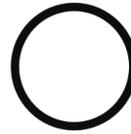


RESPIRATORY SYSTEM

Anatomy



Sheet



Slide

Number:

- 4

Done by:

- Luma Taweel

Corrected by:

- Rand Khreisat

Doctor:

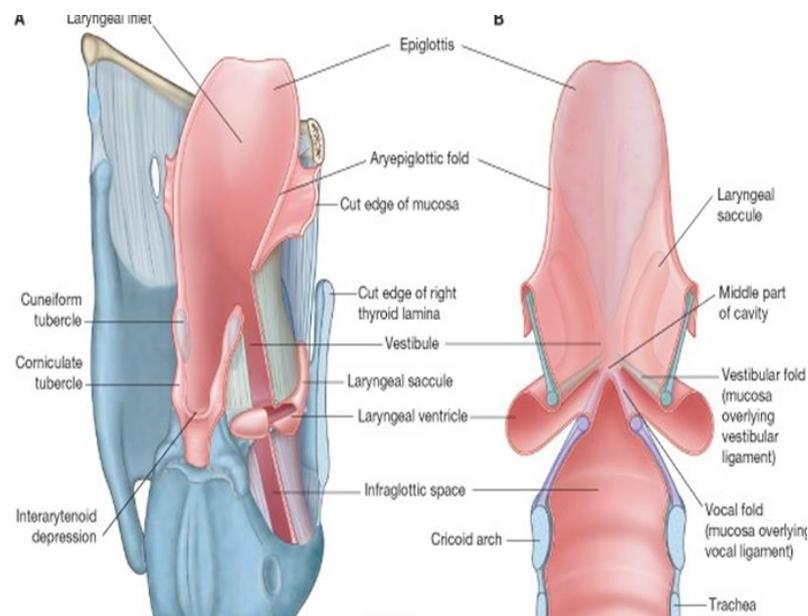
- Mohamed Al-Mohtaseb

The Laryngeal Cavity

The sheet is a bit lengthy because we tried to add all the related illustrations, please go over the slides for any further details.

In the previous lecture we learned that the larynx is a box of cartilage lined with pseudostratified ciliated columnar cells, the exception here are the true vocal cords. Membranes and ligaments also make up the larynx and they are connected together by cartilage.

This lecture is about the laryngeal cavity; the larynx from the inside where we can see the epiglottis, vestibular fold and the true vocal fold as in the image below.



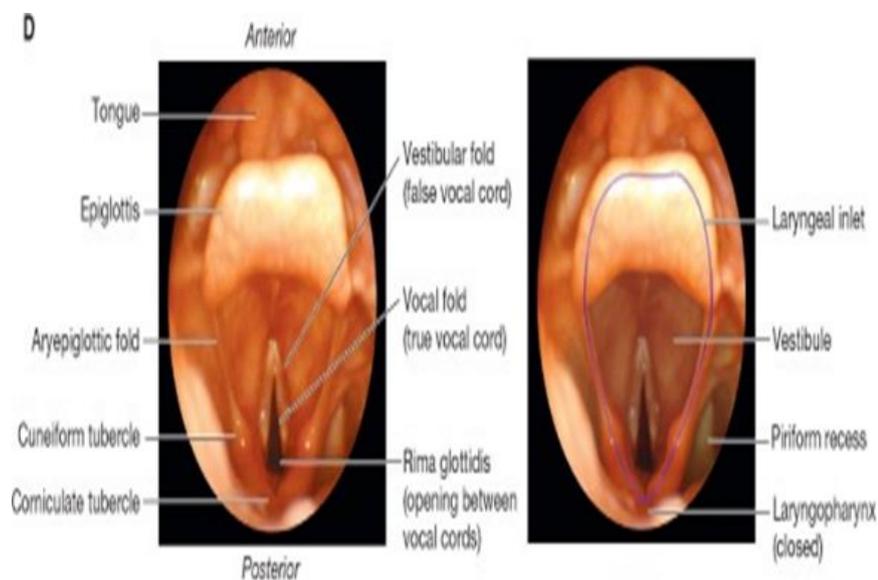
To understand the cavity of the larynx we will start by discussing its inlet, which begins at the level of the epiglottis.

The borders of the inlet are formed:

- 1) **anteriorly** and **superiorly** by the epiglottis.
- 2) **laterally** (from the sides) by aryepiglottic fold, this fold begins from the apex of arytenoid cartilage to the epiglottis. It is composed of aryepiglotticus muscle that aids in the closure of the inlet, the fold also contains the corniculate and cuneiform cartilages that strengthen the aryepiglotticus muscle contraction.
- 3) **posteriorly** by interarytenoid notch.

The image below is important and represents what is seen during anaesthesia while inserting an endotracheal tube, the tube insertion starts from the oral cavity and must pass between the true vocal cords. The true vocal cords are recognized by being the most adducted structures, they are located near the midline and are white in colour this is because they do not contain blood vessels, rather they receive blood from the surrounding connective tissue by diffusion.

Notice the aryepiglottic fold, epiglottis, true vocal cords, corniculate and cuneiform cartilages and the interarytenoid notch between the corniculate tubercles.



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Closure of the inlet of the larynx:

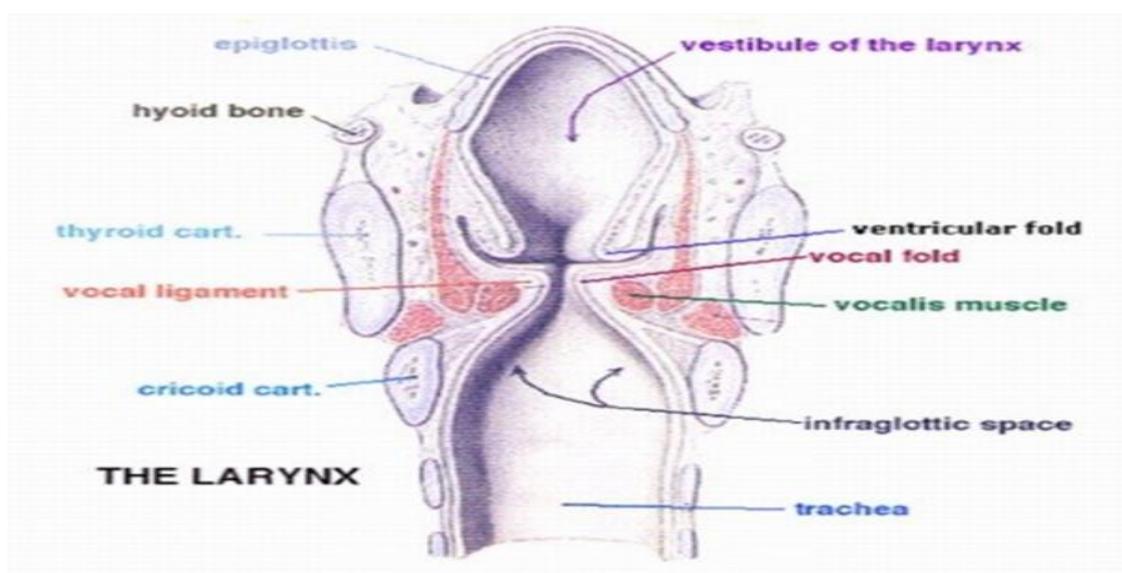
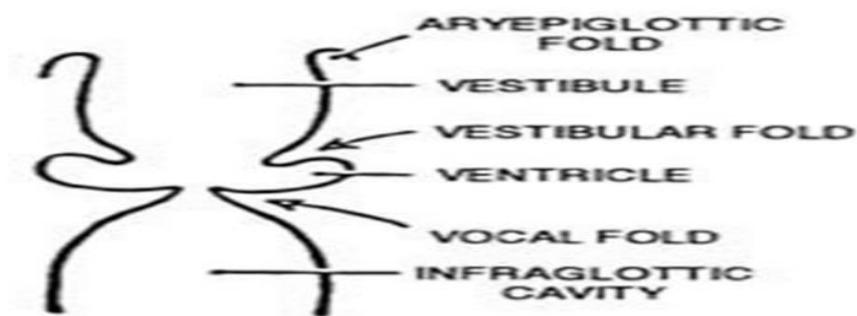
The food bolus pushes the epiglottis downward and backward, the larynx moves upward, and aryepiglotticus muscle contracts (this contraction is strengthened by cuneiform and corniculate cartilages). These events result in adduction of the aryepiglottic folds together and closure of the laryngeal inlet.

we are done talking about the inlet in specific.

The laryngeal cavity begins from the epiglottis, descends to a narrow point, followed by the Infraglottic space that continue as the trachea.

The Laryngeal cavity is divided into three parts:

1. **Vestibule: begins** between the inlet and the false vocal cords.
2. **Middle (glottic) part: begins** from the false vocal cords to the true vocal cords. On its lateral side there is a ventricle, which is a space that ascends upward leading to a saccule. The ventricles are located deep to the false vocal cords. Their lining epithelium is pseudostratified ciliated columnar, and their submucosa contains seromucous glands. The function of the ventricles and saccules is that the secretions of the submucosal glands lubricate the true vocal cords.
3. **Infraglottic:** begins from the true vocal cords to the trachea.



True vocal cords (LAB EXAM QUESTION)

Again, the true vocal cords are the most adducted part, located near the midline. They are white in colour because they lack blood vessels and are supplied by diffusion from the surrounding connective tissue.

Parts of the true vocal cords:

- 1. Vocal ligaments:** formed by the upper free edge of conus elasticus (cricothyroid membrane). It is attached to the vocal process of arytenoid and moves anteriorly to reach the inner angle of thyroid cartilage.
- 2. Mucous membrane:** the lining epithelium of the true vocal cords is stratified squamous none keratinized. It's an exception from the rest of larynx - that is lined by respiratory epithelium-. The difference in histology is to maintain mitosis and regeneration of the epithelium because the true vocal cords are prone to injury by speech or excessive use. So, because of the stratified squamous epithelium, loss of voice is temporal and lasts for 10 hours after vocal cords injury. False vocal cords are not used in speech, so they are lined by respiratory epithelium.
- 3. Vocalis muscle (thyroarytenoid)**
This muscle is striated and found in the true vocal cords, it extends from the thyroid to the arytenoid cartilage, it works during speech.

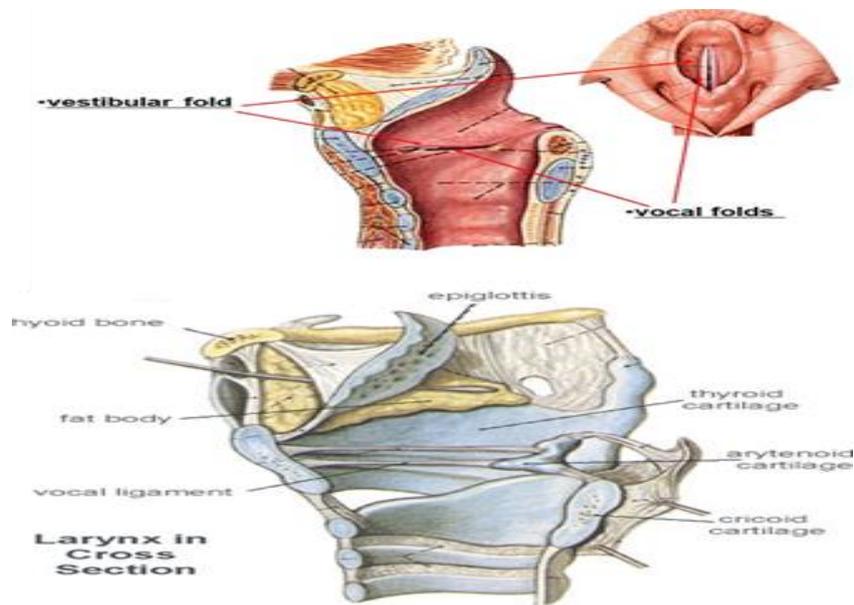
Notes:

There is no submucosa in the true vocal cords. The absence of submucosa is to prevent accumulation of fluid and edema that could lead to adduction of vocal cords and suffocation.

Lymphatics are also absent.

The true vocal cords are longer in males than in females, so males have a low pitch of the voice while females have high a pitch of voice.

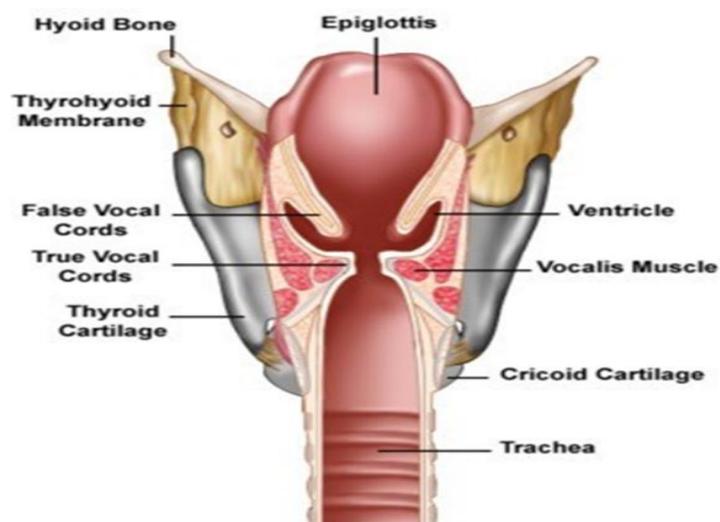
The lab question could be a pointer on the true vocal cords, "which one of the following is not characteristic of the pointed structure?"



Vestibular folds

They are the false vocal cords, which are formed by the lower free edge of quadrangular membrane. They lie superior to the true vocal cords separated by ventricles. Composed of vestibular ligaments unlike the true vocal cords they are covered by respiratory mucosa, they are rich in blood vessels, so it has a red colour and they are fixed and not movable.

*Remember the saccule that ascends upwards behind the false vocal cords.



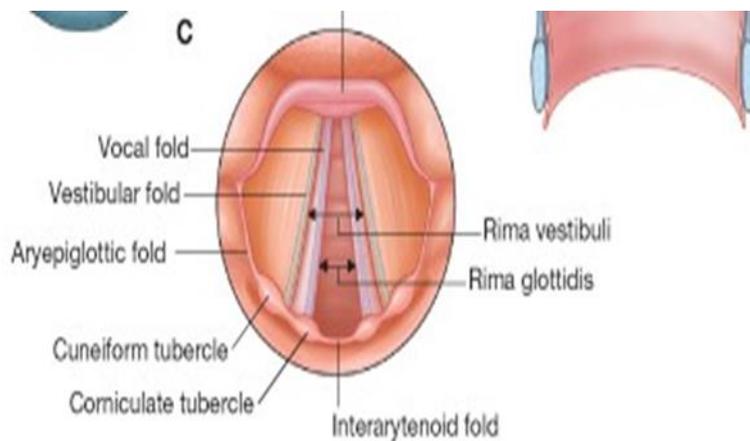
Rima vestibuli and Rima glottidis

The **Rima vestibuli** is the space between the false vocal cords.

And the Rima glottidis is the space between the true vocal cords, it's the narrowest point in the laryngeal cavity, the rima glottidis opening separates middle chamber above from the infraglottic part below.

Rima glottidis is controlled by two muscles that have opposite functions:

1. Posterior cricoarytenoid muscle: abducts the vocal cords and thus widening the Rima glottidis.
2. Lateral cricoarytenoid: adduct the true vocal cords by pulling the muscular process of arytenoid internally and thus narrowing the Rima glottidis.



Intrinsic Muscles of the larynx

The intrinsic muscles of the larynx affect three things:

1. **Inlet of the larynx:** the inlet is closed during deglutination, opened and relaxed during respiration, suddenly closed and the suddenly opened during coughing. The closure of the inlet is controlled by aryepiglotticus and transverse arytenoid muscles.
2. **True vocal cords:** they are tensed by cricothyroid and elongated and relaxed by thyroarytenoid (vocalis muscle).
3. **Rima glottidis:** posterior cricoarytenoid abducts the true vocal cords and lateral cricoarytenoid adducts them, this leads to opening and closing the rima glottidis respectively.

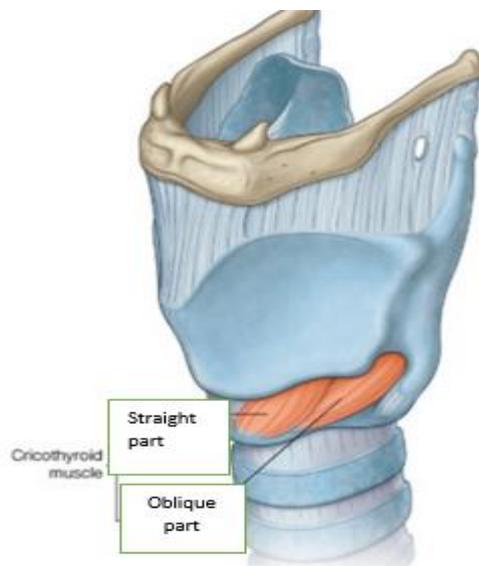
The intrinsic muscles include:

1) Cricothyroid muscle: (EXAM QUESTION)

Origin: in general, this muscle moves from the cricoid till the thyroid it has two origins (parts), oblique and straight part. The oblique part runs in a posterior direction from the arch of cricoid to the inferior horn of thyroid. The straight part runs vertically upward to the thyroid.

Nerve supply: external laryngeal nerve, a branch of superior laryngeal nerve of vagus. The external laryngeal nerve runs along with superior thyroid artery.

Clinically: In thyroidectomy, the first step is the ligation of superior thyroid artery on two ends, this ligation is then cut to prevent bleeding. In aggressive tumours that infiltrate the muscles and bones for example, the external laryngeal nerve might not be identified and could be injured through the process. Bilateral injury to the external laryngeal nerve result in bilateral paralysis of cricothyroid muscle and hoarseness of the voice (due to loss of the ability to tense vocal cords).



The doctor said that the image in the slides was labelled incorrectly.

The one to your right has been corrected.

The intrinsic muscles of the larynx from now on all are supplied by the recurrent laryngeal nerve. (the exception was the cricothyroid muscle that is supplied by external laryngeal nerve).

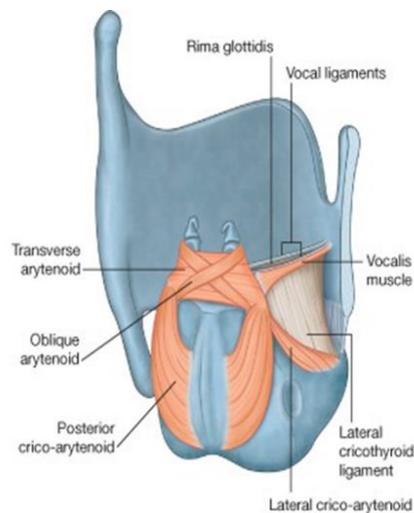
2) Posterior and lateral cricoarytenoid muscles:

origin: posterior cricoarytenoid originate from the posterior surface of cricoid lamina. The lateral cricoarytenoid muscle originate from lateral surface of cricoid lamina.

Insertion: both bind to the muscular process of arytenoid

Nerve supply: recurrent laryngeal nerve.

Action: pulling the lateral cricoarytenoid muscles internally adducts the vocal cords while pulling the Posterior cricoarytenoid externally abducts the vocal cords.

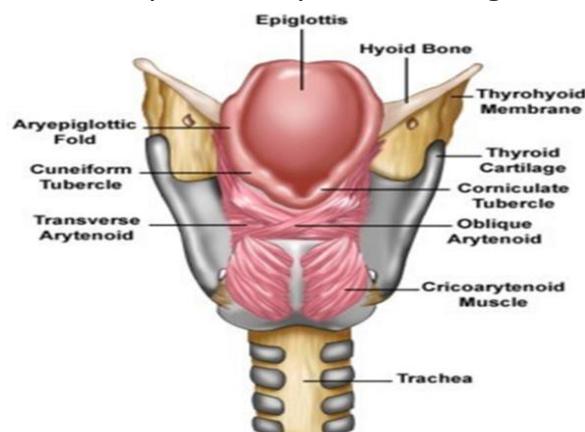


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3) Transverse arytenoid

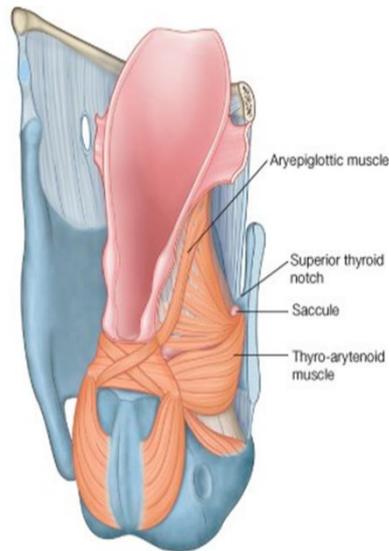
Origin: runs transversely from one arytenoid to the other arytenoid.

Function: closure of the posterior part of rima glottidis (interarytenoid).



4) Thyroarytenoid (vocalis muscle)

It's a part of true vocal cord, it relaxes (elongate) the true vocal cords. This muscle is responsible for low pitch of voice. (it opposes the cricothyroid muscle that is responsible for the high pitch)



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5) Oblique arytenoid

Origin: from the muscular process of one arytenoid to the apex of the opposite arytenoid.

Action: narrow the inlet by adducting aryepiglottic folds.

6) Aryepiglotticus muscle

Origin: between arytenoid and epiglottis

Action: widening of the laryngeal inlet by the abduction the aryepiglottic folds when acting ALONE, but it narrows the inlet when acting with oblique arytenoid.

Extrinsic muscles of the larynx

They are classified into suprahyoid and infrahyoid muscles. Suprahyoid muscles pull the larynx upward and aid in closure of the inlet. Infrahyoid muscles depress the larynx downward.

Suprahyoid muscles:

- Digastric
- Stylohyoid
- Myelohyoid
- Geniohyoid
- Assisted by Stylopharyngeus, Salpingo-pharyngeus, and Palatopharyngeus

infrahyoid muscles:

- sternothyroid
- sternohyoid
- omohyoid

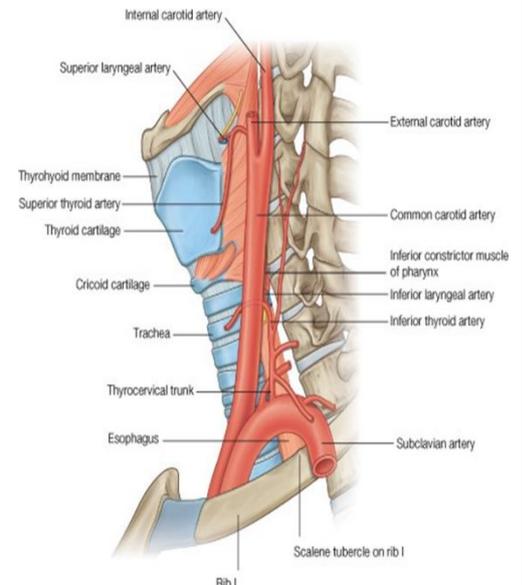
functions of larynx

- 1) deglutination, respiration, coughing, speech or phonation where the true vocal cords vibrate and the rima glottidis abducts and adducts (all mentioned in detail earlier)
- 2) effort: during heavy lifting vocal cords are adducted completely, thus a column of air is formed beneath the vocal cords and it gives efforts for lifting heavy objects (by increasing the intraabdominal pressure). After lifting there will be a deep expiration. (another way to assure good expiration is by wearing a wide belt)

Blood supply of the larynx

1. Superior laryngeal artery: pierce the thyrohyoid membrane with internal laryngeal nerve.
2. Inferior laryngeal artery: branch of the inferior thyroid artery of thyrocervical trunk of subclavian.

Subclavian artery → thyrocervical trunk → inferior thyroid → inferior laryngeal.



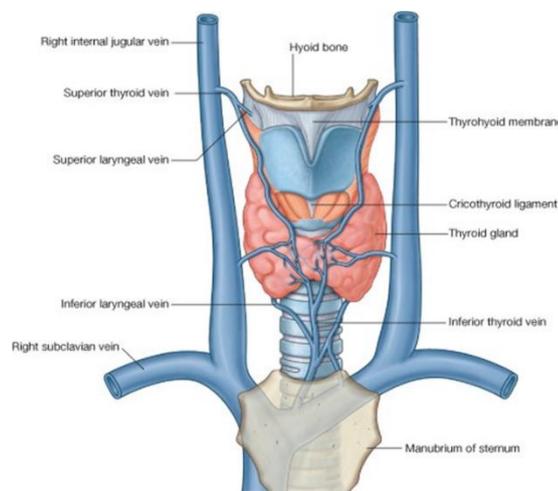
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Recurrent laryngeal nerve passes between the branches of inferior thyroid artery and then pass with the inferior laryngeal artery in a groove between oesophagus and trachea and then below the inferior constrictor muscle of the pharynx and finally it enters the larynx.

The recurrent laryngeal nerve could be injured during ligation of the inferior thyroid or inferior laryngeal arteries.

Venous drainage of larynx

- 1) Superior laryngeal vein → superior thyroid vein → internal jugular vein
- 2) Inferior laryngeal vein → inferior thyroid vein → left brachiocephalic vein. The inferior thyroid vein ends in the left brachiocephalic and not in the right because the left is more oblique and longer.



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Lymphatic drainage of the larynx

The lymphatic drainage is divided to above and below the true vocal cords:

- 1) Above the true vocal cords, lymphatics end in the deep cervical lymph nodes through the lymph nodes associated with superior laryngeal artery.
- 2) Below the true vocal cord, lymphatics drain into the lymph nodes associated with inferior laryngeal artery and ends in paratracheal lymph nodes (on the cricothyroid ligament or upper trachea)

Innervation of the larynx

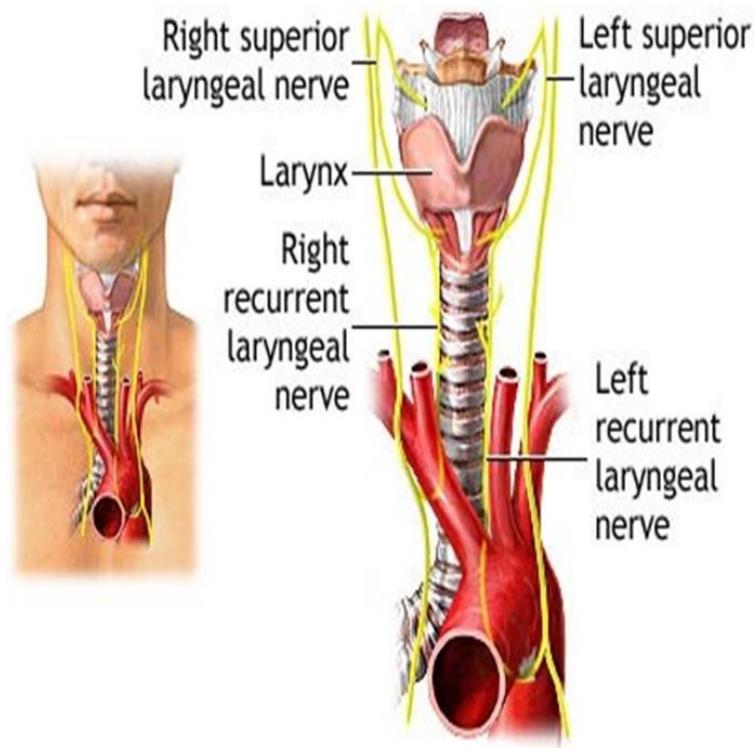
The innervation of the larynx is divided to motor and sensory; above and below the true vocal cords:

- 1) Sensory innervation to the mucosa above the true vocal cords by internal laryngeal nerve.
- 2) Sensory innervation below the true vocal cords by the recurrent laryngeal nerve.
- 3) Motor innervation to the laryngeal muscles by the recurrent laryngeal nerve (exception: cricothyroid)
- 4) cricothyroid muscle is supplied by external laryngeal nerves a branch of the superior laryngeal of the vagus.

5) Recurrent laryngeal nerves: (EXAM QUESTION)

The left recurrent nerves are longer on the left side:

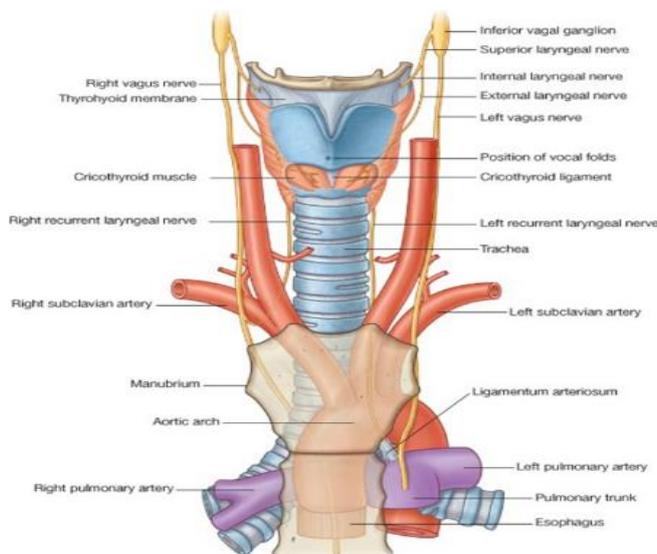
- The left vagus nerve (which is longer) descends to the thorax then it gives the left recurrent nerve below the arch of aorta, then it ascends between trachea and oesophagus to the larynx.
- The right vagus nerve gives the right recurrent nerve at the root of the neck, below the subclavian vessels. So, the right recurrent nerve isn't found in the chest and it's not related to the pleura and lung.
- Remember they innervate all the muscles except the cricothyroid, they are also sensory to the mucosa below true vocal cords.



ADAM.

Relations of the larynx

- 1) Laterally: The carotid sheath and its content. The carotid sheath contains common carotid artery, internal jugular vein and vagus nerve. In addition to the lateral lobes of thyroid.
- 2) posteriorly: Recurrent nerve
- 3) anteriorly: Skin, fascia and infrahyoid muscles.



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Clinical notes

NOTE 1: During thyroidectomy and ligation of superior thyroid artery the external laryngeal nerve could be injured. Bilateral injury to the external laryngeal nerve result in bilateral paralysis of cricothyroid muscle and hoarseness and weakness of the voice (due to loss of the ability to tense vocal cords).

NOTE 2: Injury to recurrent laryngeal nerve injury could be bilateral complete section, bilateral partial section, unilateral complete section or unilateral partial section. (section as in cut)

General notes on recurrent laryngeal nerve injury:

- Partial injury: injury to superficial fibres (deep fibres are spared) that supply the abductor muscles due to manipulation or tension. Partial injury result in adduction of vocal folds and cause suffocation if it was bilateral. It is more dangerous than complete because in complete injury vocal cords are neither adducted nor abducted. SO, most dangerous form is partial bilateral due to suffocation, tracheostomy should be performed.
- Unilateral partial of recurrent causes hoarseness of voice, while unilateral complete injury of recurrent doesn't affect speech
- Two important things to look at after recurrent nerve injury: respiration and speech.

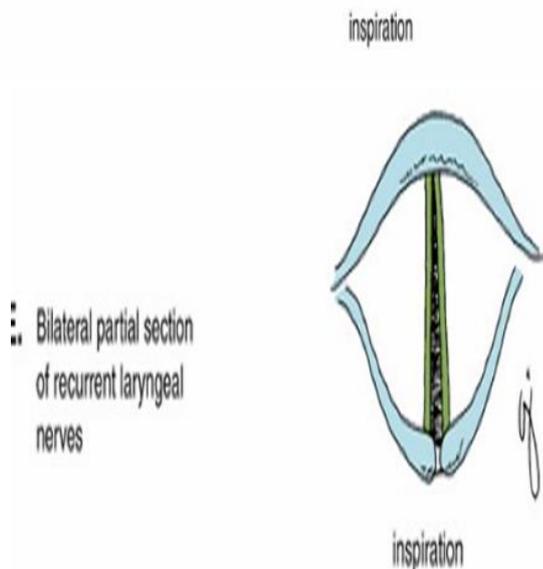
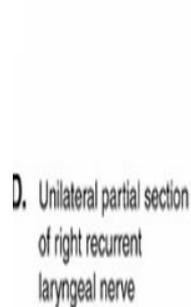
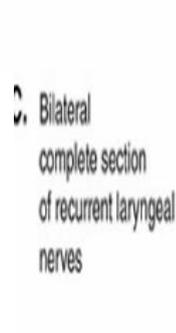
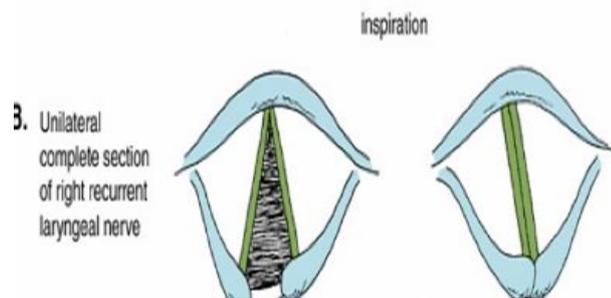
Forms of recurrent laryngeal nerve injury:

-Complete unilateral section:
speech and respiration aren't
much affected because the
other side compensates.

- Bilateral complete section:
difficulty in breathing without
suffocation, rima glottidis is
partially closed and the speech is
lost.

- Unilateral partial section:
hoarseness in voice with
difficulty in respiration.

- Bilateral partial section:
dyspnea, stridor (snoring) and
suffocation. Here the
tracheostomy is very necessary.



Best of luck!