

Larynx

Larynx – Introduction

- The **larynx** (voice box) is a **part of the respiratory system** located in the anterior midline of the neck.
 - It serves as a **passage for air**, a **sphincter** at the inlet of the lower respiratory tract, and is the **organ of phonation**.
 - It lies opposite **C3 to C6 vertebrae** in adults; slightly higher (C1–C4) in children and females.
 - **Length:** 44 mm in males, 36 mm in females.
 - **Pubertal change:** The male larynx enlarges rapidly, forming the **Adam's apple** and producing a **deeper voice**.
 - **Internal diameter:** 3 mm in infants, 12 mm in adults.
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Constitution of Larynx

The larynx consists of:

- **Framework:** 9 cartilages (3 unpaired + 3 paired).
- **Connections:** Joints, ligaments, and membranes linking the cartilages.
- **Muscles:** Intrinsic and extrinsic muscles that move the cartilages.

- **Lining:** Entire cavity covered by **mucous membrane**.
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Dissection Steps

1. Identify **sternothyroid** and **thyrohyoid** muscles.
 2. Locate **thyrohyoid membrane**, pierced by **superior laryngeal vessels** and **internal laryngeal nerve**.
 3. Note **cricothyroid muscle** externally — the only intrinsic muscle visible from outside.
 4. Observe the **cricothyroid joint** between the **inferior horn of thyroid cartilage** and **cricoid cartilage**.
 5. Identify **epiglottis**, **thyroepiglottic** and **hyoepiglottic ligaments**.
 6. Expose **posterior cricoarytenoid**, **transverse arytenoid**, and **oblique arytenoid** muscles.
 7. Recognize that **recurrent laryngeal nerve** enters the larynx deep to **inferior constrictor muscle**.
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Cartilages of Larynx

Total 9 Cartilages:

- **Unpaired (3):**

1. **Thyroid cartilage** – shield-shaped, forms laryngeal prominence.
2. **Cricoid cartilage** – ring-shaped, complete circular cartilage at base of larynx.

3. **Epiglottis** – leaf-shaped, acts as a lid over the glottis during swallowing.

- **Paired (3):**

1. **Arytenoid** – pyramid-shaped, attached to vocal cords; control movements for phonation.
2. **Corniculate** – small conical nodules on the apices of arytenoids.
3. **Cuneiform** – small rod-like cartilages within aryepiglottic folds.

Key Points:

- **Hyaline cartilage:** Thyroid, cricoid, and base of arytenoids; may ossify after age 25.
- **Elastic cartilage:** Epiglottis, corniculate, cuneiform, and processes of arytenoid; do not ossify.

Laryngeal Joints

1. **Cricothyroid Joint**

- **Type:** Synovial joint.
- **Between:** Inferior cornu of thyroid cartilage and side of cricoid cartilage.
- **Movements:**
 - Rotation around a transverse axis ? *tension and relaxation of vocal cords.*
 - Slight gliding movements also occur.

- **Function:** Adjusts pitch by stretching or relaxing vocal cords.

2. Cricothyroid Joint

- **Type:** Synovial joint.
 - **Between:** Base of arytenoid cartilage and upper border of cricoid lamina.
 - **Movements:**
 - Rotation around a vertical axis ? *adduction and abduction of vocal cords.*
 - Gliding movements in all directions.
 - **Function:** Controls opening and closing of the glottis.
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Laryngeal Ligaments and Membranes

A. Extrinsic Ligaments

1. **Thyrohyoid membrane** – between thyroid cartilage and hyoid bone; pierced by **internal laryngeal nerve** and **superior laryngeal vessels**.
2. **Hyoepiglottic ligament** – connects upper end of epiglottis to hyoid bone.
3. **Cricotracheal ligament** – connects lower border of cricoid cartilage to first tracheal ring.

B. Intrinsic Ligaments

- Formed by **fibroelastic membrane of larynx** divided by the sinus into two parts:
 1. **Quadrangle membrane (upper part):**

- Extends from arytenoid cartilage to epiglottis.
- Upper border ? **aryepiglottic fold**.
- Lower border ? **vestibular fold**.

2. **Conus elasticus (lower part):**

- Extends upward and medially from arch of cricoid cartilage.
 - Anterior thickened part ? **cricothyroid ligament**.
 - Upper free border ? **vocal fold (true vocal cord)**.
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Cavity of Larynx

1. **Extent:** From the **laryngeal inlet** to the **lower border of cricoid cartilage**.

2. **Laryngeal inlet:**

- Opens upward and backward into the **laryngopharynx**.

- **Boundaries:**

- Anterior – epiglottis
- Posterior – interarytenoid fold
- Lateral – aryepiglottic folds

3. **Subdivisions of cavity:**

- **Vestibule (supraglottis):** Above vestibular folds.
- **Sinus or ventricle:** Between vestibular and vocal folds.
- **Infraglottic cavity:** Below the vocal folds.

4. **Rima glottidis (glottic chink):**

- Opening between vocal folds; narrowest part of the larynx.
- Divided into:
 - *Intermembranous part (3/5)* – between vocal folds.
 - *Intercartilaginous part (2/5)* – between arytenoid cartilages.
- **Length:** ~23 mm in males; 17 mm in females.

5. **Sacculae of the larynx:**

- Upward extension of the ventricle; lined with mucous glands that **lubricate vocal cords** (“oil can of the larynx”).

Mucous Membrane of the Larynx

- **Lining epithelium:**

- **Stratified squamous epithelium:** Over epiglottis (anterior surface), upper part of aryepiglottic folds, and vocal folds.
- **Ciliated columnar epithelium:** Remainder of laryngeal cavity.

- **Attachment:** Loosely attached except over **vocal cords** and **posterior surface of epiglottis**, where it is tightly adherent.
 - **Mucous glands:**
 - Absent over vocal cords.
 - Abundant over epiglottis, vestibular folds, and near cuneiform cartilages.
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Clinical Anatomy

- **Foreign body aspiration:** Most foreign bodies lodge in the **glottis** — the narrowest part of airway.
- **Laryngitis:** Inflammation of mucosa ? **hoarseness** of voice.
- **Laryngeal oedema:** Can obstruct airway; may result from infection or allergy.
- **Singer's / Teacher's nodules:** Small nodules at junction of anterior one-third and posterior two-thirds of vocal cords due to overuse.
- **Piriform fossa:** Lies between quadrangle membrane and thyroid cartilage; pierced by **internal laryngeal nerve** — accidental injury can cause loss of sensation in upper larynx.
- **Referred ear pain:** Laryngeal tumours can cause ear pain via **auricular branch of vagus nerve**.
- **Foreign bodies:**
 - Large ? may cause suffocation by blocking the inlet.

- Small ? may lodge in ventricle and trigger **reflex glottic closure**.
- **Smuggler's fossa:** Piriform fossa historically used to hide small objects like gems.
- **Laryngoscopy:**
 - *Indirect laryngoscopy:* Mirror examination.
 - *Fibreoptic laryngoscopy:* Under local anaesthesia for visualization.
 - *Microlaryngoscopy:* Under microscope to excise vocal cord lesions.

Intrinsic Muscles of the Larynx

Nerve supply

- All intrinsic muscles are supplied by the **recurrent laryngeal nerve**, **except** the **cricothyroid**, which is supplied by the **external laryngeal nerve**.

Muscles Acting on the Vocal Cords

FUNCTION	MUSCLES INVOLVED	KEY ACTIONS
Abductor	Posterior cricoarytenoid	Opens the rima glottidis by rotating the arytenoid cartilage laterally; called the “safety muscle of larynx.”
Adductors	Lateral cricoarytenoid, Transverse arytenoid, Oblique arytenoid	Close the glottis by bringing vocal cords together for phonation and cough reflex.

FUNCTION	MUSCLES INVOLVED	KEY ACTIONS
Tensors	Cricothyroid	Rocks thyroid cartilage forward and downward, tightening and elongating the vocal cords to raise pitch.
Relaxors	Thyroarytenoid, Vocalis	Pull arytenoid cartilage forward, shortening and relaxing the cords to lower pitch.

Muscles Acting on the Laryngeal Inlet

FUNCTION	MUSCLES INVOLVED	DESCRIPTION
Close inlet	Aryepiglottic, Oblique arytenoid	Approximate arytenoids and pull epiglottis backward to close the laryngeal inlet during swallowing.
Open inlet	Thyroepiglottic	Widens inlet by pulling epiglottis forward after swallowing.

Muscles Elevating or Depressing the Larynx

MOVEMENT	MUSCLES
Elevation	Thyrohyoid, mylohyoid
Depression	Sternothyroid, sternohyoid

Clinical Anatomy

- **Foreign body reflex:** Entry of a foreign body into the larynx elicits **violent cough**; loss of internal laryngeal nerve function abolishes this reflex ? foreign bodies may enter silently.
- **External laryngeal nerve injury:** Causes **weakness of phonation** due to paralysis of cricothyroid ? inability to tense the vocal cords (monotone voice).
- **Unilateral recurrent laryngeal nerve injury:** Vocal cord on the affected side lies **paramedian**; phonation possible but **voice hoarse**, and cough is weak.
- **Bilateral recurrent laryngeal nerve injury:** Both cords fixed in **cadaveric position** (half-open) ? **aphonia** and **respiratory difficulty**.
- **Carcinoma of glottis:** Spreads slowly because the **vocal cords lack lymphatics** — hence best prognosis.
- **Supraglottic or subglottic carcinoma:** Spread occurs via lymphatics to **deep cervical nodes** along superior and inferior thyroid vessels.

Movements of Vocal Folds

Movements of the vocal folds determine the **shape and size of the rima glottidis** (the space between them):

1. Quiet Breathing (Rest):

- Intermembranous part ? *triangular*
- Intercartilaginous part ? *quadrangular*
- Glottis partially open.

2. Phonation (Speech):

- Vocal folds are **adducted**, reducing the glottis to a narrow slit (*chink*).
- Air passing through produces sound vibrations.

3. Forced Inspiration:

- Both parts of rima are **triangular**.
- Glottis becomes **lozenge- or diamond-shaped** due to full abduction of vocal folds.

4. Whispering:

- Intermembranous part is **closed**, but intercartilaginous part remains **open**.
- Results in a **funnel-shaped glottis**.

Infant's Larynx

- **Shape:** Short and **funnel-shaped**.
- **Size:** About **one-third** that of an adult.
- **Lumen:** Very narrow ? prone to obstruction.
- **Position:** Higher in neck — opposite **C1–C4** vertebrae (compared to C3–C6 in adults).
- **Epiglottis:** At level of **C2**, reaches **C1** during elevation, enabling **simultaneous suckling and breathing**.
- **Cartilages:** Soft and pliable; thyroid cartilage short and broad.
- **Vocal cords:** 4–4.5 mm long (shorter than in adults).

- **Mucosa:** Lax, especially in supraglottic and subglottic areas — oedema may cause **respiratory distress**.
- **Clinical Note:** Extreme care is needed during **anaesthesia** in infants due to narrow airway

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Mechanism of Speech

Speech production involves **four coordinated components**:

1. Expired Air (Energy Source):

- Expelled air from lungs and larynx generates voice.
- **Loudness** depends on the **force of expiration**.

2. Vibrators (Sound Generators):

- Vocal cords vibrate as air passes through.
- **Pitch** depends on the **rate of vibration** — controlled by cord tension and length.
- **Vowels** are produced mainly by these vibrations.

3. Resonators (Quality Modifiers):

- Air columns between vocal cords, mouth, and nasal cavity amplify and modify tone.
- Quality of voice depends on resonating chambers — explains why voices sound distinct.

4. Articulators (Speech Formers):

- Include **palate, tongue, teeth, and lips**.
- They shape airflow into distinct sounds.
- **Vowels** – from vocal cord vibration.
- **Consonants** – by modifying or obstructing airflow via articulators.

Examples:

- **Labial sounds:** Pa, Pha, Ba, Bha, Ma
- **Labiodental:** Ta, Tha, Da, Dha, Na
- **Lingual:** Cha, Ja, Jha
- **Palatal:** Ka, Kha, Ga, Gha

Clinicoanatomical Problem

A patient presents with **severe infection of the larynx** and **high fever**, followed by **inability to speak or breathe**.

Question:

Which muscles are likely paralyzed, causing extreme difficulty in breathing?

Answer:

- The infection has affected the **branches of the recurrent laryngeal nerve** supplying the **posterior cricoarytenoid muscles**.

- These are the **only abductors of the vocal cords**.
 - When they are paralyzed, the **vocal cords remain adducted**, leading to **airway obstruction** and **severe respiratory distress**.
 - **Treatment:** If infection does not resolve promptly, **tracheostomy** may be necessary to restore breathing.
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Summary of Laryngeal Muscle Actions

- **Abduction of vocal cords:** Posterior cricoarytenoid
- **Adduction of vocal cords:** Lateral cricoarytenoid, transverse arytenoid, oblique arytenoid
- **Opening of laryngeal inlet:** Thyroepiglottic
- **Closing of laryngeal inlet:** Aryepiglottic
- **Tensing of vocal cords:** Cricothyroid
- **Relaxing of vocal cords:** Thyroarytenoid

Clinicoanatomical Problem 1: Recurrent Laryngeal Nerve Injury

Case:

A thyroidectomy patient complains of a **hoarse voice** and **weak cough** post-surgery.

Explanation:

- The **recurrent laryngeal nerve** (branch of vagus) may have been injured.

- It supplies **all intrinsic muscles** of the larynx except **cricothyroid**.
 - Paralysis leads to the **vocal cord resting in a paramedian position**, causing **hoarseness**.
 - Bilateral injury results in **airway obstruction** requiring **tracheostomy**.
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Clinicoanatomical Problem 2: External Laryngeal Nerve Injury

Case:

A singer experiences **monotone voice** after ligation of the **superior thyroid artery** during surgery.

Explanation:

- The **external laryngeal nerve**, which runs with the **superior thyroid artery**, supplies **cricothyroid**.
 - Its injury prevents **tensing of vocal cords**, resulting in **loss of pitch modulation** and a **monotone voice**.
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Clinicoanatomical Problem 3: Laryngeal Oedema

Case:

A child with upper respiratory infection suddenly develops **stridor and difficulty breathing**.

Explanation:

- Due to the **narrow lumen** and **loose submucosa** in the **subglottic region**, oedema can **quickly occlude the airway**.
 - This is an emergency requiring **tracheostomy or intubation**.
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Clinicoanatomical Problem 4: Laryngeal Papilloma

Case:

A young child develops **recurrent hoarseness and voice loss**.

Explanation:

- Caused by **Human Papillomavirus (HPV)** infection forming **benign papillomas** on the vocal cords.
 - The lesion interferes with vibration and may cause **airway obstruction** if large.
 - Treated by **microlaryngoscopic removal**.
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Clinicoanatomical Problem 5: Carcinoma of the Larynx

Case:

An elderly man with long-term smoking presents with **persistent hoarseness** and **referred ear pain**.

Explanation:

- Commonly arises from **glottic region**.
 - The **auricular branch of vagus nerve** conveys referred pain to the **ear**.
 - **Early hoarseness** is an initial symptom; later, tumour may cause **airway compromise** or **lymph node spread**.
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Clinicoanatomical Problem 6: Foreign Body in Larynx

Case:

A fishbone accidentally enters the throat and the patient feels **sharp pain and choking sensation**.

Explanation:

- Fishbones can lodge in the **vallecula** or **piriform fossa**.
- The **internal laryngeal nerve** supplies mucosa of the larynx above the vocal cords; irritation causes **violent cough**.
- Removal is done under **laryngoscopic guidance**.

Frequently Asked Questions

1. What are the functions of the larynx?

- Acts as an **air passage**.
 - **Protects lower respiratory tract** during swallowing.
 - **Produces voice (phonation)**.
 - Helps in **cough reflex** and **respiratory control**.
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2. What are the cartilages of the larynx?

- **Unpaired:** Thyroid, Cricoid, Epiglottis.
 - **Paired:** Arytenoid, Corniculate, Cuneiform.
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3. Which are the synovial joints of the larynx?

- **Cricothyroid joint** and **cricoarytenoid joint**.
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4. Which intrinsic muscle is visible from the exterior of the larynx?

- **Cricothyroid muscle.**
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5. Which muscle is the only abductor of the vocal cords?

- **Posterior cricoarytenoid** — also known as the **safety muscle of the larynx.**
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6. Which muscle is supplied by the external laryngeal nerve?

- **Cricothyroid** (all others are by recurrent laryngeal nerve).
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7. What is the narrowest part of the larynx in adults and children?

- **Adults:** Rima glottidis.
 - **Children:** Below vocal cords (subglottic region).
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8. What type of epithelium lines the vocal cords?

- **Stratified squamous epithelium.**
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9. What is the extent of the larynx in adults?

- From **C3 to C6 vertebrae.**
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10. Which structure pierces the thyrohyoid membrane?

- **Internal laryngeal nerve and superior laryngeal vessels.**
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11. What is the function of the cricothyroid joint?

- Allows **rotation and gliding**, adjusting **tension of vocal cords** (modulating pitch).
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12. Which muscle acts as a tensor of the vocal cords?

- **Cricothyroid.**
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13. Which muscle acts as a relaxer of vocal cords?

- **Thyroarytenoid (including vocalis).**
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14. What is the rima glottidis?

- The **opening between the two vocal folds**, the narrowest part of the larynx.
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15. What happens in whispering?

- **Intermembranous part** of glottis is closed, **intercartilaginous part** remains open.
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16. What causes hoarseness of voice?

- **Laryngitis, vocal cord nodules, or recurrent laryngeal nerve paralysis.**
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17. Why is the larynx called the “sphincter of the air passage”?

- It **closes during swallowing** to prevent aspiration into the trachea.
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18. Why does carcinoma of the glottis spread slowly?

- Because the **vocal cords lack lymphatic drainage**, delaying metastasis.
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19. What is the shape of the infant larynx?

- **Short and funnel-shaped**, lying higher (C1–C4) than in adults.
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20. Which nerve carries sensation above and below the vocal cords?

- **Above cords:** Internal laryngeal nerve.
- **Below cords:** Recurrent laryngeal nerve.

Multiple Choice Questions

1. Which histological type of cartilage forms the **epiglottis**?

- a. Fibrous
- b. Elastic
- c. Hyaline
- d. Fibroelastic

? Answer: b. Elastic

2. Which is the **only abductor muscle** of the vocal cords?

- a. Lateral cricoarytenoid
- b. Thyroarytenoid
- c. Posterior cricoarytenoid
- d. Thyroepiglottic

? Answer: c. Posterior cricoarytenoid

3. The **recurrent laryngeal nerve** supplies all intrinsic muscles **except**:

- a. Posterior cricoarytenoid
- b. Oblique arytenoid
- c. Lateral cricoarytenoid
- d. Cricothyroid

? Answer: d. Cricothyroid

4. The **angle** between the anterior borders of thyroid laminae in adult males is approximately:

- a. 90°
- b. 100°
- c. 80°
- d. 120°

? **Answer:** a. 90°

5. Which of the following muscles is **not inserted** into the posterior border of the thyroid cartilage?

- a. Palatopharyngeus
- b. Salpingopharyngeus
- c. Stylopharyngeus
- d. Levator veli palatini

? **Answer:** d. Levator veli palatini

6. Which muscle is **not attached** to the cricoid cartilage?

- a. Cricothyroid
- b. Oblique arytenoid
- c. Lateral cricoarytenoid
- d. Posterior cricoarytenoid

? **Answer:** b. Oblique arytenoid

7. Which muscle is called the “**safety muscle**” of the larynx?

- a. Lateral cricoarytenoid
- b. Posterior cricoarytenoid
- c. Oblique arytenoid
- d. Transverse arytenoid

? **Answer:** b. Posterior cricoarytenoid

Short Notes / Structured Questions Commonly Asked:

1. Describe the **intrinsic muscles of the larynx** and their **clinical significance**.

2. Mention the **structures attached** to various parts of the **thyroid cartilage**.

3. Write short notes on:

- Rima glottidis
- Epiglottis
- Cricoid cartilage
- Vocal folds
- Pyriform fossa

Additional Viva-Style Objective Points

- What is the **angle** of thyroid laminae in females? ? About **120°**.
- Name the **muscles attached** to the posterior border of thyroid cartilage. ? **Palatopharyngeus, Stylopharyngeus, and Salpingopharyngeus**.
- Which muscle **opens** the laryngeal inlet? ? **Thyroepiglottic**.
- Which muscles **close** the laryngeal inlet? ? **Aryepiglottic** and **Oblique arytenoid**.
- What is the **epithelium** over the vocal cords? ? **Stratified squamous epithelium**.
- Which nerve provides **sensation above and below** the vocal cords?
 - Above ? **Internal laryngeal nerve**
 - Below ? **Recurrent laryngeal nerve**

Viva Voce – Larynx

1. What are the paired and unpaired cartilages of the larynx?

- *Paired:* Arytenoid, Corniculate, Cuneiform
 - *Unpaired:* Thyroid, Cricoid, Epiglottis
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2. Which laryngeal joint allows change in pitch of voice?

- **Cricothyroid joint** (tenses the vocal cords)
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3. Which muscle is supplied by the external laryngeal nerve?

- **Cricothyroid**
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4. Which muscle is the only abductor of the vocal cords?

- **Posterior cricoarytenoid**
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5. What is the “safety muscle” of the larynx? Why is it called so?

- Posterior cricoarytenoid ? keeps airway open by abducting vocal cords.
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6. What happens when the recurrent laryngeal nerve is injured?

- **Unilateral injury:** Hoarseness
 - **Bilateral injury:** Airway obstruction (cords fixed in paramedian position)
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7. What is the narrowest part of the larynx in adults?

- **Rima glottidis**

8. What is the narrowest part of the larynx in children?

- **Subglottic region**

9. What type of epithelium lines the vocal cords?

- **Stratified squamous epithelium**

10. What structures can be seen in indirect laryngoscopy?

- Epiglottis
- Aryepiglottic folds
- Vallecula
- Piriform fossa
- Vestibular folds
- Vocal folds

11. Which nerves supply sensation above and below the vocal cords?

- Above ? **Internal laryngeal nerve**
- Below ? **Recurrent laryngeal nerve**

12. What forms the inlet of the larynx?

- Anterior ? Epiglottis
- Lateral ? Aryepiglottic folds
- Posterior ? Interarytenoid notch

13. What happens to the vocal cords during phonation?

- They are **adducted**.

14. What is the position of vocal cords in forced inspiration?

- **Fully abducted**, rima glottidis becomes diamond-shaped.

15. What are the intrinsic muscles that close the laryngeal inlet?

- Aryepiglottic
- Oblique arytenoid

16. What are the intrinsic muscles that open the laryngeal inlet?

- Thyroepiglottic muscle

17. What structures pierce the thyrohyoid membrane?

- Internal laryngeal nerve

- Superior laryngeal vessels
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18. Why is glottic cancer detected early?

- Changes **voice early** due to involvement of vocal cords.
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19. Why is subglottic cancer detected late?

- Few symptoms initially; region has **poor lymphatic drainage**, so spread is slow.
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20. What is the position of the larynx in infants?

- Higher (C1–C4), funnel-shaped, narrow lumen.