The Larynx

Prof. Dr. Mohammed Hisham Al-Muhtaseb
The Larynx

- Extends from the middle of C3 vertebra till the level of the lower border of C6
- Continue as Trachea
- Above it opens into the laryngo-pharynx
- Suspended from the hyoid bone above and attached to the trachea below by membranes and ligaments
Functions

• 1. acts as an open valve in respiration

• 2. Acts as a closed valve in deglutition

• 3. Acts as a partially closed valve in the production of voice

• 4. During cough it is first closed and then open suddenly to release compressed air
Parts

• 1. Cartilage

• 2. Mucosa

• 3. Ligaments

• 4. Muscles
Cartilage

A. Single:
   - Epiglottis
   - Cricoid
   - Thyroid

B. Pairs:
   - Arytenoid
   - Cuneiform
   - Corniculate
Cricoid cartilage

- The most inferior of the laryngeal cartilages
- Completely encircles the airway
- Shaped like a 'signet ring'
- Broad lamina of cricoid cartilage posterior
- Much narrower arch of cricoid cartilage circling anteriorly.
Cricoid cartilage

- Posterior surface of the lamina has two oval depressions separated by a ridge

- The esophagus is attached to the ridge

- Depressions are for attachment of the posterior crico-arytenoid muscles.

- Has two articular facets on each side

- One facet is on the sloping superolateral surface and articulates with the base of an arytenoid cartilage;

- The other facet is on the lateral surface near its base and is for articulation with the inferior horn of the thyroid cartilage
Thyroid cartilage

- The largest of the laryngeal cartilages

- It is formed by a right and a left lamina

- Widely separated posteriorly, but converge and join anteriorly

- Posterior margin of each lamina is elongated to form a superior horn and an inferior horn
Thyroid cartilage

- Most superior point of the site of fusion between the two laminae is the **laryngeal prominence** ('Adam's apple')

- Angle between the two laminae is more acute in men (90°) than in women (120°)

- Superior to the laryngeal prominence, the **superior thyroid notch** separates the two laminae

- Superior thyroid notch and the laryngeal prominence are **palpable** landmarks in the neck

- Less distinct **inferior thyroid notch** in the midline along the base of the thyroid cartilage.
Thyroid cartilage

- The medial surface of the inferior horn has a facet for articulation with the cricoid cartilage;

- The superior horn is connected by a ligament to the posterior end of the greater horn of the hyoid bone.

- Lateral surface of lamina is marked by a ridge (the oblique line), which curves anteriorly from the base of the superior horn to the inferior margin of the lamina.

- Ends of the oblique line are expanded to form superior and inferior thyroid tubercles

- The oblique line is a site of attachment for the extrinsic muscles of the larynx (sternothyroid, thyrohyoid, and inferior constrictor).
Epiglottis

- Is a 'leaf-shaped' cartilage attached by its stem to the angle of the thyroid cartilage.

- Projects posterolaterally from its attachment to the thyroid cartilage.

- The attachment is via the **thyro-epiglottic ligament** in the midline between the laryngeal prominence and the inferior thyroid notch.

- The upper margin of the epiglottis is behind the pharyngeal part of the tongue.

- The inferior half of the posterior surface of the epiglottis is raised slightly to form an **epiglottic tubercle**.
Arytenoid cartilages

- Two arytenoid cartilages are pyramid-shaped cartilages with three surfaces.

- Base of arytenoid cartilage and an Apex of arytenoid cartilage.

- The base of arytenoid cartilage is concave and articulates with the facet on the superolateral surface of the cricoid cartilage;

- The apex of arytenoid cartilage articulates with a corniculate cartilage;

- The medial surface of each cartilage faces the other;
Arytenoid cartilages

• The **anterolateral surface** has two depressions, separated by a ridge, for **muscle (vocalis) and ligament (vestibular ligament)** attachment.

• The anterior angle of the base of arytenoid cartilage is elongated into a **vocal process** to which the **vocal ligament** is attached.

• The lateral angle is similarly elongated into a **muscular process** for attachment of the posterior and lateral crico-arytenoid muscles.
Corniculate and Cuneiform

- The **corniculate** cartilages are two small conical cartilages

- Bases articulate with the apices of the arytenoid cartilages

- Their apices project posteromedially towards each other.

- The **Cuneiform** are two small club-shaped cartilages

- Lie anterior to the corniculate cartilages

- Suspended in the part of the fibroelastic membrane that attaches the arytenoid the epiglottis.
Ligaments
Extrinsic ligaments

• Thyrohyoid membrane
• Hyo-epiglottic ligament
• Cricotracheal ligament
Thyrohyoid membrane

• Tough fibroelastic ligament that spans between the superior margin of the thyroid cartilage below and the hyoid bone

• Attached to the thyroid laminae and adjacent anterior margins of the superior horns

• Ascends medial to the greater horns and posterior to the body of the hyoid bone to attach to the superior margins of these structures.

• An aperture in the lateral part of the thyrohyoid membrane on each side is for the superior laryngeal arteries, nerves, and lymphatics
Thyrohyoid membrane

• The posterior borders of the thyrohyoid membrane are thickened to form the lateral thyrohyoid ligaments.

• Also thickened anteriorly in the midline to form the median thyrohyoid ligament.

• Occasionally, there is a small cartilage (triticeal cartilage) in each lateral thyrohyoid ligament.
Extrinsic ligaments

- **Cricotracheal ligament** runs from the lower border of the cricoid cartilage to the adjacent upper border of the first tracheal cartilage.

- **The hyo-epiglottic ligament** extends from the midline of the epiglottis, anterosuperiorly to the body of the hyoid bone.
Intrinsic ligaments

• The fibro-elastic membrane of larynx links together the cartilages and completes the architectural framework of the laryngeal cavity

• It is composed of two parts—a lower cricothyroid ligament and an upper quadrangular membrane.
Cricothyroid ligament

- Cricovocal membrane or cricothyroid membrane

- Attached to the arch of cricoid cartilage and extends superiorly

- End in a **free upper margin** within the space enclosed by the thyroid cartilage

- Upper free margin attaches:
  - **Anteriorly** to the thyroid cartilage;
  - **Posteriorly** to the vocal processes of the arytenoid cartilages.

- The free margin is thickened to form the **vocal ligament**, which is under the vocal fold (true 'vocal cord') of the larynx.

- The cricothyroid ligament is also thickened anteriorly to form a **median cricothyroid ligament**

- *In emergency situations, the median cricothyroid ligament can be perforated to establish an airway*
Quadrangular membrane

- Runs between the lateral margin of the epiglottis and the anterolateral surface of the arytenoid cartilage
- Attached to the corniculate cartilage
- Free upper margin and a free lower margin
- **Free lower margin** is thickened to form the vestibular ligament under the vestibular fold (false 'vocal cord')
Quadrangular membrane

- Vestibular ligament is separated from the vocal ligament below by a gap.
- When viewed from above the vestibular ligament is **lateral** to the vocal ligament.
Cartilage and Ligaments
Laryngeal joints
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 downwards** on the cricoid cartilage

- Forward movement and downward rotation of the thyroid cartilage effectively **lengthens and puts tension on the vocal ligaments**
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
Cavity of the larynx
Laryngeal cavity

- 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 is oblique and points posterosuperiorly.
laryngeal inlet

- Anterior border is formed by mucosa covering the superior margin of the *epiglottis*.

- Lateral borders are formed by mucosal folds (*aryepiglottic folds*).

- Posterior border in the midline is formed by a mucosal fold that forms a depression (*interarytenoid notch*) between the two corniculate tubercles.

![Laryngeal cavity diagram](image)
- 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;
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.
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

• The vestibule 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;
Division into three major regions

• The **middle part** of the laryngeal cavity is very thin and is between the vestibular folds above and the vocal folds below.

• **Vocal folds enclose the vocal ligaments and related soft tissues below.**

• The **infraglottic space** is the most inferior chamber and is between the vocal folds and the inferior opening of the larynx;
Vocal Folds

- Consist of:
  - Vocal ligament
  - Mucous membrane (stratified squamous)
  - Vocalis muscle
  - No submucosa
  - No blood vessels (white in color)
  - On each side extend between the vocal process of the arytenoid and the back of the anterior lamina of thyroid.
  - Longer in male which cause the difference of the pitch of the voice between genders
Vestibular folds

- False vocal cords

- Vestibular folds enclose the vestibular ligaments and associated soft tissues

- Vascularised (red in color)

- Fixed and not movable unlike the vocal cord

- Superior to the vocal cord
Laryngeal ventricles and saccules

- On 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 saccule) projects anterosuperiorly between the vestibular fold and thyroid cartilage.

- Within the walls of these laryngeal saccules are numerous mucous glands.

- Mucus secreted into the saccules lubricates the vocal folds.
Rima vestibuli and rima glottidis

- **Rima vestibuli** 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.
Rima vestibuli and rima glottidis

- **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.

- 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
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

Cricothyroid muscles

- Pull the thyroid cartilage **forward** and **rotate** it down relative to the cricoid cartilage

- These actions **Tenses vocal cords**

- Are the only intrinsic muscles innervated by the **superior laryngeal branches** of the vagus nerves

- All other intrinsic muscles are innervated by the **recurrent laryngeal branches** of the vagus nerves
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

- 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
Thyroarytenoid (vocalis)

- From the Inner surface of thyroid cartilage to the Arytenoid cartilage
- Relaxes vocal cords
- 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

- Recurrent laryngeal nerve
Extrinsic muscles

• Elevators of the larynx:
  • 1. Digastric muscle
  • 2. Stylohyoid
  • 3. Myelohyoid
  • 4. Geniohyoid

• The larynx moves up in swallowing by these muscles assisted by:
  • Stylopharngeus, Salpingo-pharngeus, And Palatopharngeus.

• Depressors of the larynx:
  • 1. Sternothyroid
  • 2. Sternohyoid
  • 3. Omohyoid
Muscles and Cavity

greater cornu of hyoid bone
thyrohyoid membrane
cuneiform cartilage
corniculate cartilage
arytenoid cartilage
thyroid cartilage
lamina of cricoid cartilage
epiglottis
tubercle of epiglottis
aryepiglottic muscle
aryepiglottic muscle
oblique arytenoid muscle
transverse arytenoid muscle
posterior cricoarytenoid muscle
trachea
first ring of trachea
vocal fold
vestibular fold
rima glottidis
cuneiform cartilage
corniculate cartilage
thyroid cartilage
vocal ligament
arytenoid cartilage
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.

- 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 **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.
Arteries

- The **inferior laryngeal artery** originates from the inferior thyroid branch of the thyrocervical trunk of the subclavian artery.

- 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.
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 nodes associated with the inferior thyroid artery

• Or with nodes associated with the front of the cricothyroid ligament or upper trachea.
Innervations
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**;
Superior laryngeal nerves

- 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**.
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**.
Recurrent laryngeal nerves

- The **left** recurrent laryngeal nerve 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

- Enter the larynx deep to the margin of the inferior constrictor
Relations of the larynx

- On each side:
  - Carotid sheath (contents), 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 (criciothyroid M.).
Section of the Recurrent laryngeal nerve

• 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.
Section of the Recurrent laryngeal nerve

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
Section of the Recurrent laryngeal nerve

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).
Section of the Recurrent laryngeal nerve

4. Bilateral partial section:

- 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
Thank you