# LARYNX-TRACHEA

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# Respiratory System Anatomy

- Structurally
  - **Upper respiratory system**
    - Nose, pharynx, larynx and associated structures
  - **Lower respiratory system**
    - Trachea, bronchi and lungs
- Functionally
  - **Conducting zone** – conducts air to lungs
    - Nose, pharynx, larynx, trachea, bronchi, bronchioles and terminal bronchioles
  - **Respiratory zone** – main site of gas exchange
    - Respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli

# Larynx (Voice Box)

- Continuous with the trachea inferiorly
- The three functions of the larynx are:
  - To provide a **patent airway**
  - To **act as a switching mechanism to route air and food into the proper channels**
  - To function in **voice production**

- Organ of phonation (vocalization)
- Formed of cartilage, muscles and connective tissue
- Inner surface is covered by the respiratory mucosa
- Superiorly opens into the laryngopharynx, inferiorly continuous with the trachea
- Lies between the level of C3-C6 cervical vertebrae

# LARYNGEAL SKELETON

Skeleton of larynx is formed of 3 unpaired and 3 paired cartilages

- Unpaired cartilages
  - Thyroid cartilage
  - Cricoid cartilage
  - Epiglottic cartilage
- Paired cartilages
  - Arytenoid
  - Corniculate
  - Cuneiform

All of these cartilages ossify by age, except the ***epiglottic cartilage*** and ***vocal process of the arytenoid cartilages***.

## Thyroid cartilage

- Largest cartilage of the larynx
- Formed of two laminae which fuse anteriorly at the ***thyroid angle*** to form ***laryngeal prominence (Adam's apple)***
- Has superior and inferior thyroid notches, superior and inferior horns (cornu)

**Thyroid cartilage (continued)**

- Superior border of the thyroid cartilage attaches to the hyoid bone by ***thyrohyoid membrane***
    - Thyrohyoid membrane is pierced by the internal branch of the superior laryngeal nerve and the superior laryngeal vessels
    - Lateral part of the thyrohyoid membrane is called the ***lateral thyrohyoid ligament*** and its anterior part thickens to form the ***median thyrohyoid ligament***
- Inferior horn of the thyroid cartilage articulates with the lateral parts of the cricoid cartilage

## Cricoid cartilage

- A ring shaped cartilage
- Posterior part is called the ***lamina,*** anterior part is called ***arch***
- Attaches to the inferior part of the thyroid cartilage by the ***cricothyroid ligament***
- Inferiorly attaches to the first tracheal ring by the ***cricotracheal ligament***

## Epiglottic cartilage

- A heart shaped cartilage
- Inferior end is attached to the thyroid cartilage by the ***thyroepiglottic ligament***, which lies slightly superior to the attachment of the vocal ligaments
- Upper part is attached to the hyoid bone by the ***hyoepiglottic ligament***
- Most superior end is free
- **Epiglottis** – elastic cartilage that covers the laryngeal inlet during swallowing

## Arytenoid cartilages

- Pyramidal in shape
- Has three processes
  - Apex (superior), articulates with the corniculate cartilage
  - Vocal process (anterior), vocal ligament attaches here
  - Muscular process (lateral), posterior cricoarytenoid muscle and lateral cricoarytenoid muscle attaches here

**Extrinsic ligaments of the larynx**

Thyrohyoid membrane
- Median thyrohyoid ligament
- Lateral thyrohyoid ligaments

Hyoepiglottic ligament

Cricotracheal ligament

# FIBROELASTIC MEMBRANE OF THE LARYNX

- Lies under the mucosa of the larynx
- Has thickenings at certain regions and forms some of the ligaments between the cartilages
- Formed of two parts
  - **Conus elasticus**
  - **Quadrangular membrane**

# Conus elasticus (cricovocal membrane)

Has two parts

- Median cricothyroid ligament
  - Lies anteriorly between the cricoid and thyroid cartilages
- Lateral cricothyroid ligament
  - Extends superiorly from the upper margin of the cricoid cartilage and terminates with a free margin
  - Its free upper margin thickens to form the ***vocal ligament***, which is covered by mucosa to form the ***vocal fold***
  - The opening between the two vocal folds is called *rima glottis*

# CLINICAL NOTE

## Cricothyrotomy

In emergency situations, when the airway is blocked above the level of the vocal folds, the median cricothyroid ligament can be perforated and a small tube inserted through the incision to establish an airway. Except for small vessels and the occasional presence of a pyramidal lobe of the thyroid gland, normally there are few structures between the median cricothyroid ligament and the skin.

- Each **vocal ligament**, converges anteriorly and attaches to the anterior part of the inner surface of the thyroid cartilage (thyroid angle)

- Posteriorly they individually attach to the vocal processes of the arytenoid cartilages

- Vocal ligament is covered by mucosa to form the ***vocal fold (true vocal folds)***

# Quadrangular membrane

- A thin submucosal connective tissue extending between the lateral parts of epigliottic and arytenoid cartilages

- Its free superior margin forms the *aryepiglottic ligament*, which is covered by mucosa to form the *aryepiglottic fold* (cuneiform and corniculate cartilages lies within this fold)

- Its free inferior margin forms the ***vestibular ligament***, which is covered by mucosa to form the ***vestibular fold (false vocal fold)***

# INTERIOR OF THE LARYNX

- Interior of the larynx is covered by the respiratory mucosa
- Extends between the laryngeal inlet to the inferior border of the cricoid cartilage
- Divided into three parts
  - Vestibule (lies superior to vestibular folds)
  - Ventricles (lies between the vestibular and vocal folds)
  - Infraglottic cavity (lies inferior to vocal folds)

## Rima glottis

- Opening between the two vocal folds (true vocal folds) is called the ***rima glottis***
- Rima glottis widens during inspiration and two vocal folds are approximated during phonation
- Various changes of the vocal folds determine the color, pitch and the tones of sound
  - Pitch increase with tensing, decreases by relaxation
  - Intensity of expiration determines the loudness of sound

# LARYNGEAL MUSCLES

- **Extrisic muscles** (covered in the neck)
  - These are suprahyoid and infrahyoid muscles
    - They either depress or elavate the larynx and hyoid bone
- **Intrinsic muscles** (will be covered here)
  - Move the laryngeal parts
  - There are six intrinsic muscles

## Cricothyroid muscle

Tenses the vocal folds by pulling the thyroid cartilage anteroinferiorly (to produce high pitch sound)

## Posterior cricoarytenoid muscle

- The only muscle widening the rima glottis
- Inserts to the muscular process of the arytenoid

## Lateral crico-arytenoid muscle

- Approximates the vocal processes thus, narrowing the anterior part of rima glottis (contracts alone during whispering)
- Inserts to the muscular process of the arytenoid

## Thyroarytenoid muscle

Relaxes the vocal folds by pulling the arytenoid cartilages anteriorly (to produce low pitch sounds)

# Vocalis muscle

- The most medial fibers of thyroarytenoid muscle form the vocalis muscle
- Make minute adjustments to the sound by contracting and relaxing which will increase and decrease the pitch as in singing

## Arytenoid muscle

- Has transverse and oblique parts, both parts approximate the arytenoid cartilages
- Acting together with the lateral cricoarytenoids, fully narrows the rima glottis (normal phonation occur when air is blown in this position)
- In case the lateral cricoarytenoids contract without the contraction of the arytenoids, the posterior part of the rima glottis remains open (this is the position of the rima glottis during whispering)

All of the intrinsic muscles are innervated by the ***inferior (recurrent) laryngeal nerve*** except the ***cricothyroid muscle***, which is innervated by the ***external laryngeal nerve*** (branch of the superior laryngeal nerve)

Both the inferior and superior laryngeal nerves are branches of **vagus nerve (CN X)**

**Nerves (continued)**

Internal laryngeal nerve (sensory and autonomic)

- Pierces the thyrohyoid membrane together with the superior laryngeal artery
- Supplies the mucosa superior to the vocal folds

External laryngeal nerve (motor)

- Innervates the cricothyroid muscle

Inferior (recurrent) laryngeal nerve (motor and sensory)

- Supplies all the of the intrinsic muscles, except the cricothyroid
- Supplies the mucosa inferior to the vocal folds

## CLINICAL NOTE

## Injury to the recurrent laryngeal nerve

- With bilateral injury to the recurrent laryngeal nerve the voice is almost absent, as the vocal folds can not adduct

- In unilateral injury the voice is poor initially, but recovers to some extend as the contralateral vocal fold crosses the midline as the muscles of the intact side contracts to compensate

## CLINICAL NOTE

## Injury to the superior laryngeal nerve

- Injury to the superior laryngeal nerve leads to the loss of sensation within the superior part of larynx, protective coughing reflex will be inactive (due to the impairment of the external branch)

- The voice will become monotonous, as the pitch can not be altered as the cricothroid muscle is paralysed (due to the impairment of the internal branch)

**Arteries of the larynx**

Superior and inferior laryngeal arteries (branches of superior and inferior thyroid arteries respectively)

## Veins of the larynx

- Drains into the superior and inferior laryngeal veins (which in turn drain into the superior and inferior thyroid veins)

## Lymphatic drainage

- Lymph vessels from the superior part of vocal folds drain into the superior deep cervical lymph nodes

- Lymph from the inferior part of the vocal folds drain into inferior deep cervical lymph nodes

# Trachea (Windpipe)

- Connects larynx with bronchi
- Extends from larynx to superior border of T5
    - Terminates by dividing into right and left main bronchi

  divides into right and left primary bronchi
- Walls are reinforced with C-shaped hyaline cartilage
- Anterior to oesaphagus

- Trachea is formed of ***tracheal rings*** which are incomplete posteriorly
- Posterior parts of the tracheal rings are closed by smooth muscle called the ***trachealis muscle***
- Trachea is enclosed with a fibroelastic membrane
  - This membrane thickens between the tracheal rings to form ***anular ligaments (tracheal ligaments)*** between the adjacent rings

## CLINICAL NOTE

## Tracheostomy

- Tracheostomy is performed in upper airway obstruction or respiratory failure
- A tracheostomy tube is inserted between tracheal rings 1-2, 2-3 or 3-4