

Doctor.021
no.

3

RS ANATOMY



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A Quick recap

Larynx (voice box) a part of respiratory track that extends from middle C3 vertebrae till lower border of C6.

Consist of:

- 1) **Cartilage** (3 single: epiglottis & thyroid & cricoid / 3 pairs: Arytenoid & corniculate & cuneiform)
- 2) **Mucosa** (pseudo stratified columnar ciliated epithelium with goblet cells, except the true vocal cord which is as oral mucosa)
- 3) **Muscles** (Intrinsic & extrinsic) in this sheet
- 4) **Ligaments & membranes** (3 Extrinsic & 2 intrinsic)

In this lecture we will study:

Laryngeal joints, cavities of larynx, the folds, muscles, the Function of larynx, blood supply & innervation and lastly some clinical notes. (Familiar with them in previous lecture)

Note that: purple is for slides content.

Laryngeal Joints

1) Cricothyroid joints

- Between the inferior horns of the thyroid cartilage and the cricoid cartilage, are **synovial**.
- Surrounded by a capsule and is reinforced by associated ligaments.
- Enable the thyroid cartilage to move forward and tilt بميل downwards on the cricoid cartilage.
- Forward movement and downward rotation of the thyroid cartilage effectively lengthens and puts tension on the vocal ligaments.

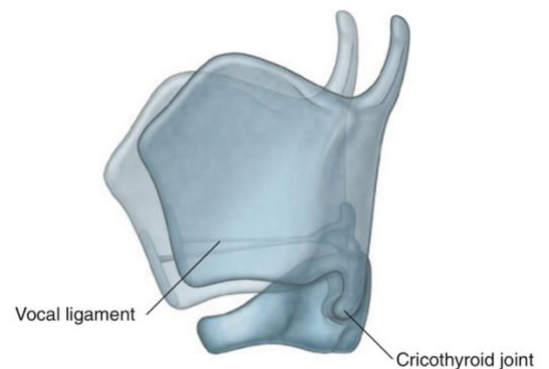


Fig. 8.219 Movements of the cricothyroid joints.

- Forward & downward of thyroid cartilage = tension of vocal, works as cricothyroid muscle (tension)
- Vocalis muscles = relaxation & lengthening of vocal cords

2) Crico-arytenoid joints

- Between articular facets on the superolateral surfaces of the cricoid cartilage and the bases of the arytenoid cartilages
- Enable the arytenoid cartilages to slide away or towards each other and to rotate.
- The vocal processes pivot either towards or away from the midline.
- These movements abduct and adduct the vocal ligaments.
- Synovial joint
- Rotatory movement by the **muscular** process resulting in moving abduction of vocal cords by posterior cricoarytenoid muscle, adduction by lateral cricoarytenoid muscle.
- So important in vocal vibration

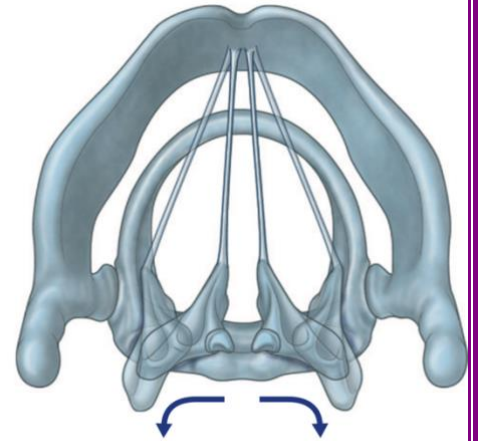


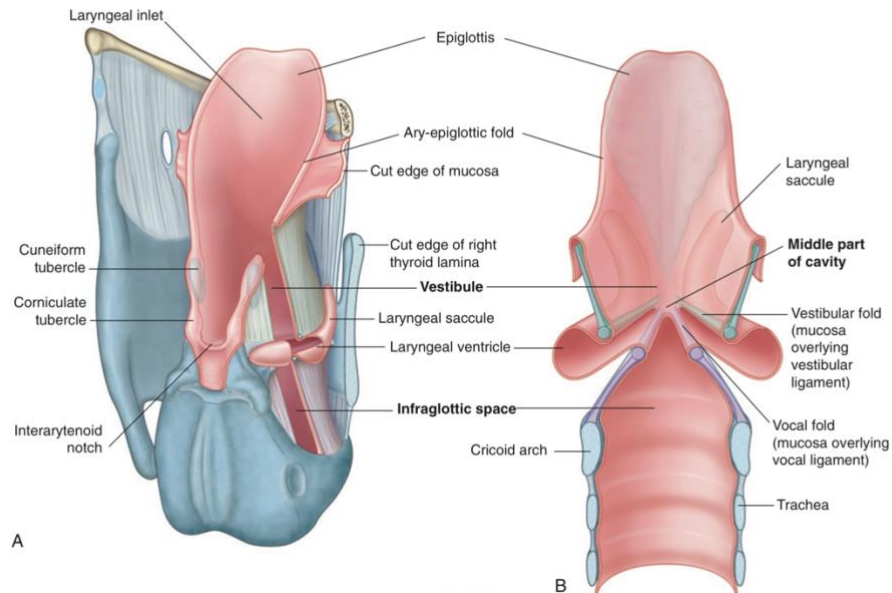
Fig. 8.220 Movements of the crico-arytenoid joints.

Cavity of the larynx

1) Laryngeal cavity

- From the inlet till the trachea
- Divided to 3 compartments: 1st above false vocal (vestibule of larynx), 2nd between false & true (glottic), 3rd infraglottic
- The central cavity of the larynx is tubular in shape and is lined by mucosa.
- Support is provided by the of larynx and by the cartilages to which it is attached.

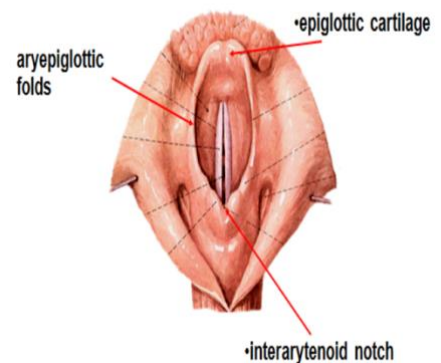
- The superior aperture of the cavity (**laryngeal inlet**) opens into the anterior aspect of the pharynx just below and posterior to the tongue
- Laryngeal inlet is oblique and points postero-superiorly.



2) laryngeal inlet

- Anterior border is formed by mucosa covering the superior margin of the epiglottis.
- Both Lateral borders are formed by **mucosal folds (aryepiglottic folds)** which contain aryepiglottic muscle.
- Posterior border in the midline is formed by a mucosal fold that forms a depression (**interarytenoid notch**) between the two corniculate tubercles
- Closure (deglutition) of the inlet by: epiglottis downward, larynx upward, muscles between Arytenoids will close to the midline.

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



Aryepiglottic folds:

- Enclose the superior margins of the quadrangular membranes and adjacent soft tissues.
- From the epiglottis to the Arytenoid
- Two tubercles on the more posterolateral margin side mark the positions of the underlying cuneiform (in the fold exist) and corniculate cartilages (at the end of the fold with the apex of Arytenoid).

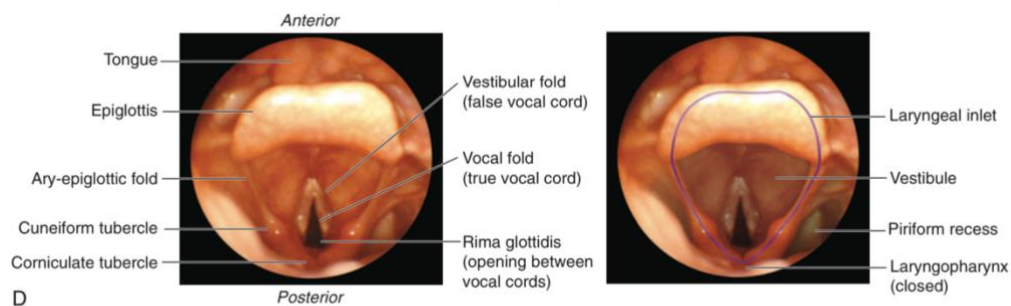


Fig. 8.221 Laryngeal cavity. A. Posterolateral view. B. Posterior view (cut away). C. Superior view through the laryngeal inlet. D. Labeled photograph of the larynx, superior view.

3) 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.

4) Division into three major regions:

The vestibular and vocal folds, divide it into three major regions-
the.

vestibule, a middle chamber, and the infraglottic cavity.

A) Vestibular (supraglottic)

- is the upper chamber of the laryngeal cavity between the laryngeal inlet and the vestibular folds

- Vestibular folds enclose the vestibular ligaments and associated soft tissues.
- Above the false vocal cords

B) Middle chamber (glottic)

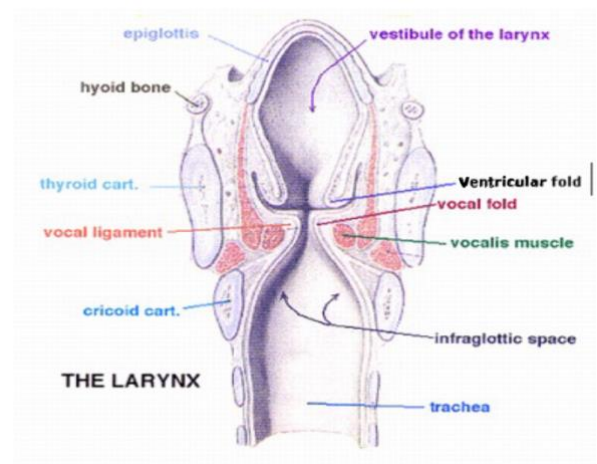
- Also called **Ventricular fold**
- is very thin and is between the vestibular folds above and the vocal folds below (between the true & false vocal cords)
- Vocal folds enclose the vocal ligaments and related soft tissues below.
- Laryngeal sacculae exist in the cavity, which **contains sero-mucosal glands**, in submucosa, for lubricant of true vocal folds, this secretion doesn't reach false cords.

C) Infraglottic cavity

- Is the most inferior chamber and is between the true vocal folds and the inferior opening of the larynx (trachea).

Notes:

- Remember that adduction of true vocal folds = suffocation = increase pressure in lungs.
- Before the surgery we put endotracheal tube from the inlet till the trachea to provide oxygen and inhale gases to the lungs.
- Suprasternal tracheostomy: surgical procedure by making a cut **below** the true vocal cords
- Bilateral injury for recurrent laryngeal nerve result in adduction of true cords. So we need the tracheostomy.



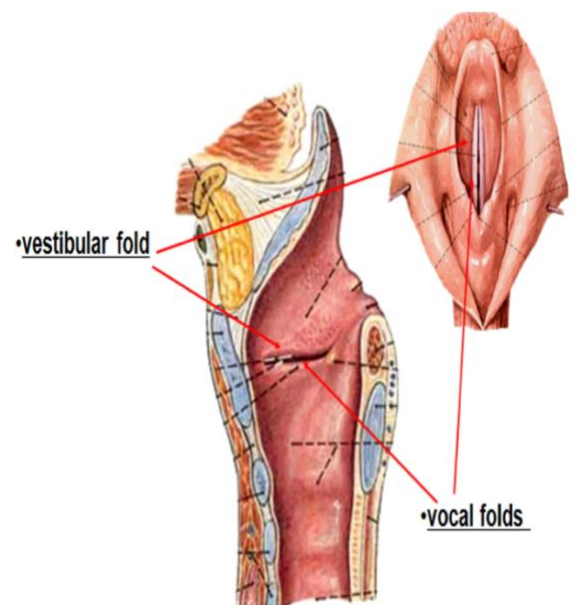
Folds

1) Vocal Folds (true folds)

- Consist of: مهم (مكان أسنلة)
 1. Vocal ligament (from the upper free edge conus elasticus “cricothyroid ligament”)
 2. Mucous membrane (stratified squamous non keratinized)
 3. Vocalis Muscles (thyroarytenoid muscle) striated muscle that responsible of relaxation of vocal cords)
- Features:
 1. **No** submucosa = no fluid accumulation= no adduction
 2. **No** lymphatic
 3. **No** blood vessels (white in color) get blood by diffusion
 4. On each side extend between the vocal process of the arytenoid and the back of the anterior lamina of thyroid.
 5. Longer in male which cause the difference of the pitch of the voice between genders (low pitch in male)

2) Vestibular folds (False vocal cords)

- Features:
 1. Vascularised (red in color)
 2. Fixed and not movable unlike the vocal cord
 3. Superior to the vocal cord
 4. Not related to phonation
 5. Contraction = narrowing of the space between two folds **but** true folds are the main
- If the false folds get cut nothing will happen.



3) Laryngeal ventricles and saccules

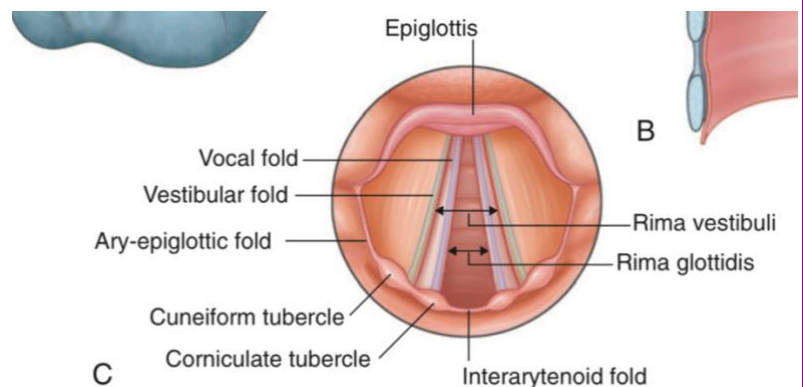
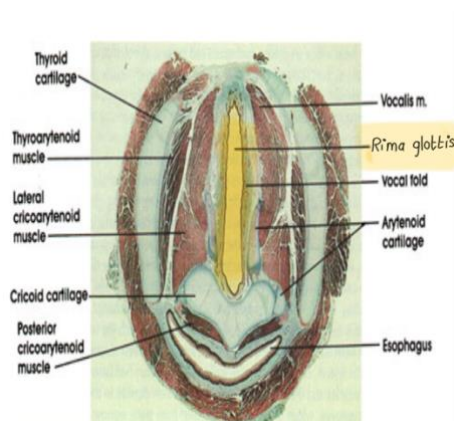
- One each side, the mucosa of the middle cavity bulges laterally through the gap between the vestibular and vocal ligaments to produce a laryngeal ventricle.

- Tubular extension of each ventricle (laryngeal sacculae) projects anterosuperiorly between the vestibular fold and thyroid cartilage
- Within the walls of these laryngeal sacculae are numerous **mucous glands**.
- Mucus secreted into the sacculae lubricates the vocal folds. Lubrication of true vocal folds

4) Rima vestibuli and rima glottidis

Rima vestibuli

- Space between false 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



The Rima glottidis

- is formed by the vocal folds (true vocal cords) and adjacent mucosa-covered parts of the arytenoid cartilages
- More important than vestibuli one
- Posterior & lateral Arytenoid muscles work on it
- Tension & relaxation don't effect the space **but** the adduction (lateral) & abduction (posterior) does.

- Rima glottidis opening 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
 - Rima glottis is the narrowest part of the laryngeal cavity
 - **Oblique transverse cricoarytenoid muscle** located on the posterior of Rima glottidis
- Both the rima glottidis and the rima vestibuli**
- can be opened and closed by movement of the arytenoid cartilages and associated membranes.

Muscles

Intrinsic muscles

- Adjust tension in the vocal ligaments
- Open and close the rima glottidis
- Control the inner dimensions of the vestibule
- Close the rima vestibuli

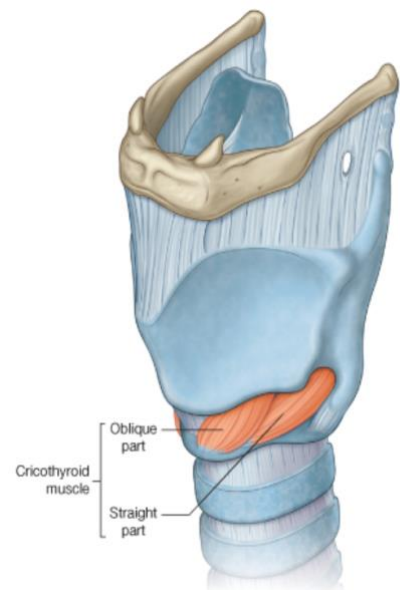
The muscles divided to three groups:

1. Group affect the inlet of the larynx
 - aryepiglottic muscle. (open the inlet)
 - transversus arytenoid muscle (narrow)
 - oblique arytenoid muscle (narrow)
2. Group affect the length and tense of the vocal cords
 - cricothyroid (tense the vocal cords)
 - thyroarytenoid (vocalis muscle) (relax the vocal cords)
3. Affect the abduction and adduction of vocal cords (rima glottidis)
 - lateral cricoarytenoid (adduction)
 - posterior cricoarytenoid (abduction)

Cricothyroid muscles

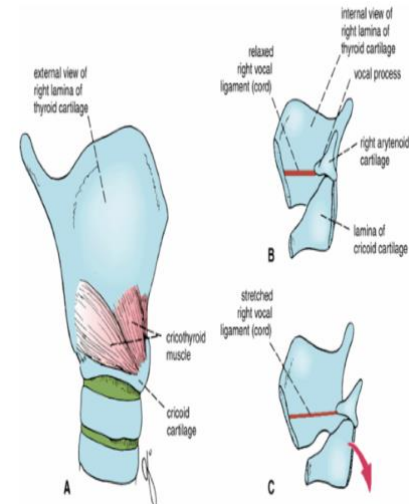
- Fan-shaped muscles
- Attached to the anterolateral surfaces of the cricoid cartilage and expand superiorly and posteriorly to attach to the thyroid cartilage
- Each muscle has an oblique part and a straight part:

The oblique part runs in a posterior direction from the arch of the cricoid to the inferior horn of the thyroid cartilage



The straight part runs more vertically from the arch of the cricoid to the posteroinferior margin of the thyroid lamina

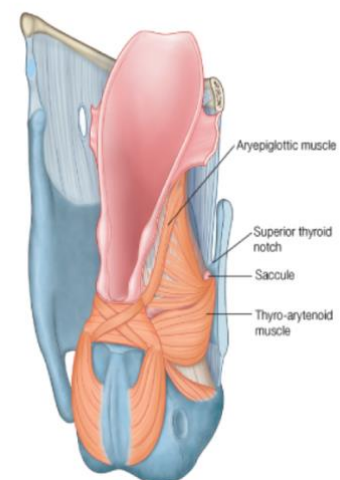
- Pull the thyroid cartilage forward and rotate it down relative to the cricoid cartilage
- these actions Tenses vocal cords (result in high pitch of voice)
- Are the only intrinsic muscles innervated by external laryngeal nerve which is branch of the superior laryngeal branches of the vagus nerves
- All other intrinsic muscles are innervated by the recurrent laryngeal branches of the vagus nerves



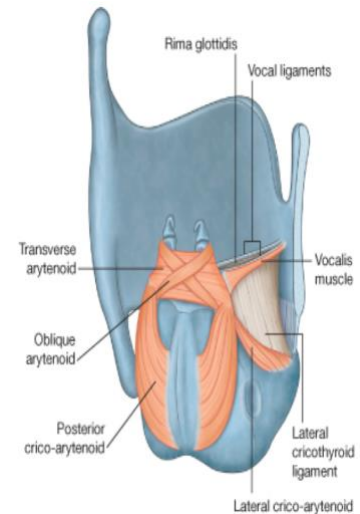
The external laryngeal nerve runs with **superior thyroid artery**, clinically : in thyroidectomy , the surgeon ligates the superior thyroid artery, the nerve may be accidentally cut, if the cut on one side this will result in low pitch of voice - weakness of the voice , while if it on both sides the result , hoarseness of the voice

Thyroarytenoid (vocalis)

- From the Inner surface of thyroid cartilage to the Arytenoid cartilage (when it reaches the arytenoid, runs with the vocal cord, so its from the content of vocal cord)
- Relaxes vocal cords
- Recurrent laryngeal nerve
- Posterior crico-arytenoid muscles



- There is a right and a left posterior crico-arytenoid
- The fibers of each muscle originate from the Back of cricoid cartilage , and run superiorly and laterally to the muscular processes of the arytenoid cartilage
- **Abducts** the vocal cords by rotating arytenoid cartilage (**external and posterior**)
- Innervated by the recurrent laryngeal branches of the vagus nerves

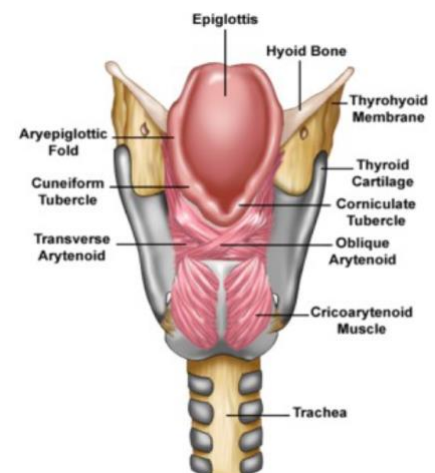


Lateral crico-arytenoid muscles

- Muscle on each side originates from the Upper border of cricoid cartilage, and runs posteriorly and superiorly to insert on the muscular process of the arytenoid
- **Adducts** the vocal cords by internally rotating arytenoid cartilage
- Innervated by the recurrent laryngeal

Transverse arytenoid

- Originates from Back and medial surface of arytenoid cartilage and insert in the Back and medial surface of opposite arytenoid cartilage
- Closes posterior part of rima glottidis by approximating arytenoid cartilages
- Recurrent laryngeal nerve

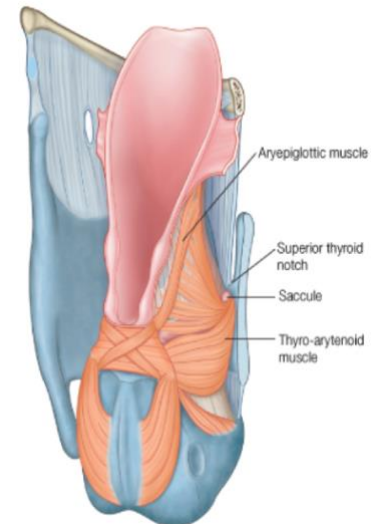


Oblique arytenoid

- From the Muscular process of arytenoid cartilage to the Apex of opposite arytenoid cartilage
- Narrows the inlet by bringing the aryepiglottic folds together
- Recurrent laryngeal nerve

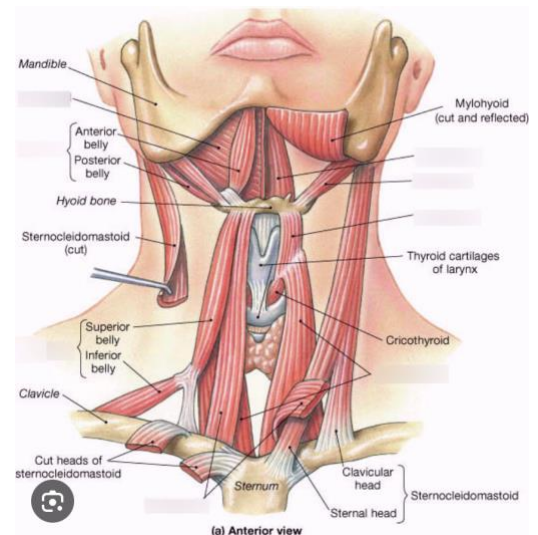
Thyroepiglottic (aryepiglottic muscles)

- From the Medial surface of thyroid cartilage to the Lateral margin of epiglottis and aryepiglottic fold
- Widens the inlet by pulling the aryepiglottic folds apart (not that imp function)
- Recurrent laryngeal nerve



Extrinsic muscles

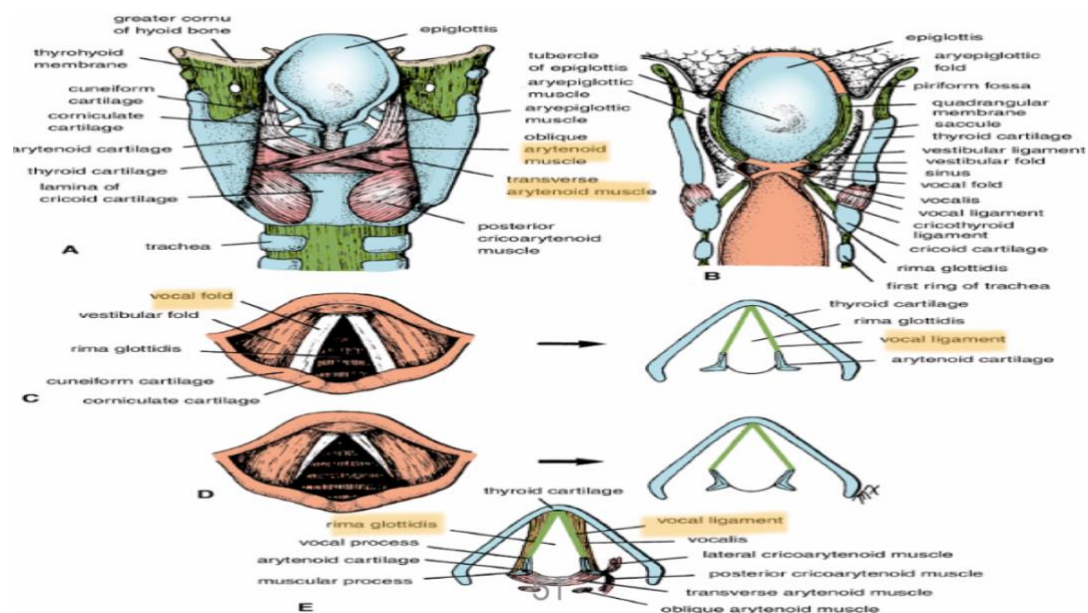
- Elevators of the larynx:
- 1. Digastric muscle
- 2. Stylohyoid
- 3. Mylohyoid (diaphragma oris) from mylohyoid line (2 muscles Lt and Rt , and meet in the midline
- 4. Geniohyoid from inferior genial tubercle → hyoid bone
- The larynx moves up in swallowing by these muscles assisted by :
- Stylopharngus, Salpingo-pharngus, And Palatopharngus.



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- Depressors of the larynx :
- 1. Sternothyroid
- 2. Sternohyoid sternum → hyoid
- 3. Omohyoid

Muscles and Cavity

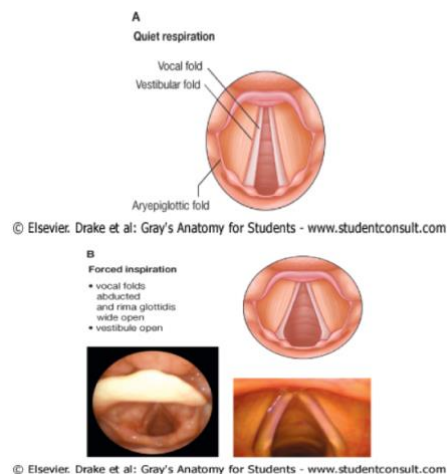


Function of the larynx

Respiration

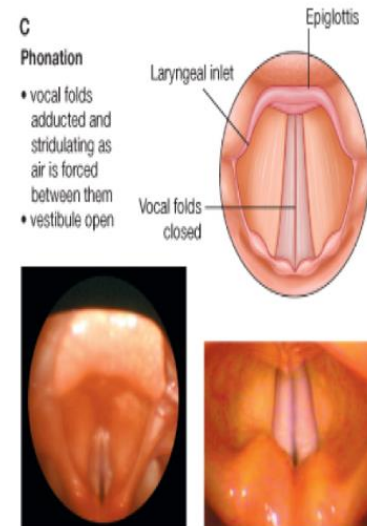
- During quiet respiration, the laryngeal inlet, vestibule, rima vestibuli, and rima glottidis are open
- During forced inspiration the arytenoid cartilages are rotated laterally, mainly by the action of the posterior crico-arytenoid muscles.

- As a result, the vocal folds are abducted, and the rima glottidis widens into a rhomboid shape, effectively increases the diameter of the laryngeal airway.



Phonation

- When phonating, the arytenoid cartilages and vocal folds are adducted and air is forced through the closed rima glottidis
- 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
- Tension in the vocal folds can be adjusted by the vocalis and cricothyroid muscles.

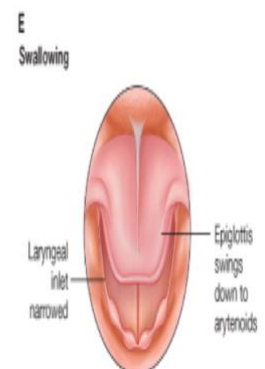


Effort closure

- 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 (**coughing**)
- The rima glottidis is completely closed, as is the rima vestibuli and lower parts of the vestibule
- The result is to completely and forcefully shut the airway.

Swallowing

- During swallowing, the rima glottidis, 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 **backward and 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

Arteries

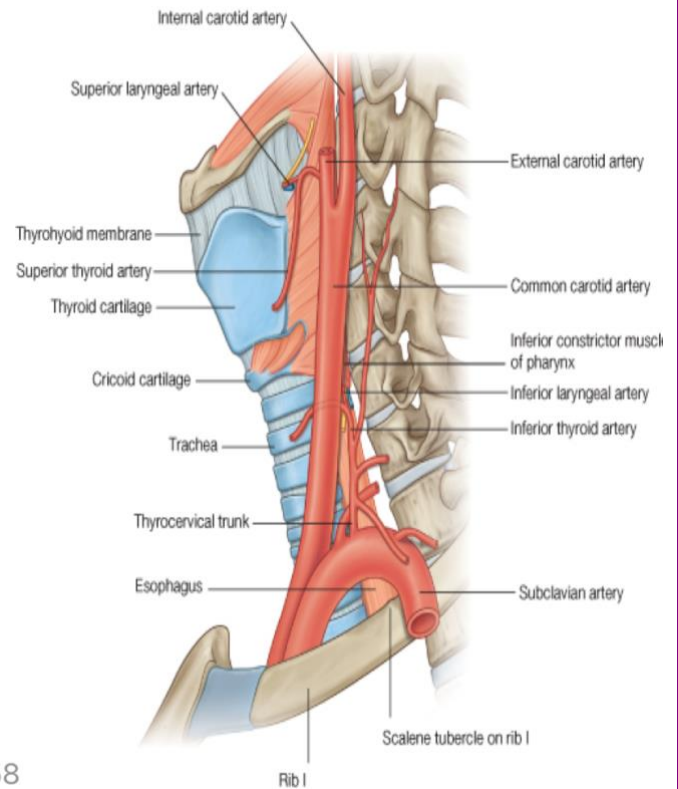
- The major blood supply to the larynx is by the superior and inferior laryngeal arteries
- The superior laryngeal artery originates from the superior thyroid branch of the external carotid artery,
- Accompanies the **internal branch** of the superior laryngeal nerve through the thyrohyoid membrane to reach the larynx.
- The inferior laryngeal artery originates from the inferior thyroid branch of the thyrocervical trunk of the subclavian artery

Note : the inferior THYROID artery runs along the

recurrent laryngeal nerve , same idea here , if we ligate this artery or its branch ILA , the nerve may be cut

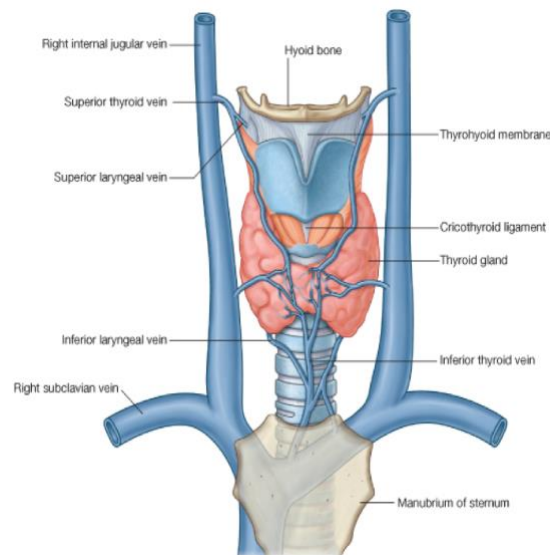
the result of the cut will mentioned at the end of sheet

- Together with the recurrent laryngeal nerve, ascends in the groove between the esophagus and trachea
- It enters the larynx by passing deep to the margin of the inferior constrictor muscle of the pharynx



Veins

- Veins draining the larynx accompany the arteries:
- Superior laryngeal veins drain into superior thyroid veins, which in turn drain into the internal jugular veins
- Inferior laryngeal veins drain into inferior thyroid veins, which drain into the left brachiocephalic veins (longer)



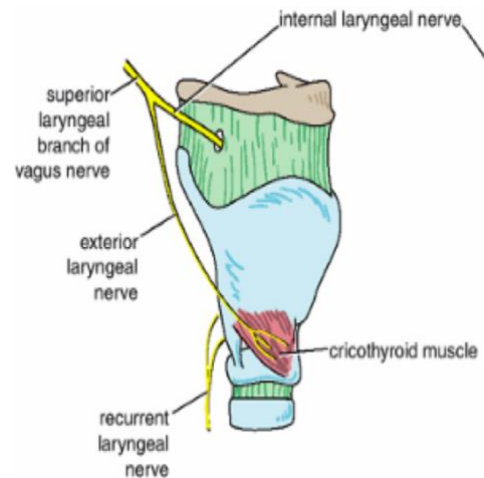
Lymphatics

- Lymphatics drain regions above and below the vocal folds:
- Those above the vocal folds follow the superior laryngeal artery and terminate in deep cervical nodes
- Those below the vocal folds drain into deep cervical nodes associated with the inferior thyroid artery
- Or with nodes associated with the front of the cricothyroid ligament or upper trachea (paratracheal lymph nodes) but then to deep cervical LN

Innervation

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) 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 passes anteroinferiorly to penetrate the thyrohyoid membrane
- Internal nerve is mainly sensory and supplies the laryngeal cavity down to the level of the vocal folds.

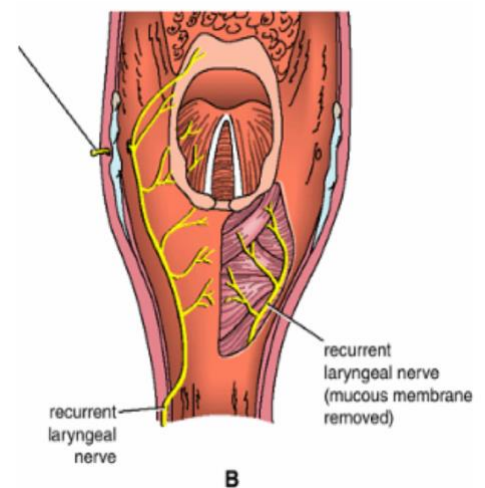


External Laryngeal nerve → motor to cricothyroid muscle
→ runs with superior thyroid A

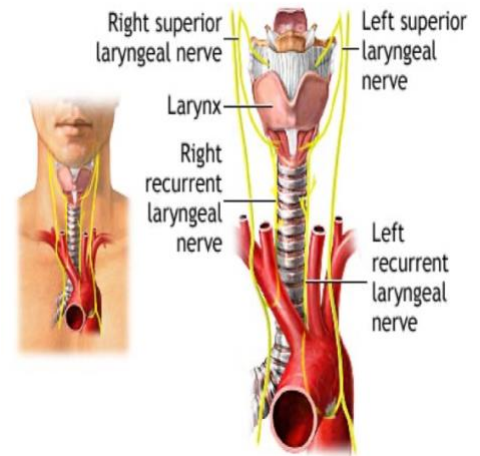
Internal Laryngeal nerve → sensory to the mucosa of the larynx **above** the true vocal cords

Recurrent laryngeal nerves

- The recurrent laryngeal nerves are:
- Sensory to the laryngeal cavity **below** the level of the vocal folds;
- Motor to all intrinsic muscles of the larynx except for the cricothyroid.
- The left recurrent laryngeal nerve (**longer**) originates in the thorax whereas the right recurrent laryngeal nerve originates in the root of the neck

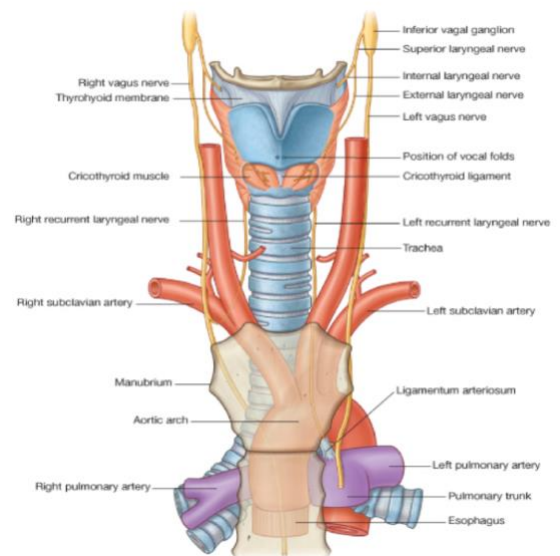


- Both nerves generally ascend in the neck in the groove between the esophagus and trachea



Relations of the larynx

- On each side:
- Carotid sheath (contents: CCA , jugular vein, vagus and sympathetic chain on posterior wall), and lateral lobe of the thyroid gland
- Posterior:
- Pharynx and the right recurrent laryngeal nerve
- Anterior:
- Skin, fascia and its contents, 4 infra-hyoid muscles



Clinical notes

Thyroidectomy

- 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 M.). On both sides result in hoarseness of voice

Section of the Recurrent laryngeal nerve important

Complete cut → no suffocation (the cords neither abdducted nor adducted [cadaveric position])

Partial cut → the superficial fibers injured which innervate the abductor muscles → if bilateral the cord adducted → suffocation , so we do to the patient (tracheostomy either emergency or surgical)

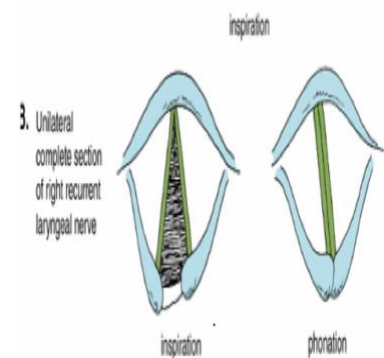
In 4 cases , look at respiration and speech

The most dangerous case regarding respiration : bilateral partial section

To loss the speech → bilateral

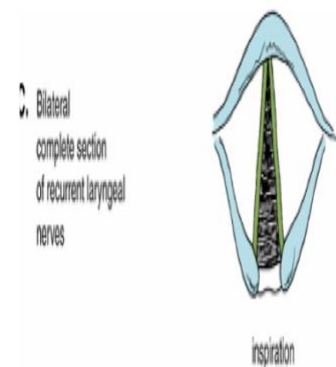
1. Unilateral complete section:

- One vocal fold (on the affected side) in the position midway between abducted and adducted
- Speech not greatly affected as the other vocal cord compensate for the action.



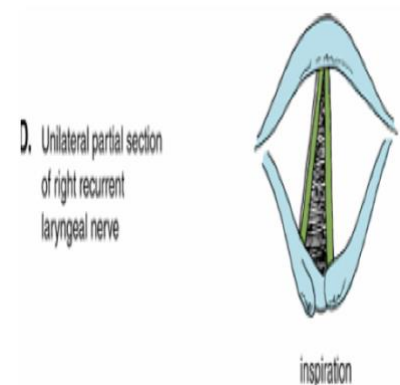
2. Bilateral complete section:

- Both vocal folds in position midway between abducted and adducted
- Breathing is impaired since the rima glottis is partially close and speech is lost



3. Unilateral partial section

- 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)



4. Bilateral partial section:

- This results 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

∴ Bilateral partial section of recurrent laryngeal nerves



Quick summary:

- 1) Laryngeal joints: Cricothyroid & cricoarytenoid joints
- 2) Laryngeal cavity (from the inlet to the inferior opening) has 3 compartments: supraglottic, glottic, inferaglottic
- 3) In laryngeal cavity we have aryepiglottic fold
- 4) Differences between true & false vocal
- 5) Laryngeal saccule in glottic cavity = mucosal secretion
- 6) Rima vestibuli & Rima glottidis= space between folds
- 7) Intrinsic muscles: Cricothyroid (external laryngeal) , thyroarytenoid, lateral cricoarytenoid, aryepiglottic, transverse & oblique Arytenoid
- 8) Extrinsic muscles
- 9) Function of larynx: respiratory, phonation, enclosure, swallowing
- 10) Blood mainly : superior & inferior laryngeal
- 11) Innervation: superior (external & internal) laryngeal nerve & recurrent laryngeal

Q & A:

- 1) Vocal ligament formed by:
 - a) Cricothyroid ligament
 - b) Quadrangular membrane
 - c) Conus elasticus
- 2) Innervated by recurrent laryngeal nerve and relaxes vocal cords:
 - A) Thyroarytenoid
 - B) Cricothyroid

Ans: C-A

V1