effectively **increases the diameter of the laryngeal airway** .

2) Phonation

- When phonating, the arytenoid cartilages and vocal folds are adducted and air is forced through the closed Rima glottides . This action causes the vocal folds to vibrate against each other and produce sounds .Can then be modified by the upper parts of the airway and oral cavity(wall of the nose ,wall of the pharynx, wall of the nose and wall of the oral cavity) so we have nasal sound , oral sound and lingual sound .

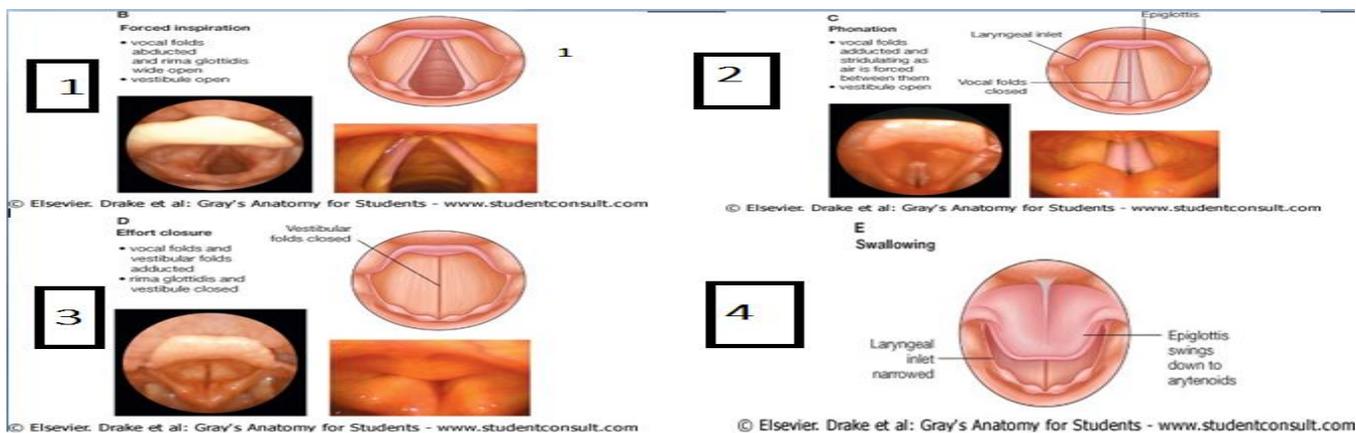
Tension in the vocal folds can be adjusted by the Vocalis and cricothyroid muscles .

3) Effort closure

- Effort closure of the larynx occurs when air is retained in the thoracic cavity to **stabilize the trunk** . For example during heavy lifting ,or as part of the mechanism for increasing intra-abdominal pressure .The Rima glottides is **completely closed**, the vocal cord reach the midline . The result is to completely and **forcefully shut the airway** .

4) Swallowing

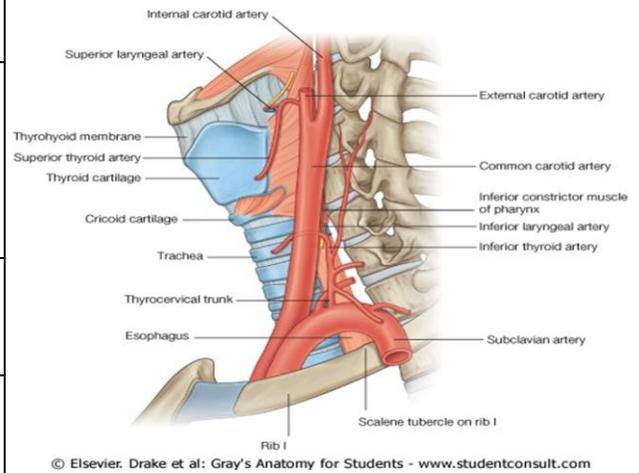
- During swallowing, the Rima glottides ,the Rima vestibuli ,and vestibule are closed and the laryngeal inlet is narrowed
- The larynx moves up and forward
- This action causes the epiglottis to swing downward to effectively narrow or close the laryngeal inlet
- The up and forward movement of the larynx also opens the esophagus
- All these actions together prevent solids and liquids from entry into the airway



Blood Supply

- The major blood supply to the larynx is by the superior **and** inferior laryngeal arteries
- There is important relationship between inferior laryngeal artery and inferior thyroid artery with recurrent laryngeal nerve (clinical note page 11)
- Recurrent pass between the branches of inferior thyroid
- Together, inferior thyroid artery and inferior laryngeal artery, with the recurrent laryngeal nerve, ascends in the groove between the esophagus and trachea
- Sup thyroid = external laryngeal
- Very important table ↴

Blood supply	superior laryngeal artery	inferior laryngeal arteries
Origin	superior thyroid branch of the external carotid artery	inferior thyroid branch of the thyrocervical trunk of the subclavian artery
Accompanies nerve	internal branch of the <u>superior laryngeal nerve</u>	<u>recurrent laryngeal nerve</u>
How they reach the larynx	through the thyrohyoid membrane	passing deep to the margin of the inferior constrictor muscle of the pharynx



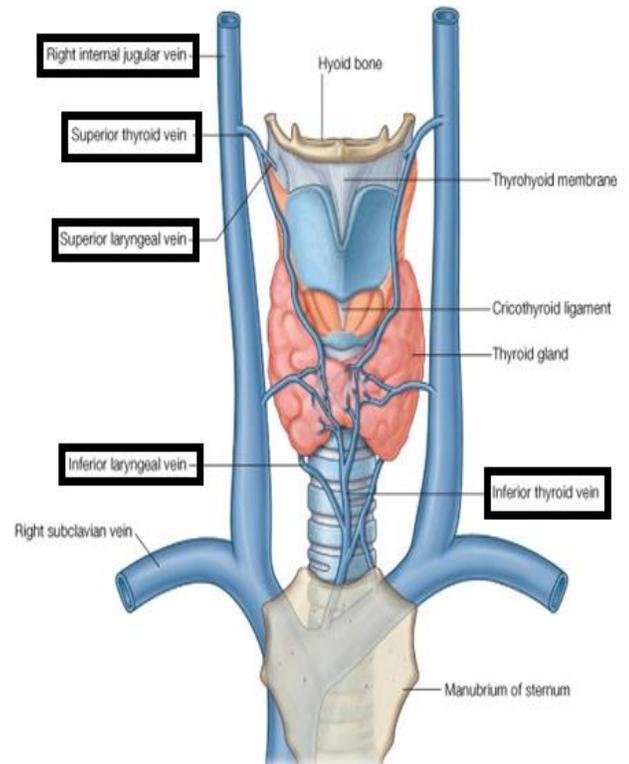
Veins draining

- 1) Superior laryngeal veins → superior thyroid veins → internal jugular veins
- 2) Inferior laryngeal veins → inferior thyroid veins → left brachiocephalic veins

Lymphatics

Lymphatics drainage divided into two groups

- Those **above** the vocal folds follow the *superior laryngeal artery* and terminate in deep cervical nodes
- Those **below** the vocal folds drain into the node around the trachea (para tracheal lymph node)

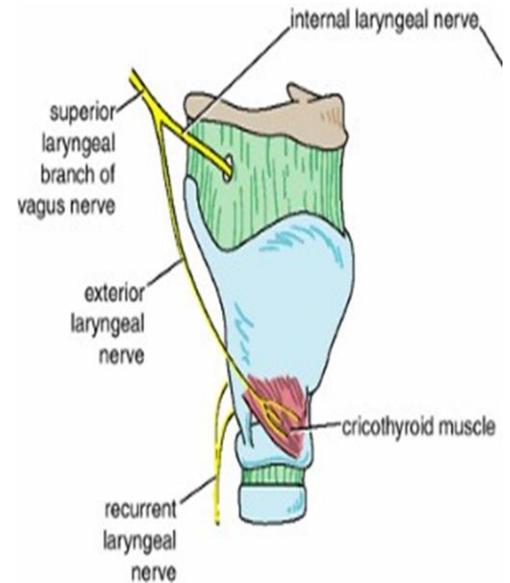


Nerve supply of the larynx

1) Superior laryngeal nerves

The superior laryngeal nerves originate from the inferior vagal ganglia high in the neck. They descend medial to the internal carotid artery and divide into internal and external branches above the hyoid bone.

- **The external branch** (external laryngeal nerve) → motor → descends along the lateral wall of the pharynx to supply the inferior constrictor of the pharynx and ends by supplying the cricothyroid muscle.
- **The internal laryngeal nerve** → sensory → passes anteroinferiorly to penetrate the thyrohyoid membrane. Internal nerve is mainly sensory and supplies the laryngeal cavity above to the level of the vocal folds

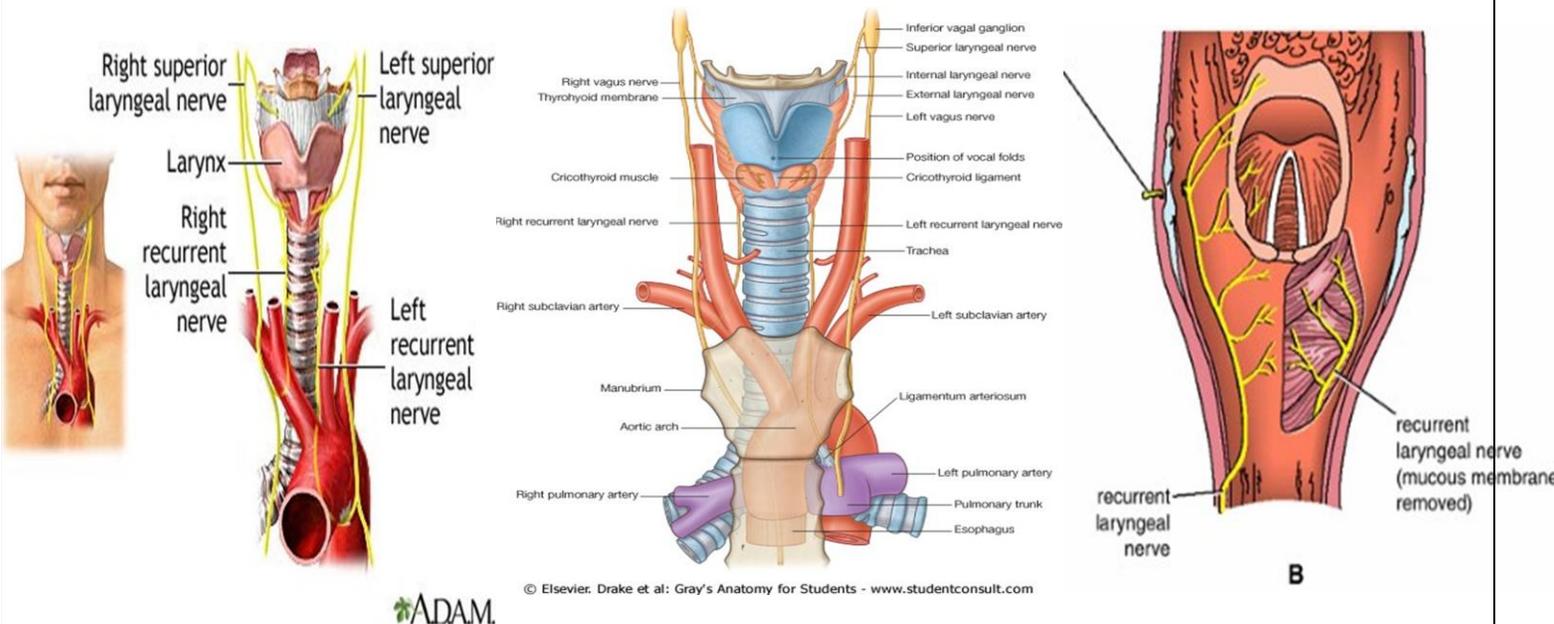


2) Recurrent laryngeal nerves

The recurrent laryngeal nerves are :

- Sensory to the laryngeal cavity **below the level of the vocal folds** ;
Inferior Thyroid and inferior laryngeal
- Motor to all intrinsic muscles of the larynx **except for the cricothyroid** .

The **left** recurrent laryngeal nerve originates in the **thorax below the arch of aorta** whereas the **right** recurrent laryngeal nerve originates in the **root of the neck**. So, left is longer than right
Both nerves generally ascend in the neck in the groove between the esophagus and trachea
Enter the larynx deep to the margin of the inferior constrictor



Relations of the larynx

On each side →

- 1) Carotid sheath which contain , Internal jugular vein , vagus nerve and , common carotid artery , common carotid artery continue as internal carotid artery
- 2) lateral lobe of the thyroid gland

Posterior →

- 1) Pharynx and esophagus
- 2) the right recurrent laryngeal nerve

Anterior →

- 1) Skin
- 2) fascia and its contents,
- 3) infra-hyoid muscles (Sternohyoid ,sternothyroid, thyrohyoid , omohyoid)

Clinical notes "في سؤال مؤكد عليها ب الامتحان "

Thyroidectomy

- 1) From the slides: (Sectioning of the **external laryngeal** nerve might happen in thyroidectomy .Due to the close relationship between the external laryngeal nerve and the superior thyroid artery .Produces **weakness in voice** since the vocal cords cannot be tensed cricothyroid muscle)

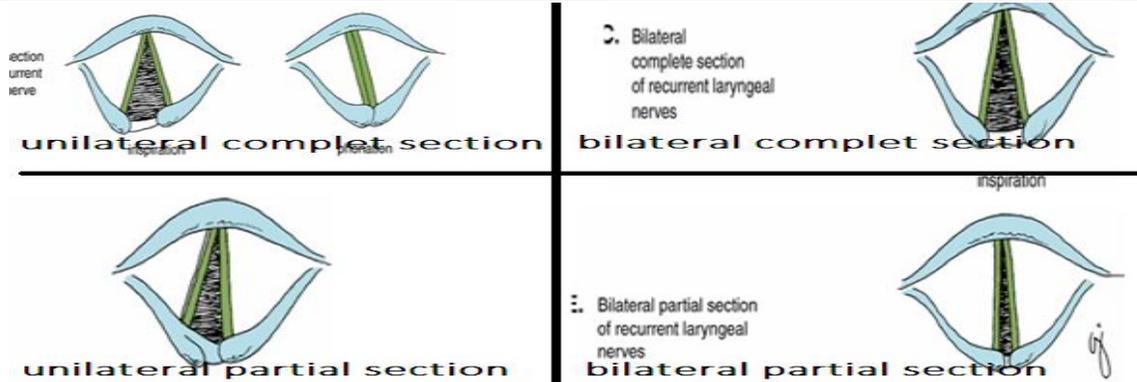
As we know, with the superior thyroid artery, there is the external laryngeal nerve (which supplies the cricothyroid muscle---- the only muscle located outside the larynx and is responsible for the tense of the vocal cord – high pitch)

During ligation of the superior thyroid artery, if the nerve was injured, that will cause paralysis to the supplied muscle, and that will result in weakness in case of unilateral injury /hoarseness of the voice in case of bilateral injury.

- 2) Section of the **Recurrent laryngeal nerve**

We have 4 cases , we must note the effect on respiration and speech

In case of complete section , complete cut in the nerve .while in partial section, during manipulation , injury of **suPerficial** fibers that mainly supply the **aBductor** muscles, so if there is injury in them there will be paralysis in the abductors , that will cause the adductor to work.



The case	The affected part	Effect on respiration	Effect of speech
Unilateral complete section	One vocal fold) on the affected side) in the position midway between abducted and adducted	Respiration normal	Speech not greatly affected as the other vocal cord compensate for the action
Bilateral complete section	Both vocal folds in position midway between abducted and adducted	Breathing is impaired little since the Rima glottis is partially close	speech is lost
Unilateral partial section (more dangerous)	This results in a greater degree of paralysis of the abductor muscles than of the adductor. Therefore the affected cord is in the adducted midline position		Hoarseness of the voice) the other vocal fold compensates the action (
Bilateral partial section (most dangerous)	This results in bilateral paralysis of the abductor muscles Therefore the vocal folds are adducted together in the midline	Acute breathlessness (Dyspnea)and stridor follow Lead to suffocation so tracheostomy is necessary	More hoarseness

