SPAU3330

Voice & Resonance

Notes

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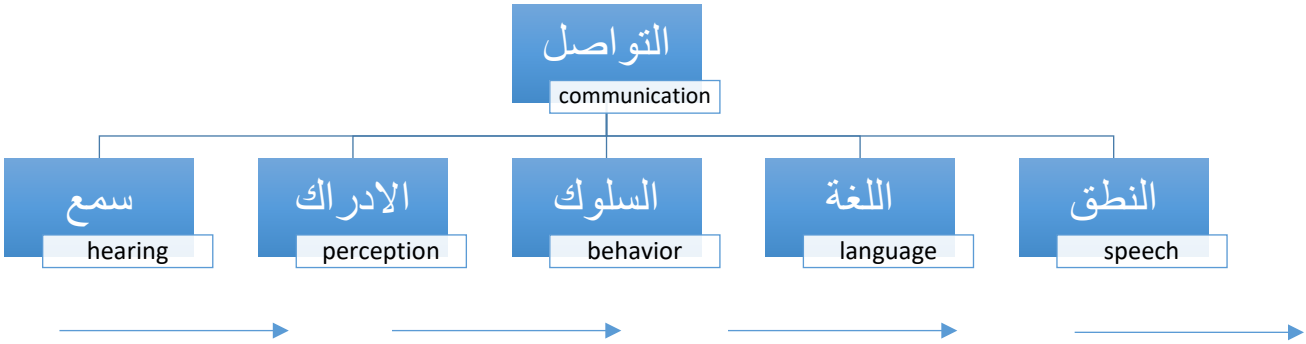
Table of Contents

Chapter One: Introduction



Introduction:

- The larynx sits on top of the airway
  - → **The primary function**: protecting the airway from any kind of obstruction (if it did → *laryngeal reflex activity - cough/spastic closure)*
  - → **The secondary function**: the production of human voice
  - → It also helps on thoracic fixation

The biological function of the larynx:

The primary function of the airway: the transportation of air in and out of the lungs.

- → **The function of the larynx**: protecting the airway for an unobstructed passage of the air supply.
- → **The primary biological function of the larynx:** is to keep fluids and foods from going into the airway (aspiration). *(If it went in, it expels it → laryngeal reflex activity - cough/spastic closure)*
  - o The larynx sits at the front, bottom of the throat **(pharynx)**, and at the top of the windpipe **(trachea)**
  - o Lies superior in the respiratory passage way opposite approximately the fifth or sixth cervical vertebral body.

During **Swallowing**:

- The larynx rises high in the neck → elevating the esophagus and trachea along with it.
- As swallowing progresses:
  - → the tongue comes back

→ the **epiglottis** (which acts as a partial cover) closes over the open **glottis** (the opening leading to the lungs)

Chapter Two: Normal voice [physiology and anatomy]

Normal aspects of voice:

Normal voice may be characterized by five aspects:

1. **Loudness**
   - the voice must be loud enough to be heard
   - "adequate carrying power"
   - the voice can be heard and speech can be understood over the noise of most everyday environmental sounds (Example: television)
2. **Hygiene**
   - the voice must be produced in a manner that is hygienic and safe
   - without vocal trauma and resulting laryngeal lesions
3. **Pleasantness**
   - the voice should have a pleasant quality
   - not distracting and interferes with verbal communication
4. **Flexibility**
   - the normal voice should be flexible enough to accurately express emotion
   - "window into the soul"
   - sometimes judge how people feel based on the sound of his or her voice
5. **Representation**
   - can change the meaning of a verbal message by changing the emotional tone of one's voice
   - *Example: "Oh wonderful!"* → Can either be said happily or sarcastically

Voice:

- Pitch → Frequency
- Loudness →Amplitude
- Quality → harsh, breathy, hyper nasal, hypo nasal

Normal processes of voice production:

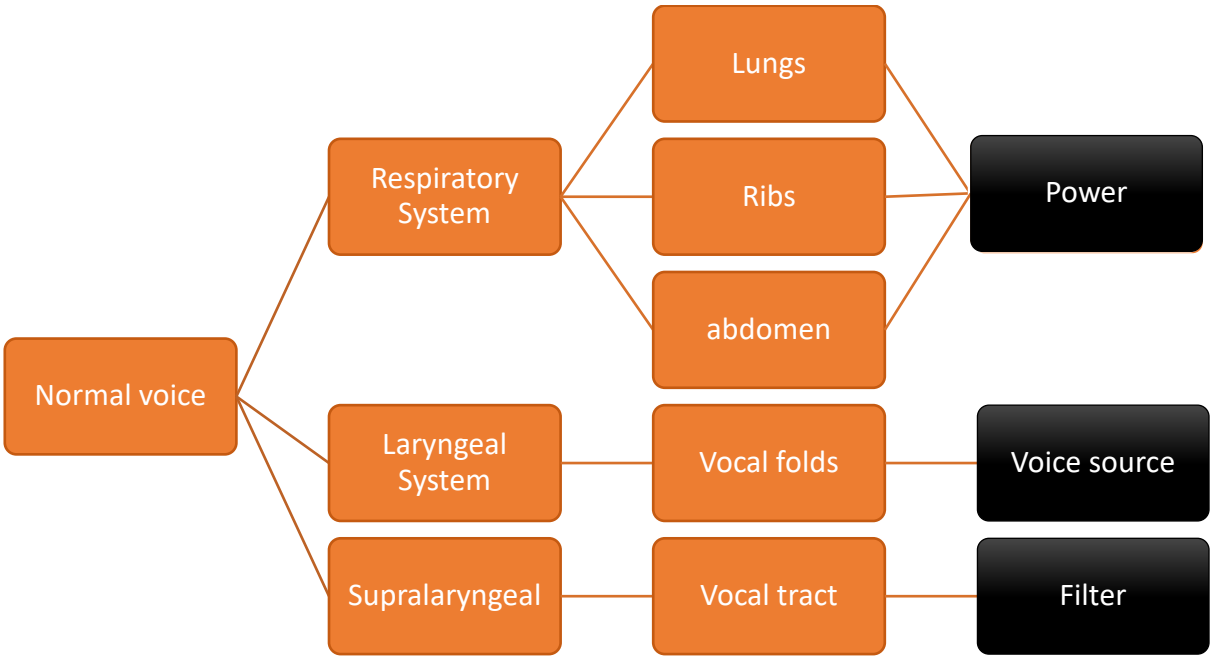
3 individual processes that depend on each other:

1. *Respiration* 2. *Phonation* 3. *Resonance*

- They depend on each other (**interdependent**): without respiration, phonation won't be able to occur (you'll literally die).

Respiration:

- Much of the power required for normal speech can be supplied by the **passive forces** of respiration (passive exhalation)
- Additional power required for normal speech can be supplied by the **active forces** of respiration (active exhalation)



Phonation:

The phonatory system is the source of **voiced sound**.

Normal phonation (voice production) results from:

- *normal expiratory airflow*
- *normal vocal fold structure and function*
- *normal supraglottic structure and function*
- *normal nervous system control*

The vocal folds either:

- **abduct**: move away from each other, starting together at midline
- **adduct**: move toward each other, ending together at midline

The Larynx:

The larynx is placed higher in a child's body compared to an adult.

- The larynx's form: a framework of **cartilage**, **ligaments**, **membranes**, and **folds**

➔ **1 bone**
➔ **9 cartilages (3 paired)**
➔ **Intrinsic and extrinsic laryngeal muscles**

Ligaments and membranes connect the larynx:

- *Superiorly* to the **hyoid bone**,
- *Inferiorly* to the **cricoid cartilage**,
- *Anteriorly* to the **epiglottis**.
- These attachments of the larynx **loosely position** it at midline in the neck

➔ Because the larynx is not rigidly fixed in the neck, it is capable of limited **up-down** and **side-to-side** movements

- ❖ **Cartilages** of the larynx are held together by membranes and ligaments
- ❖ **Vocal folds** lie **within** the laryngeal cavity.
- ❖ The laryngeal cavity is lined with a **wet mucosa** that is continuous with the mucosa of the tongue, pharynx, and trachea. It is rich with sensory receptors and mucus-secreting glands

→ This mucosa covers the laryngeal:

- o cartilages
- o membranes
- o ligaments
- o muscles

→ Irritation or drying of this lining can often contribute to a hoarse voice quality.

Framework:

FIGURE 2.7 Anterior View of the Laryngeal Cartilages, Hyoid Bone, and Epiglottis

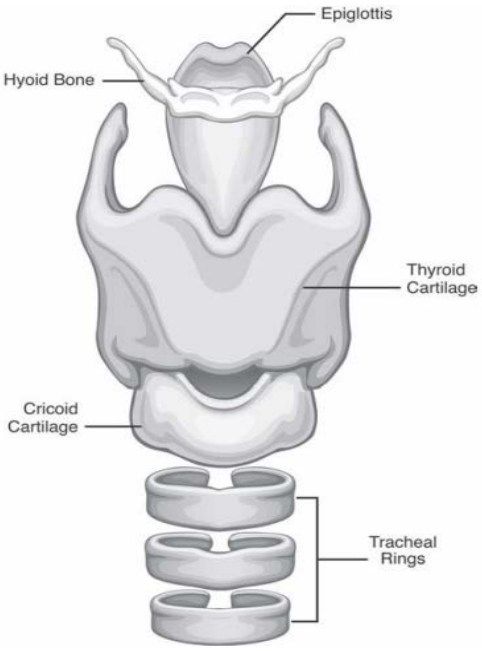
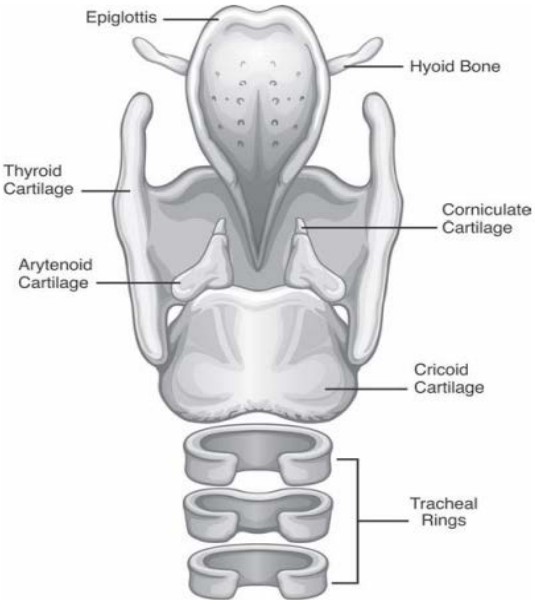
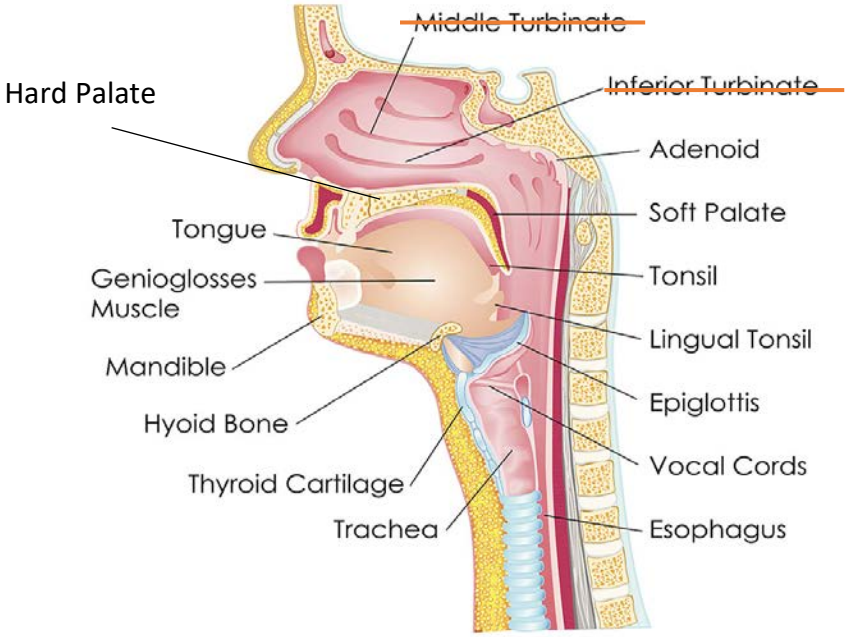


FIGURE 2.8 Posterior View of the Laryngeal Cartilages, Hyoid Bone, and Epigolottis

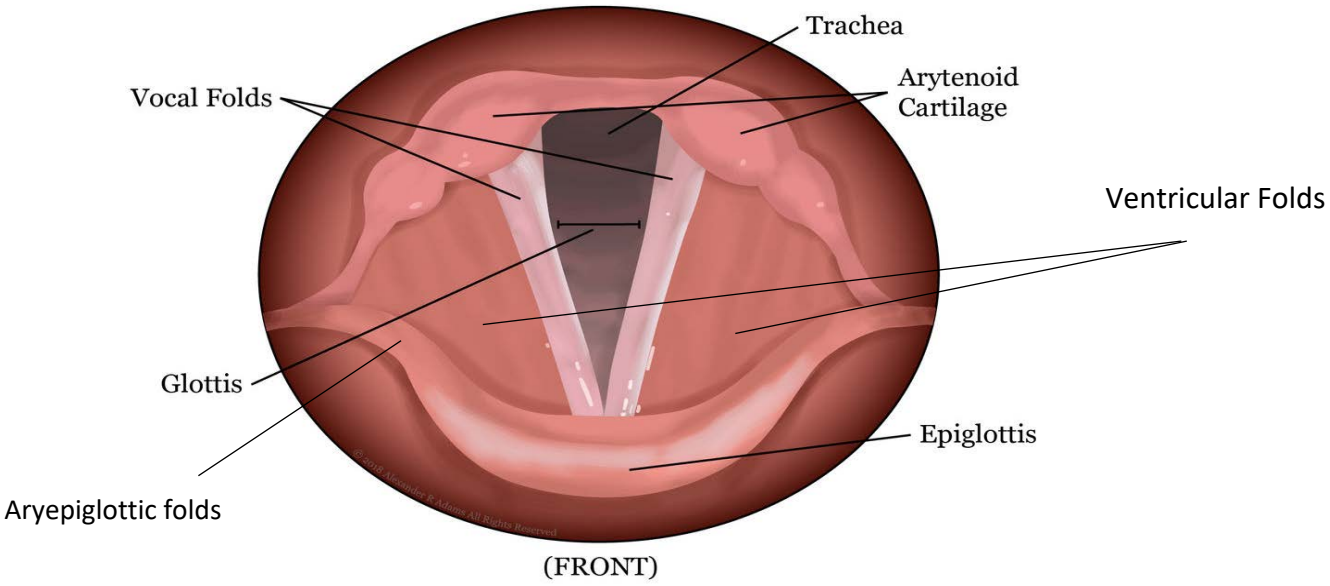


Four spectograms of the same speaker producing the /i/ vowel under four conditions: breathy, normal, harsh, and hoarse. The relative spacing of the formants stays the same as the signal source changes.

Side view of throat anatomy:

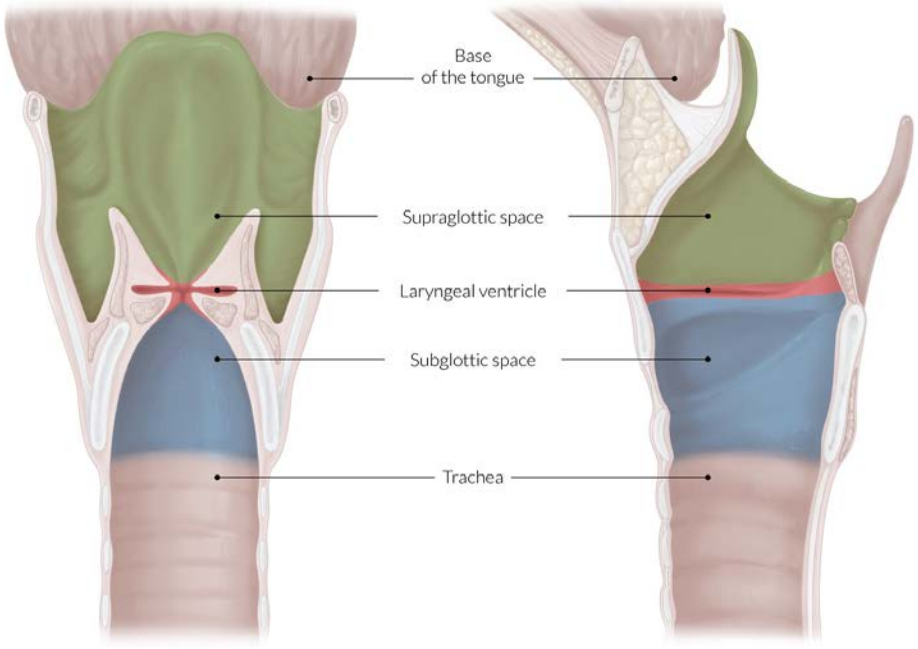


Vocal folds anatomy:



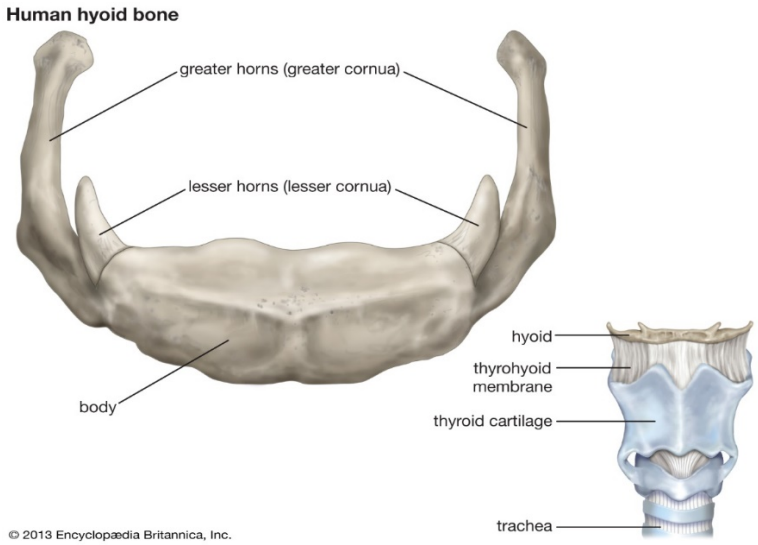
Laryngeal cavities:

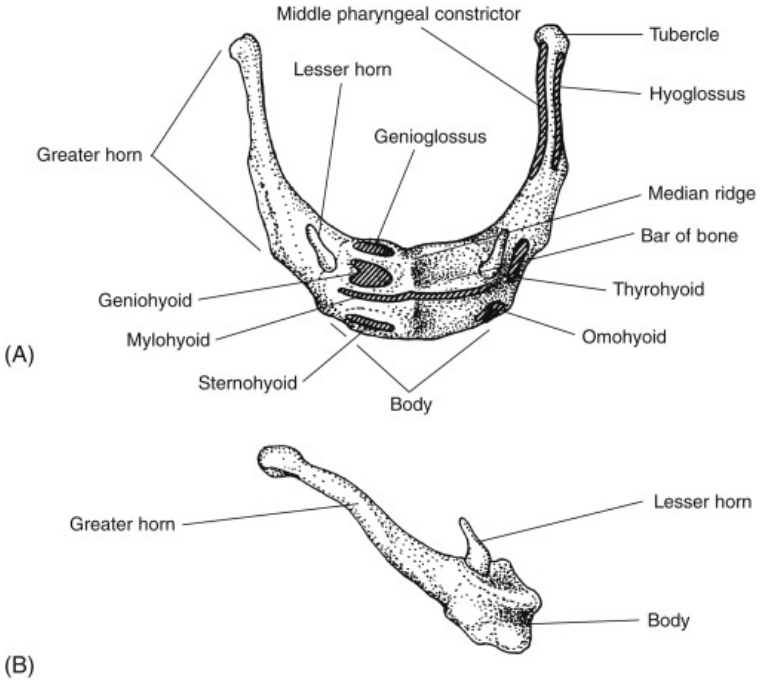
- **Supraglottal cavity:** from the VF to the aryepiglottic folds.
  → It can function as a resonator of the sound produced by the VF
- **Subglottal cavity:** from the VF to the 1st tracheal ring.
  → Here the pressure increases until it is sufficient to start VF vibration
- **Ventricles:** lateral space between false and true VF.
  → Resonance



Hyoid Bone:

- the only laryngeal bone
- it's U – shaped
- the only bone in the body that is **not** attached to another bone
- Part of the laryngeal system **attachment** for superior and inferior **extrinsic** laryngeal muscles (where they are attached to)





Laryngeal cartilages:

The laryngeal cartilages consists of:

- Thyroid → 1
- Cricoid → 2
- Arytenoids → 2
- Corniculated → 2
- Cuneiforms → 2
- Epiglottis → 1
  - All of them add up to 9
  - 3 of them are paired

All the laryngeal cartilages are coated with a **tough leathery covering (the perichondrium)**, which gives the larynx a *waxy look*.

→ This **perichondrium** is thicker on the outside than the inside of the larynx.

Five major laryngeal cartilages are **important for voice production** and airway protection are:

- the **thyroid**
- the **cricoid**
- the **paired arytenoids**
- the **epiglottis**

The two other cartilages only a **minimal role in the phonatory functions** of the larynx:

- Two other small **paired** cartilages,
  - the **corniculates** → cone-shaped, elastic cartilages on the apex of the arytenoids extending into the aryepiglottic folds
  - the **cuneiforms** → cone-shaped, elastic nodules located in the aryepiglottic fold

Cartilages:

1. The Thyroid Cartilage

- Unpaired
- hyaline cartilage
- the largest cartilage
- It has several parts:
  - *two lamina,*
  - *a superior thyroid notch,*
  - *two superior horns,*
  - *two inferior horns,*
  - *two oblique lines*

- **Adam's apple** → The two lamina fuse <u>anteriorly</u> in the midline and form the *laryngeal prominence* [another word for Adam's apple]
- **superior cornua** attaches <u>indirectly</u> to the **major cornua** of the hyoid bone
- **inferior cornua** attaches <u>posteriorly</u> to the **cricoid cartilage**

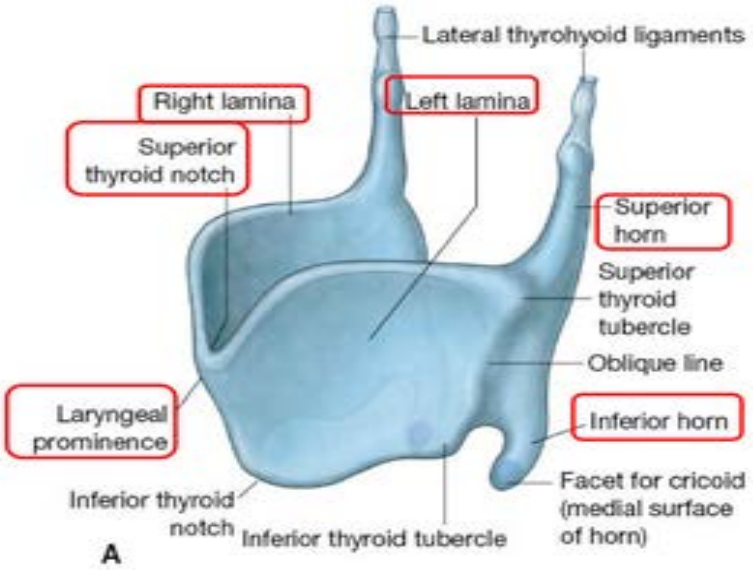
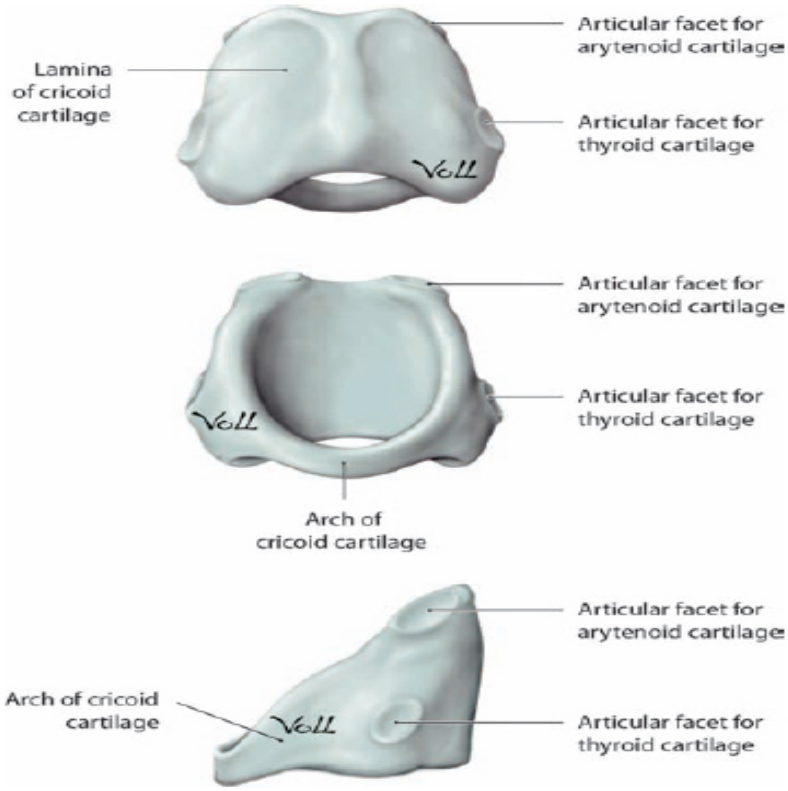


Fig. 8.199A Thyroid cartilage. **A.** Anterolateral view. **B.** Superior view.

2. <u>The Cricoid Cartilage</u>:

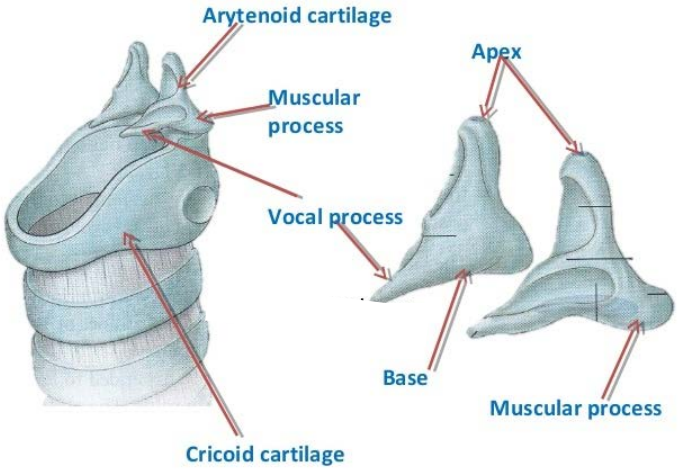
- Unpaired
- Hyaline cartilage
- 2nd largest cartilage
- sits on top of the trachea
- shaped like a signet ring
- connected to the first tracheal ring
- The two pyramid-shaped *arytenoid cartilages* sit atop its high posterior wall
- anterior arch (anulus)
- posterior lamina (signet)
- 4 articular facet:
    - → 2 with thyroid – to allow a rocking motion
    - → 2 with arytenoids



3. <u>The Arytenoid Cartilages</u>

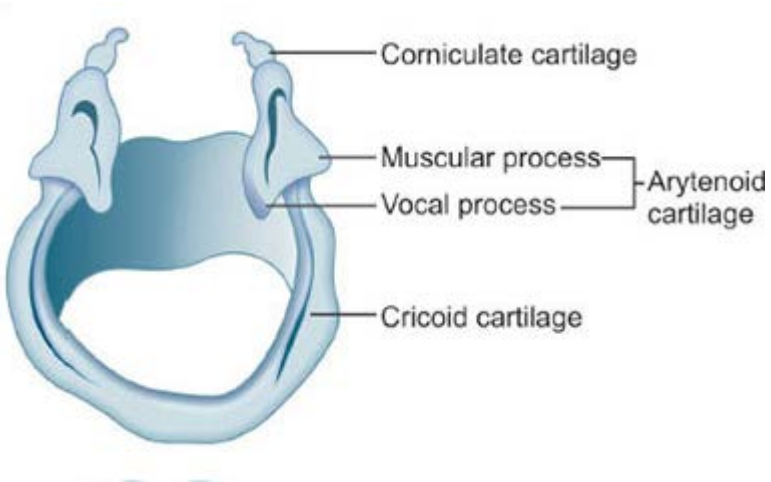
- Paired
- hyaline + elastic
- sit on top of the superior surface of the signet portion of the cricoid cartilage
- pyramid shaped: apex and base
- base of each arytenoid cartilage has **two** *concave* and *smooth* surfaces
  - → it's called ***"processes"*** where the muscles attach
  - → **One process:** is <u>laterally</u> directed and is the attachment for those *intrinsic* laryngeal muscles that cause the arytenoid cartilage to *rock, rotate,* and *slide* on the cricoid cartilage. *[<u>lateral projection</u> = **Muscular process** (insertion of the cricoarytenoid muscle)]*
  - → **The other process:** is <u>anteriorly</u> directed and is the posterior attachment for the *vocal ligament* and *vocalis muscle*. *[<u>anterior projection</u> = **Vocal process** (posterior attach VF)]*
- Movements:
  - o rocking: *forward and backward*
  - o gliding
  - o no rotational movement

➢ The facets on the cricoid cartilage help and assist in the movement



4. <u>The Corniculated Cartilages</u>

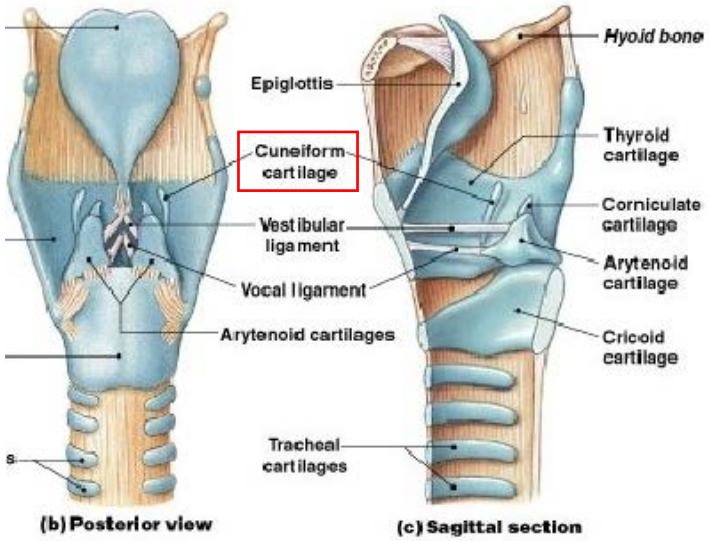
- Paired
- Elastic cartilages
- Sits on top of the **apex** of the **arytenoid cartilages**
- Extending into the aryepiglottic folds
- Pyramid shaped
- Part of the arytenoids
- **Functions:**
  - → Helps by playing a role in the *relaxing*, *tensing* and *approximating* the vocal cords of the larynx due to which sounds generation is possible
  - → helps the larynx by allowing the *opening* and *closing* of Glottis

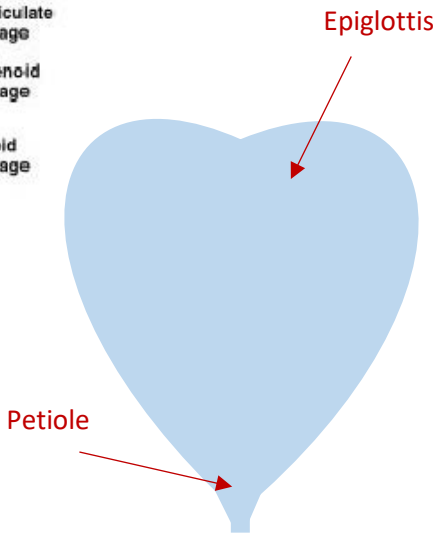


5. <u>The Cuneiform Cartilages</u>

- Paired small cartilages (nod-shaped)
- Elastic cartilages (nodules)

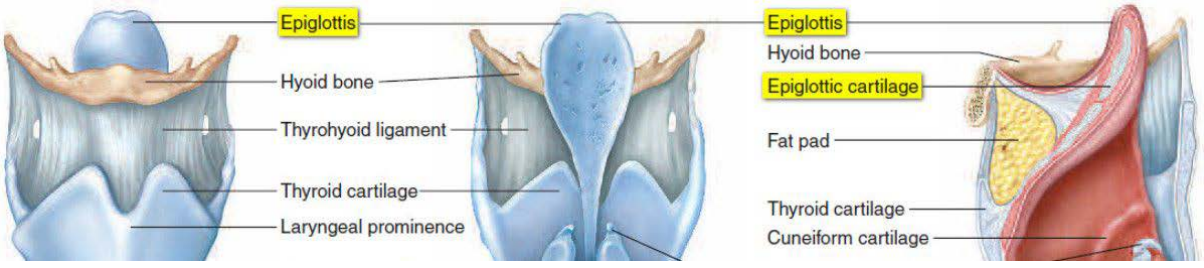
- Embedded in the mucous membrane
- Located in the aryepiglottic folds
- Functions:
  - → **Biological function**:
    Supportive framework for a corniculated fold tissue running from the corniculate to the epiglottis cartilage = aryepiglottic fold
  - → **nonbiological function**:
    No role even for phonation





6. <u>Epiglottis</u>

- Non-paired cartilage (leaf-shaped)
- Elastic cartilage
- Petiole (*a stem*) attached to the inside of the thyroid
- Anterior surface attached to the hyoid bone by the ligaments
- **Function**:
  - → **biological function**: closes off the airway directing the food towards the esophagus during swallowing
  - → **nonbiological function**: tongue position moves the epiglottis but no real function for phonation or articulation



Extrinsic Laryngeal Muscles:

Extrinsic → outside the larynx

- **ORIGIN**: the immovable fixed end of the muscle that connects to a bone at the **origin.**
- **INSERTION**: the movable end of the muscle connects at the **insertion.**
- It's ALWAYS from the **INSERTION to the ORIGIN**.

Extrinsic Laryngeal muscles:

- 8
- One side is attached to the laryngeal structure
- The second is attached to the outside of the larynx:
    - Mandible
    - mastoid or styloid process (thyroid)
    - thorax

4 are **suprahyoid:** [**superior to the hyoid bone]**

- Digastric anterior + posterior
- Geniohyoid
- Mylohyoid
- Stylohyoid

4 are **infrahyoid:** [**situated next to the larynx below the hyoid bone]**

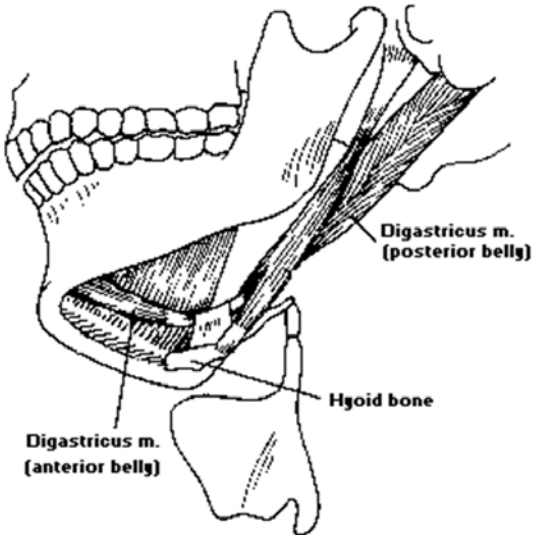
- Thyrohyoid
- Sternohyoid
- Omohyoid
- Sternothyoid

Suprahyoid Extrinsic Muscles:

1. Digastric Muscle

- **Suprahyoid** Muscle
- 2 muscle sections:
    - → **Anterior** belly
    - → **Posterior** belly
- **Origin:** mandible or mastoid
- **Insertion:** is the intermediate tendon that is connected to the hyoid bone
- **The function**:
    - → **Anterior belly** – pulls hyoid bone forward and elevates larynx
    - → **Posterior belly** – pulls the hyoid up and posteriorly + elevates the larynx

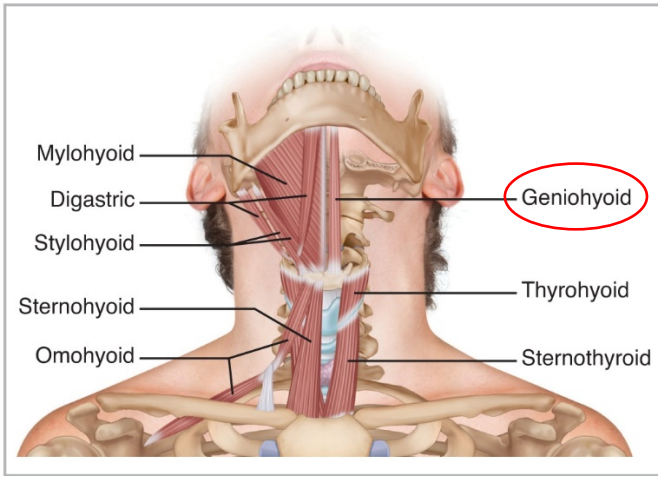
→ *[The posterior is longer than the anterior because it's all the way to the mastoid]*



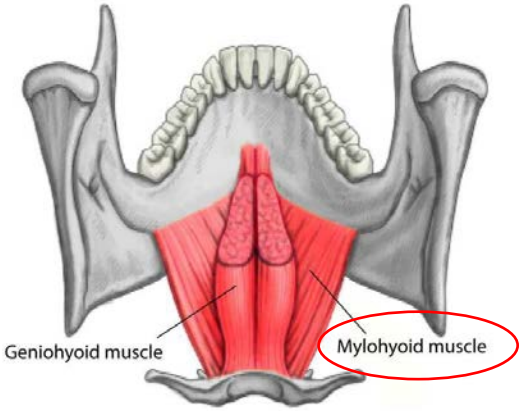
2. <u>Geniohyoid Muscle</u>

- **Suprahyoid** muscle
- *On the internal surface so it's hard to see*
- **Paired cylindrical muscle** (lies on the surface of the **mylohyoid bone**)
- They are holding the mandible from within
- Beneath it is the mylohyoid bone (in the middle)
- **The origin**: mandibular symphysis of mandible (interior mental spine of mandible)
- **The insertion**: is anterior surface of the hyoid body
- **The function**:
  → pulls the hyoid bone forward and upward (larynx)

  - **Temporalis** has to do with the opening and closing of the mouth (the jaw) it's not the suprahyoid job (like this muscle). It's known for *chewing*.
  - **The suprahyoid jobs are to hold them in place (either to hold it up or move it forward)**



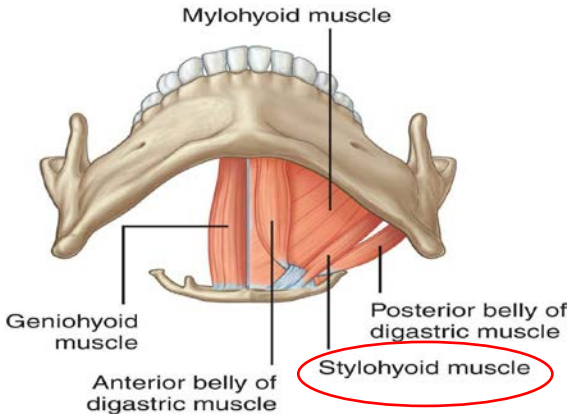
3. Mylohyoid muscle
   - **Suprahyoid** muscle
   - **unpaired**
   - The thin muscle forming the floor of the mouth
   - **The origin**: inner surface of the mandible
   - **The insertion**: fibers cross to the midline raphe which extends to the hyoid body
   - **The function**:
     → pulls the hyoid bone forward and upward (larynx)



Posterior view

4. Stylohyoid Muscle
   - **Suprahyoid** muscle
   - **Paired**
   - A long slender muscle located on the surface of the **posterior belly of the digastric**
   - **The origin**: styloid process of the temporal bone
   - **The insertion**: body of the hyoid

- **The function**:
  - → pulls the hyoid bone posteriorly and upward (larynx)



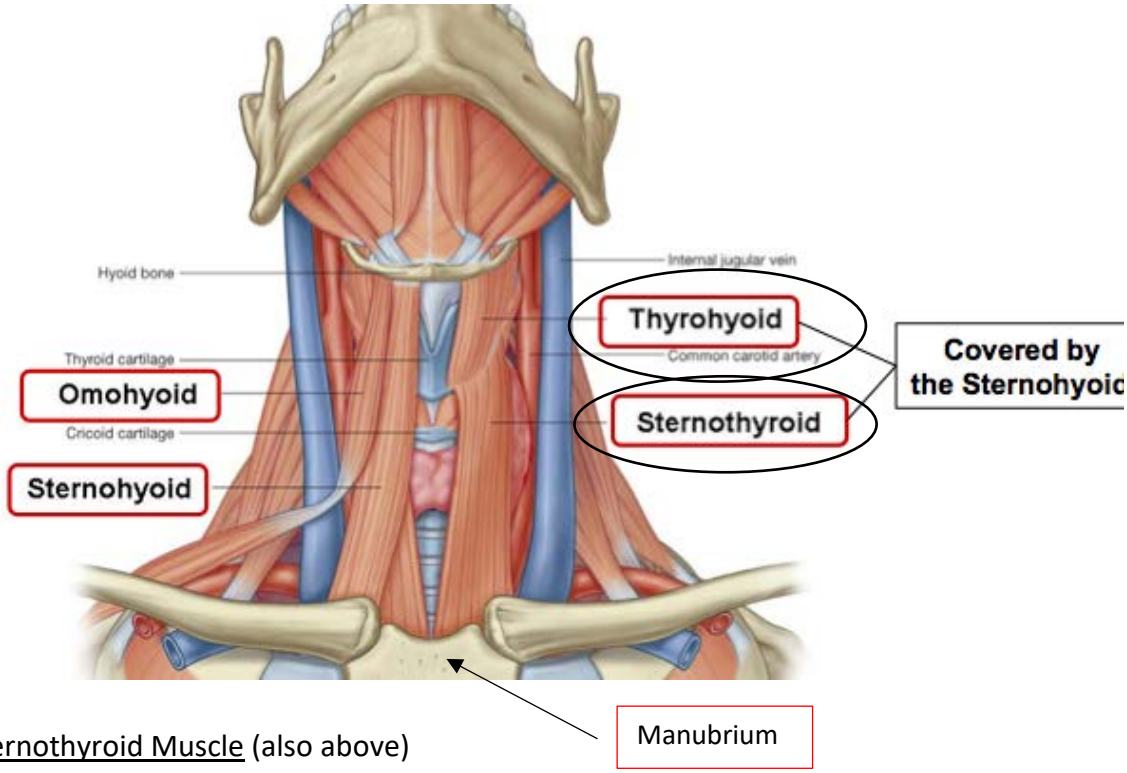
- ➢ The suprahyoid muscles:
  - o Form a sling supporting the hyoid and the larynx

Suprahyoid Extrinsic Muscles	Posterior belly / anterior belly	Function
Digastric	Anterior	• pulls the hyoid up + forward (larynx) • **front vowels** [/ i /, / e /] • **consonants** with high front tongue position [/ sh /, / s /]
Digastric	Posterior	• pulls the hyoid up + backward (larynx)
Geniohyoid	Anterior	• pulls the hyoid up + forward (larynx) • **front vowels** [/ i /, / e /] • **consonants** with high front tongue position [/ sh /, / s /]
Mylohyoid	Anterior	• pulls the hyoid up + forward (larynx) • **front vowels** [/ i /, / e /] • **consonants** with high front tongue position [/ sh /, / s /]
Stylohyoid	Posterior	• pulls the hyoid up + backward (larynx)

Infrahyoid Muscles:

5. Thyrohyoid muscle

- **Infrahyoid** muscle
- **Paired** muscle
- This is hanging **above the sternothyoid** and in place
- Thin muscle lying deep to the **omohyoid**
- **The origin:** oblique line of the thyroid lamina
- **The insertion:** Greater horn (cornu) of the hyoid bone
- **The function:**
  - → Decreases the difference between the thyroid and hyoid



6. Sternothyroid Muscle (also above)

- **Infrahyoid** muscle
- **Paired** muscle
- Long thin muscle on the anterior side of the neck
- There is cartilage between the bones in order to help when it comes to breathing and movement
- **The origin: Manubrium** and **costal cartilage** of the first rib
- **The insertion:** oblique line of the thyroid
- **The function:**
  - → pulls down the thyroid

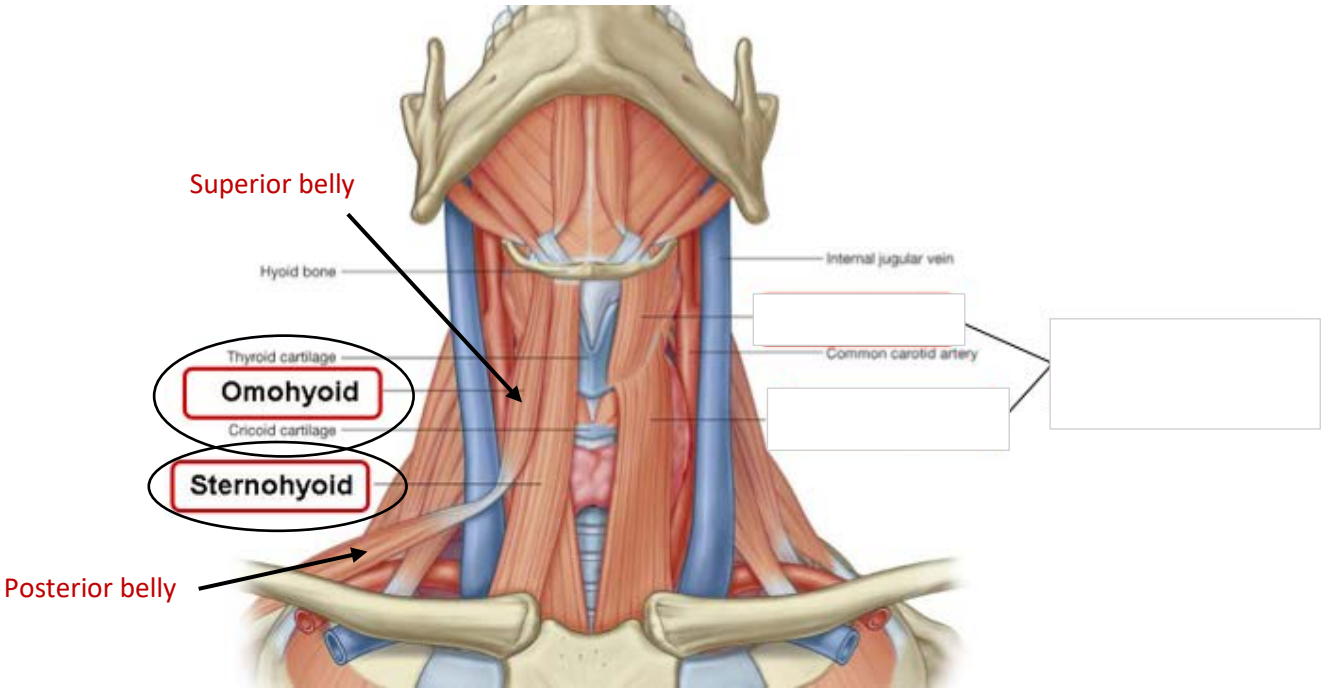
7. <u>Sternohyoid Muscle</u> (also above)

- **Infrahyoid** muscle
- **Paired** muscle
- From **hyoid** down to the **sternum**
- Thin muscle lying on anterior side of the neck
- **The origin**: Manubrium and end of clavicle
- **The insertion**: hyoid body
- **The function**:
  - → pulls down the hyoid

8. <u>Omohyoid Muscle</u>
   - **Infrahyoid** muscle
   - **Paired** muscles
   - It has **superior** and **inferior** parts
   - Long narrow 2 parts
     - → Muscle on *anterior* and *lateral* surface of the neck *[inferior and superior bellies]*
   - **The origin**:
     - → **Inferior belly**: surface of the scapula
     - → **Superior belly**: intermediate tendon connected to hyoid
   - **The insertion**:
     - → **Inferior belly**: intermediate tendon
     - → **Superior belly**: great horn of the hyoid
   - **The function**:
     - → both pull down the hyoid

It's <u>always</u>:

Insertion → origin



Intrinsic Laryngeal Muscles:

Intrinsic → inside the larynx

The intrinsic laryngeal muscles connect the laryngeal cartilages to <u>each other</u>.

Intrinsic Laryngeal Muscles:

Stating this point but in different words

- 5
- Both attachments are to the laryngeal structures (both the **origin** and **insertion**)

The intrinsic laryngeal muscles consists of:

- Interarytenoid muscles / Arytenoideus
  - → *Transverse*
  - → *Oblique*
- Lateral cricoarytenoid
- Posterior cricoarytenoid
- Cricothyroid
- Thyroarytenoid
  - → *Thyrovocalis*
  - → *Thyromuscularis*

➢ **The usual functions**:
- → Control the shape of the **glottis**
- → Vibration of the **vocal folds** *[alter both the length and the tension placed upon the vocal folds]*

Intrinsic Muscles:

<u>Vocabulary:</u>

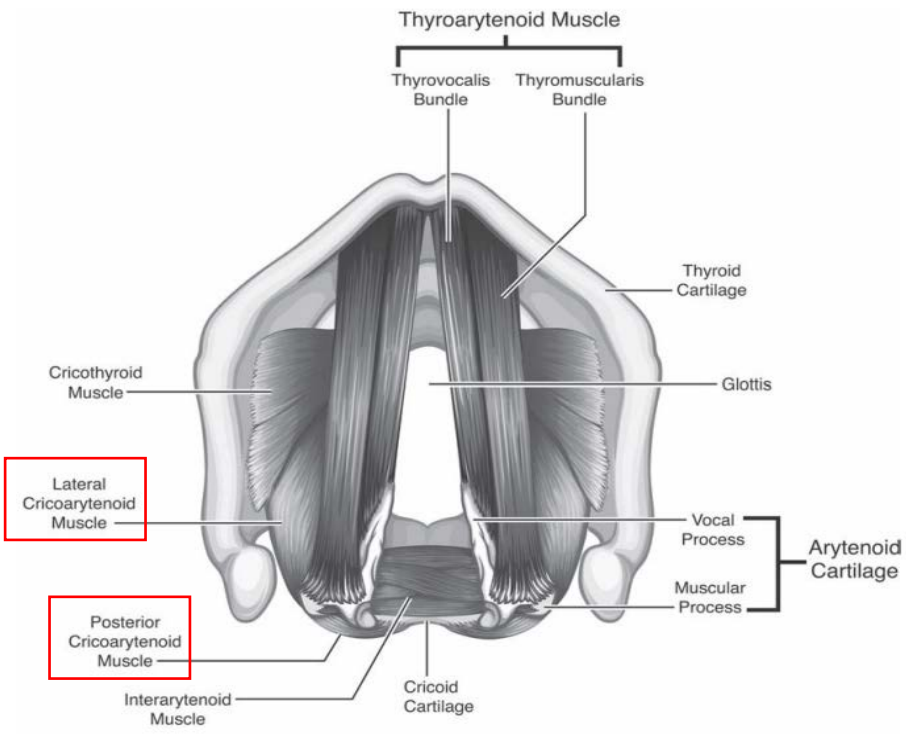
➢ **abduct**: move away from each other, starting together at midline
➢ **adduct**: move toward each other, ending together at midline

1. <u>Posterior Cricoarytenoid (PCA)</u>

- **Intrinsic** Muscle
- **Paired**
- A fan-shaped muscle located on the *posterior surface* of the **cricoid**
- **The origin**: On the posterior lamina of the cricoid
- **The insertion**: Posterior surface of the muscular process of the arytenoid
- The function:
  - → Abducts the arytenoids [opening the glottis]

→ This muscle is particularly active during more active abduction, such as when needed for a **quick or deep inhalation**

FIGURE 2.14 Superior View of the Intrinsic Laryngeal Muscles



2. Lateral Cricoarytenoid (LCA)

- **Intrinsic** muscle
- **Paired**
- A fan-shaped muscle lying along the *upper surface* of the **cricoid cartilage**
- **The origin**: Upper border of the cricoid
- **The insertion**: Anterior surface of the muscular process of the arytenoid
- **The function**:
  - → Adducts the vocal processes of the arytenoids [closing the glottis]
  - → [results in *stiffening* of all layers of the vocal folds]

3. Interarytenoid (IA)

- **Intrinsic** Muscle
- **Unpaired** (the only unpaired intrinsic laryngeal muscle)
- It consists of 2 muscle bundles:
  1. *Transverse Arytenoid*
     - Unpaired
     - **The origin**: Lateral margin of one arytenoid and courses to the lateral margin of the other arytenoid

Transverse shape

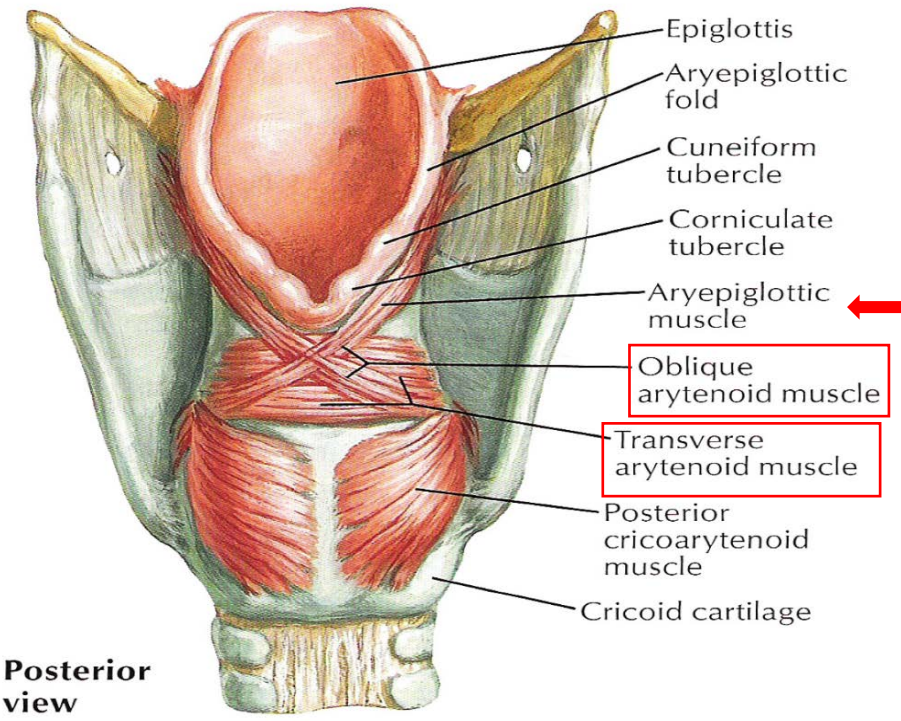
- **The insertion**: Arytenoid of the opposite side
- **The function**:
  - → Adducts the arytenoids [closing the glottis]

2. *Oblique Arytenoid*

Oblique shape

- Paired
- **The origin**: Base of one arytenoid and courses to the apex of the other arytenoid
- **The insertion**: Arytenoid of the opposite side
- **The function**:
  - → Adducts the arytenoids [closing the glottis]

- The **aryepiglottic muscle** is composed of **oblique IA** fibers that have continued *laterally* around the apex of the arytenoid and *inserted* into the epiglottis.
  - ➢ Contraction of the **aryepiglottic muscle** *results* in the **epiglottis being pulled downward and backward**, which *results* in the **entrance of the larynx being covered**.

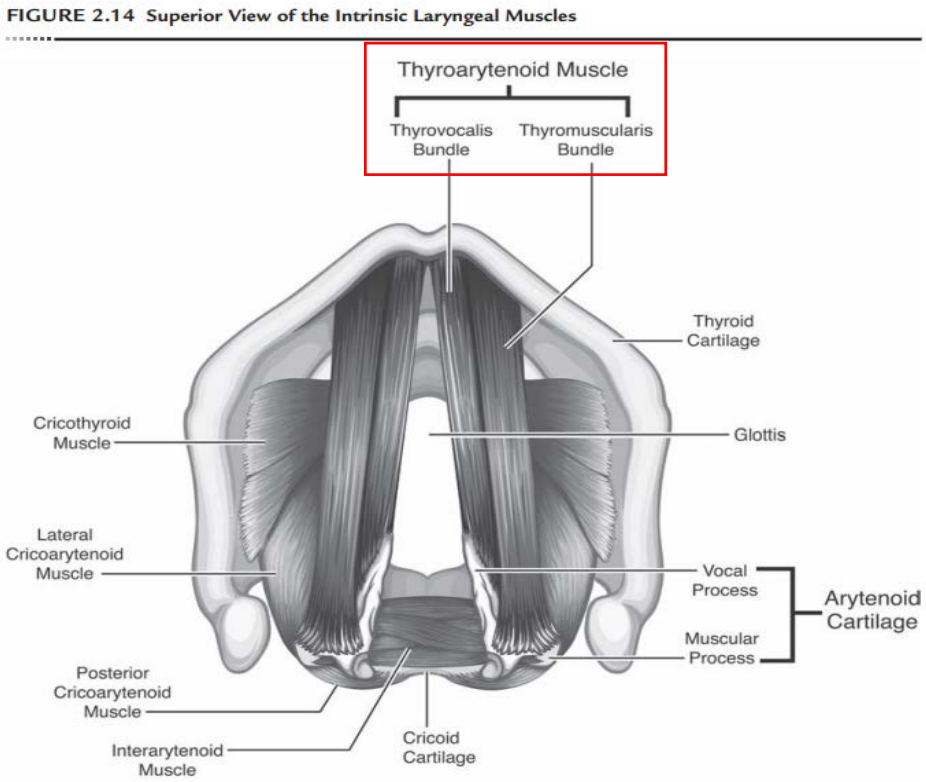


4. Thyroarytenoid (TA)

- **Intrinsic** muscle
- **Paired**
- A bundle of fibers making up the **true Vocal Folds**
- It can be divided into 2 muscle groups:
    1. *Thyrovocalis muscle* (*medially* and **more active**) [also known as Vocalis]
    2. *Thyromuscularis muscle* (*laterally* and **less active**) [also known as Muscularis]
- **The origin**: [Anteriorly] from the posterior surface of the thyroid
- **The insertion**: Along the lateral base of an arytenoids from the vocal process to the muscular process
- **The function**:
    - → Decrease the distance between thyroid and arytenoids
    - → Contraction of the **muscularis** draws the arytenoid cartilages *forward*, *relaxing* and *adducting* the vocal folds

    - length of the Vocal Folds → decreased
    - mass → increased
    - tension → decreased

    → Decreasing the vocal pitch



5. Cricothyroid (CT)

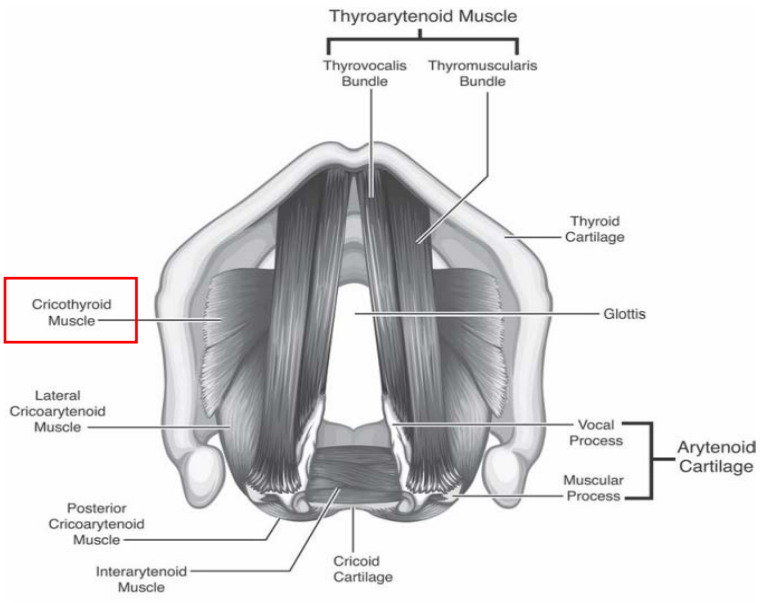
- **Intrinsic** muscle
- **Paired**
- A fan-shaped muscle located between the **cricoid** and **thyroid**
- consisting of fibers oriented in 2 directions:
    1. pars oblique (lower fibers)
        - ➢ insert near the thyroid lamina and the inferior horn of the thyroid cartilage
    2. pars recta (upper fibers)
        - ➢ insert into the lower surface of the thyroid lamina
- **The origin**: Arch of cricoid
- **The insertion**: Inferior margin of the thyroid
- **The function**:

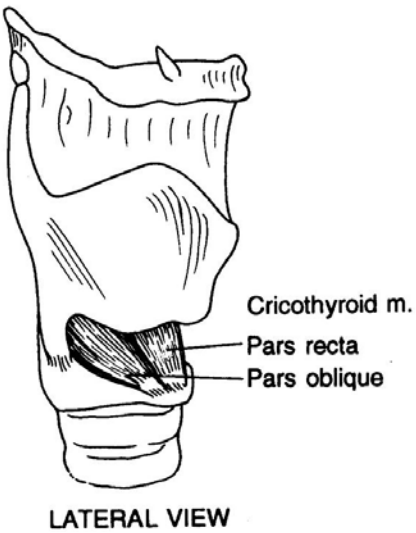
→ Decrease the distance between thyroid and cricoid, [increase the distance between the thyroid and arytenoid]

- Length of vocal cords → increased
- Mass → decreased
- Tension → increased

→ Increasing the vocal pitch

FIGURE 2.14 Superior View of the Intrinsic Laryngeal Muscles





Motion	Muscles	How?
Adduction [move toward each other]	• Interarytenoids (transverse + oblique) • Lateral cricoarytenoid (LCA)	• **Oblique** : approximate the arytenoids • **Transverse**: Bind the arytenoids together → causing them to slide toward the midline and squeezing the vocal process • **Lateral cricoarytenoid (LCA)**: Medial compression
Abduction [move away from each other]	• Posterior Cricoarytenoid (PCA)	• Pulls the muscular process of the arytenoids **[posteriorly],** → rocking the arytenoids back to their axis **(active during physical exercise to permit greater air in and out)**
Raising pitch	• Cricothyroid (CT)	• Decreases the distance between the cricoid and the thyroid cartilages, thus elongating the vocal process and places it under **increased tension** → **More tense – increased pitch**
Lowering pitch	• Thyroarytenoid (TA)	• Tilts the **thyroid backward** to relax the vocal process and at the same time pulls the muscular process forward to assist in medial compression

Viewing of Vocal Folds

Viewing the Vocal Folds:

There are multiple methods for viewing the vocal folds:

1. **Laryngoscopy**: examination of the **interior portion** (inside) of the **larynx**
   → Some problems one may face while doing laryngoscopy:
   - Larynx is located **deep in the neck**
   - Larynx is **dark**
   - Vocal folds vibrate more than **100 cycles per seconds**
2. **Indirect Laryngoscopy**: examination of larynx while using a **small mirror** held at the back of the throat
   → The dental mirror is pushed to the **soft palate**
   → Only **Larynx structures** could be seen
   → *Manuel Garcia (1855) France*
3. **Photography of the Larynx**: high speed motion pictures
   → **High-speed** motion pictures
   → **4000** frames per sec
   → Pictures are then placed next to each other
   → *Paul Moore (1937), MIT, UF*
4. **Endoscopy**: a procedure in which an instrument is introduced into the body to give a view of its **internal parts**
   → **Direct laryngoscopy**
   → There is:
   - **Rigid**:
     - Rigid scopes are often used in surgery
   - **Flexible**:
     - Flexible scopes show the throat better and are more comfortable for the patient
5. **Fiberscope**: A **flexible fibre-optic instrument** connected to a **cold light source**, a camera and a monitor are used to directly examine the cavities of the body
   → Using **transnasal endoscope**
   → Better light and better optic fibers
   → only sees **structure**
6. **Videostroboscopy**: provides a **slow-moving**, **magnified view** of the **vocal cords** in action
   → noninvasive diagnostic procedure
   → **Video recording** of the motion of the vocal folds
   → Directly observes the motion of the larynx
   → It provides **information** about:

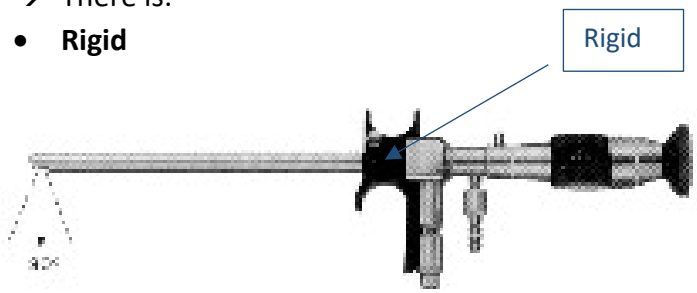
- **Nature** of VF vibration
- **Presence** or **absence** of anything on the Vocal folds (absence or presence of pathology)
- Documents **small changes** in the **vibration pattern** or **structure**

→ **Retinal lag**:

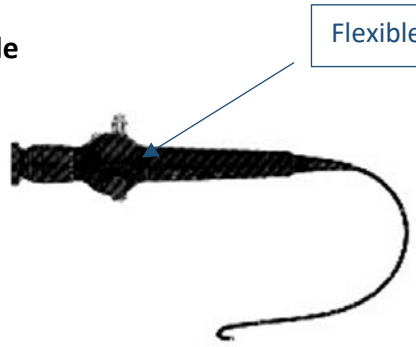
- The retina can perceive **five images per second**
- **Time lag** = 1/5 to 1/7 of a second *(Kallen, 1932)*
- When an object is presented to someone in parts (intermittently), it will appear to be moving slowly or standing still → this is why the video goes in slow motion so we can see everything
- It takes the **average of the vibrations**, not every single one

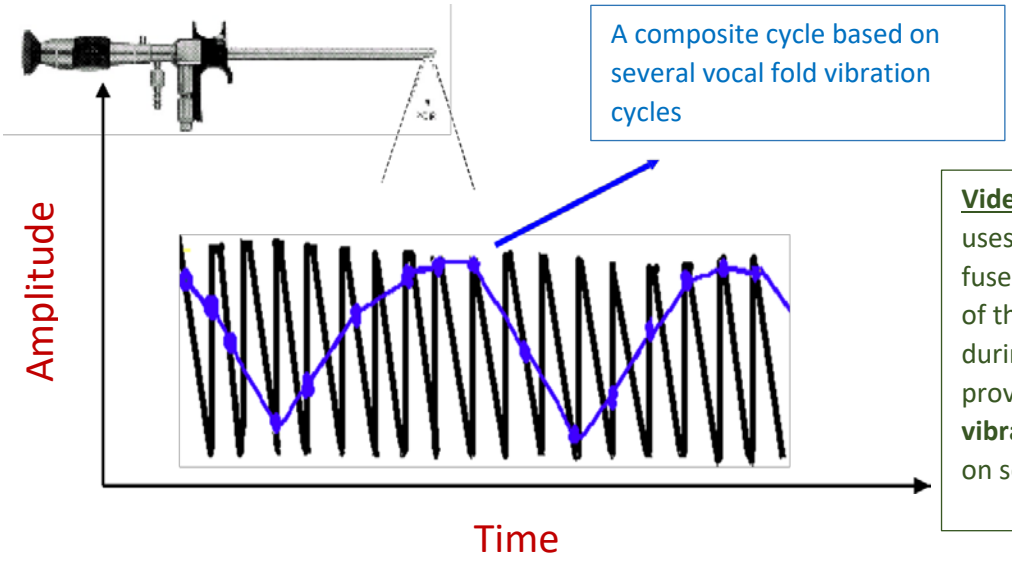
→ There is:

- **Rigid**

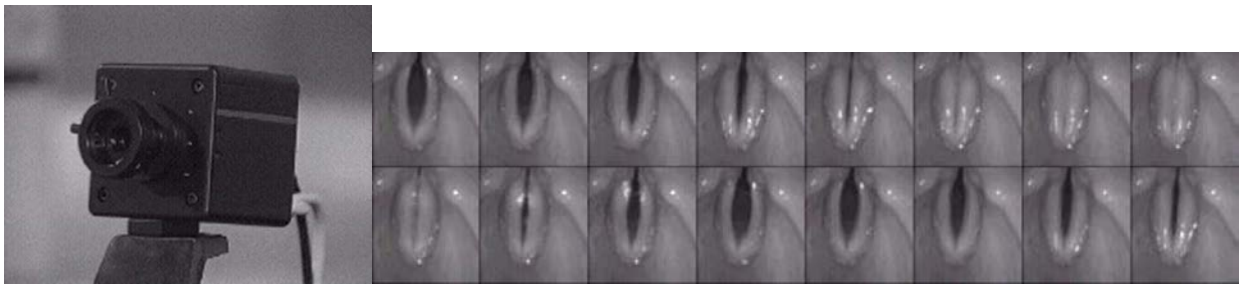


- **Flexible**



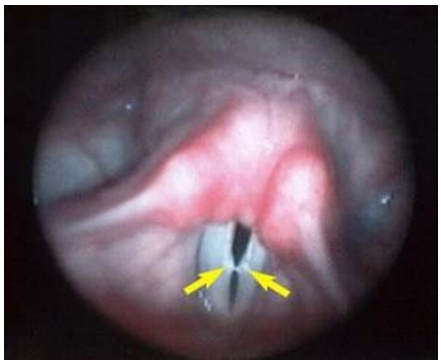


Videostroboscopy uses the **retinal lag** to fuse illuminated points of the vocal folds during vibration, providing an **average vibratory cycle** base on several fused cycles



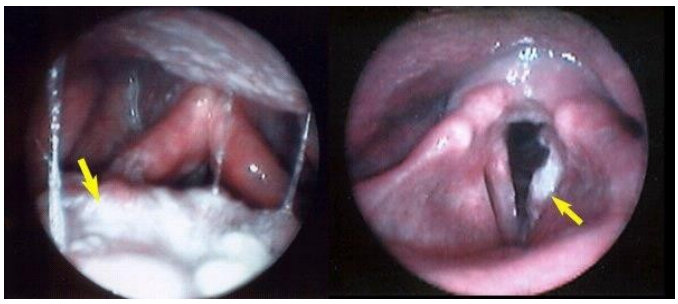
❖ **Vocal Nodules**

- *Misuse* – screaming
- *Abuse* – talking nonstop
- There are types of vocal nodules (unilateral or bilateral)



❖ **Laryngeal cancer**

- Has to do with the vocal cords
- If it gets too bad then they need surgery
- There is something called an artificial larynx – this allows them to talk but in a robotic voice



❖ **Regular frequencies:**

- *Men*: 120 Hz
- *Women*: 250 – 300 Hz
- *Children*: 300 – 400 Hz

Main Ligaments/Membranes:

The main ligaments/ membranes:

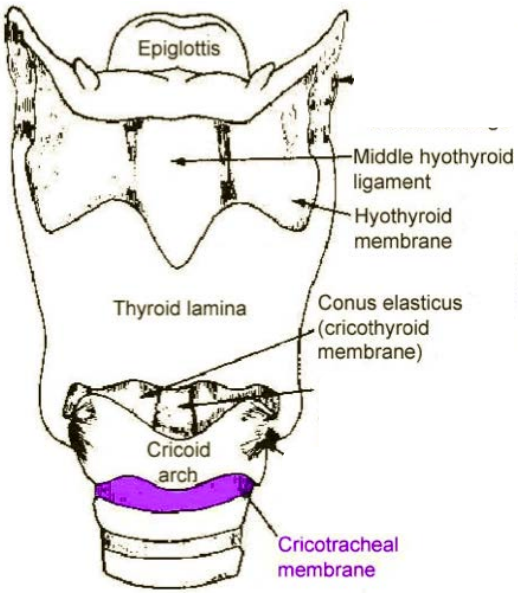
1. **Hyothyroid membrane**:
   - An **extrinsic laryngeal connection** between **hyoid** and **thyroid**

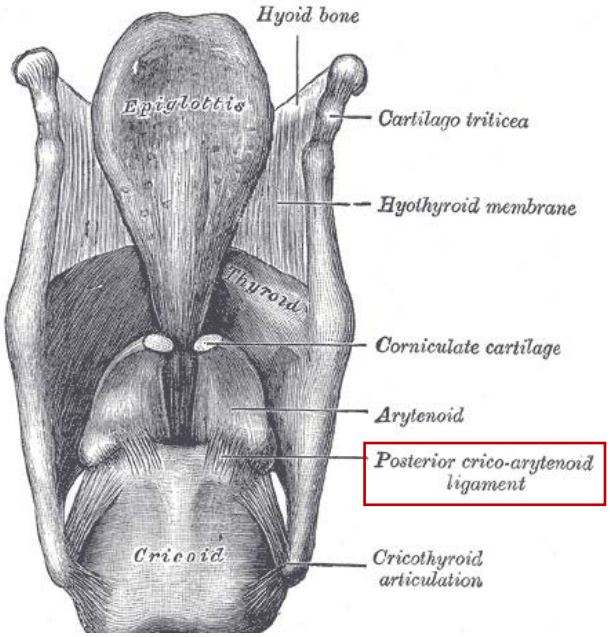
2. **Middle Hyothyroid ligament**:
   - The **thicker portion** of the hyothyroid membrane
   - **extrinsic** laryngeal ligament

3. **Cricotracheal membrane**:
   - An **extrinsic laryngeal connection** between **cricoid** and **1st tracheal ring**
   - Easy access to the Vocal folds
   - This place is where they usually open in order to help if they can't breathe (when the vocal folds close)

4. **Posterior Cricoarytenoid Ligament**:
   - The **largest intrinsic ligament**
   - Between **cricoid** and **arytenoid**
   - **restricting** and **dictating** movements of the arytenoids

5. **Conus elasticus**:
   - **Membrane** covering **cricoid arch**, **thyroid**, and the **Vocal folds**





Anatomy of the Vocal Folds:

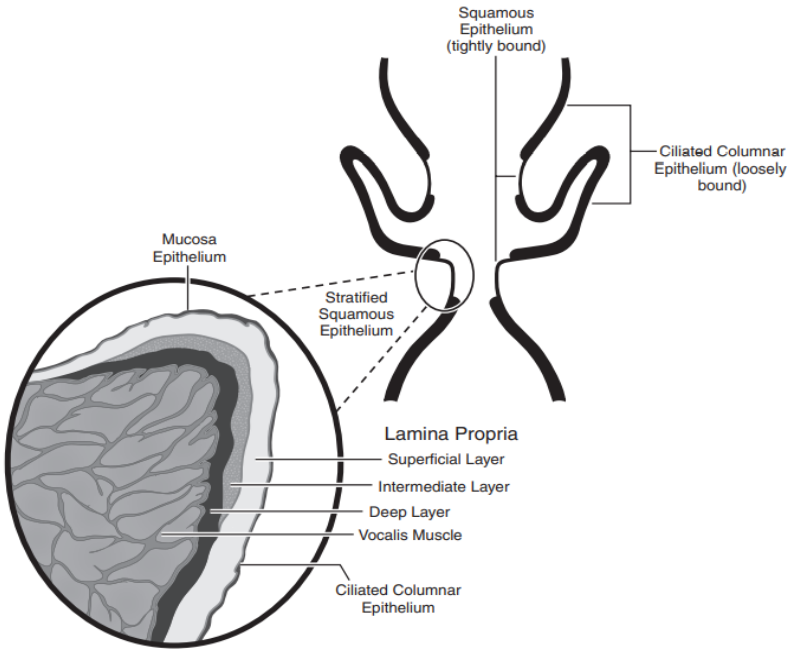
There is a **5 layer model** for the true **vocal folds**: Proposed by *Hirano (1974, 1981)*

1. **Epithelium** (outer layer):
   - **stiff mosaic tissue** for **protection**
   - composed of **elastin fibers** → allow for **stretching** and **recoil** thus permitting movement during vocal fold vibration

2. **lamina propria** (middle layer):
   - There are 3 sections of the Lamina Propria:
     A. **Superficial layer** (Reinke's space):
        - **loose fibers** with **fluid spaces** → [cobwebs] → can cause nodules
     B. **Intermediate layer**
        - **elastic fibers** with **recoil features** and it acts like a rubber band
     C. **Deep layer**
        - **thick collagenous** fibers
        - *less* elastic = "cotton thread"

3. **Vocalis muscle** (thyrovocalis)
   - **vibrates** the vocal folds for **sound production**
   - it is in charge of **length** and **tension**

FIGURE 2.16 The Vocal Fold in Cross Section



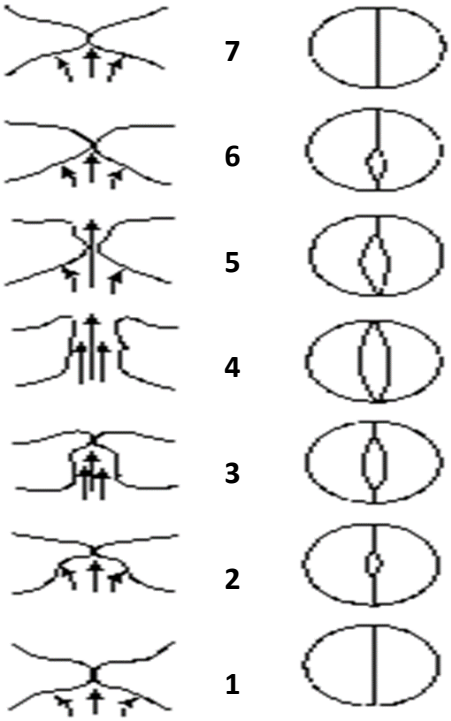
The **combination** of the **mechanical properties** of these **5 layers** determines the *mode* of vocal fold vibration:

- **Fundamental Frequency [F0]** = vibratory cycles / seconds
- **The unit of F0 is:** Hertz [Hz]
- **One cycle** = 1 open + 1 close
  → It is called **simple harmonic motion**

Mechanical Properties:

Mechanical properties of the Vocal folds:

1. **Tension** (stiffness):
   - major determinant of F0
   - **increase tension** → *[decrease elasticity]* → **increase vibrations**
   - **decrease tension** → *[increase elasticity]* → **decrease vibrations**
2. **Mass** (thickness):
   - distribution of the vocal fold mass is related to the **length** and **tension**
   - **Increase mass** → **decrease vibration**
   - **Decrease mass** → **increase vibration**
3. **Length** (source):
   - male vocal folds are longer than the female's and *vibrate less*
   - **increase length** → **decrease vibration**
   - **decrease length** → **increase vibration**



Theories of Production of Vocal Fold vibration:

There are two theories that explain vocal fold production:

A. **Neurochronaxic theory**:
- This theory states that **vocal fold vibration** is ***almost*** **totally dependent** on the **rate of neural impulses** received by the laryngeal muscles
  - → Not a strong theory
  - → Even though nerves can fire (send impulses) quite fast → the rapid pattern of vibration observed during production of high frequencies cannot be explained by the rate of nerve impulse
  - → **In other words**: They say that the vibrations are an action from the brain
    - The nerves ***don't*** catch up to the **speed of the vibrations** → that's why it's a weak theory

B. **Myoelastic-Aerodynamic theory**:
- This theory is *widely accepted*
- it takes into account:
  - → **Aerodynamic**: laws of physics which regulates movement/control of air molecules *[air flow and pressure]*
  - → **Myoelastic**: states that the **laryngeal physical properties** [positioning of *structures*, *tension*, *length*, *distribution of mass*, etc.] are controlled by the **intrinsic laryngeal muscles** [muscle contraction] → muscle activity
- The assumptions of this theory are:
  1) The vocal folds are **appropriately positioned** (postured) in a **closed** or **semi closed position**
  2) Then **pressure** is built up *below* the folds
  3) The vocal folds *repeatedly* **open** and **close automatically**

This **cycle of vibration** will repeat as long as **sufficient subglottal air pressure** can build up to blow the vocal folds apart again

Bernoulli Effect → **Positive air pressure** from the lungs *forces* the vocal folds to open momentarily, but the high velocity air produces a **lowered pressure** by the *Bernoulli Effect* which brings the vocal folds back together.

- The implications (conclusions) of this theory are:
  1) The vocal folds **do not open and close** *during* phonation because there is a **separate muscle contraction** for each opening/closing movement *(Only its outer covering vibrates)*
     - It is positioned where the **airway** and the **esophagus** separate

- The vocal folds **open to allow breathing** and **close during swallowing** to prevent food from entering into the lungs and during voicing

2) The vocal folds **open and close automatically** → as long as the folds are in a position of **closure** or **near closure**, and there is **sufficient** buildup of **pressure** *below* them

<u>Forces that cause the vocal folds to **open**:</u>

- The buildup of **air pressure** on one side of the vocal folds → *below them*
  1) **Drop in pressure along the glottal margin of the vocal folds**:
     - This is explained by the <u>*Bernoulli effect*</u>:
       - → **Positive air pressure** from the lungs *forces* the vocal folds to open momentarily, but the high velocity air produces a **lowered pressure** which brings the vocal folds back together
       - → An example of the <u>*Bernoulli effect*</u> could be: *the "shower curtain example"*

  2) **The force of the elastic recoil of the folds**:
     - consider the adducted position of the folds at its rest position
       - → once the **air pressure** building *below* the folds is enough to blow them apart
       - → the folds are **"pushed away"** from the **rest position**
       - → **opposing elastic recoil forces** will tend to **restore** the folds to the *original* position/shape

<u>Important factors governing vocal fold vibration</u>:

1) **<u>Vocal fold position</u>**:
   - Degree of **adduction** [closing]
   - Glottal adductors are:
     A. *Lateral cricoarytenoid muscle*
     B. *Transverse interarytenoid muscle*
     C. *Oblique interarytenoid muscle*

2) **<u>Vocal fold myoelasticity</u>**:
   - The **length** and the **tension**
   - glottal tensors/relaxors:
     A. *Cricothyroid muscle*
     B. *Thyroarytenoid muscle*

3) **<u>Amount/size of pressure drop along the folds</u>**

Mechanism of Vocal frequency change:

The mechanism of vocal **frequency change**:

1) **[muscles] By the amount of**:
   - Tension
   - Mass
   - Length

   ❖ Open/close quotients or phases

   ❖ *Frequency (Hz)* → ***pitch***

   ❖ **There are 4 modes of vibrations** [4 ranges of pitch registers]:
      - **Whispering**: the *highest pitch*
      - **Modal**: *normal voice* for talking and singing
      - **Falsetto:** men to the high *"feminine"* quality sound
      - **Vocal fry**: the *lowest vocal register* and is produced through a loose glottal closure
2) By changing the airflow

Mechanism of Vocal Intensity Change:

The mechanism of Vocal **Intensity Change**:

1) **By the amount of glottal resistance**:
   - **increase** medial **compression** [muscles]
      → **increase size** of burst of air
      → **increase impact** collision of air molecules
      → **increase displacement** of acoustic vibration

❖ *Intensity [sound level pressure level (SPL)]* → ***Loudness***

2) **Size and shape of vocal tract**:
   - Laryngeal
   - Pharyngeal
   - Oral
   - Nasal
3) **Air pressure and the air flow [speed]**:
4) **Increase time of closure**:
   - This is done by the lateral cricarytenoid muscle (LCA)

- **More air in the lungs** results in a **greater buildup of subglottal air pressure** when the vocal folds **adduct** → particularly the longer they remain adducted.
- As **vocal intensity increases**, the vocal folds tend to **remain closed for longer periods of time during each vibratory cycle**.
- When the vocal folds are eventually **blown open**, they **abduct more widely**.
   → This allows more and more air molecules to escape—air that is **explosively turbulent** and that generates **more acoustic power**

Mechanism of vocal quality variation:

The ***"quality"*** of one's voice is what distinguishes it from other voices of similar pitch and loudness.

In general, changes in **voice quality** appear to result from changes at **two levels** of the speech production system:

(1) **The glottal source**
(2) **The resonant characteristics of the vocal tract**

The mechanism of Vocal **Quality Variation**:

1) **<u>Quality of the phonatory system</u>**:
    - Multiple factors play a role:
        - Tissues
        - Elasticity
        - Age
        - Smoking

2) **<u>Coordination of the muscles</u>**:
    - If there is a **tremor**

3) **<u>Shape and configuration of the vocal tract</u>**:
    - Like the **cleft palate**

4) **<u>length of the cross sectional area</u>**:
    - **Cross sectional area** means **diameter**

5) **<u>size of resonators</u>**:
    - oral
    - nasal
    - pharyngeal

6) **<u>style of the articulators</u>**:
    - like **high hard palate**

7) **<u>edge of the vibrating tissue</u>**:
    - **periodicity** → the regularity of vocal fold vibration
        - *periodic*
        - *aperiodic*

Chapter Three: Functional Voice Disorders

Etiologies:

Etiology: the cause, set of causes, or manner of causation of a disease or condition

→ Voice disorders may arise from a **wide array** of possible **etiologies**
→ The **more aware** the voice pathologist is of these possible causes, the more likely that **efficient diagnoses** and **management plans** may be **established**

Vocal abuse: is any *behavior or occurrence* that strains or injures the vocal folds

→ **This may include**:
- Talking in noisy environments
- Using caffeine products
- Excessive talking
- throat clearing
- coughing
- smoking
- Screaming/yelling/cheering
- Giving speeches or lectures
- Spending time in smoky environments (2nd hand smoker)

❖ **Vocal abuse can lead to two common conditions**:
A. Vocal Nodules
B. Contact Ulcers and granuloma

Vocal misuse: is *improper voice usage*

→ **such as**:
- speaking too loudly or at an **abnormally high** or **low pitch**

❖ **Etiologies of Vocal Misuse**: Functional voicing **behaviors** that contribute to the **development** and **maintenance** of laryngeal pathologies

Vocal components that can be used **inappropriately**:

- *type of breathing* → breathing orally
- *phonatory habits* → the misuse behaviors
- *resonance* → can be from a disorder
- *pitch* → always talking in a higher or lower pitch rather than your normal pitch
- *loudness*
- *rate*

Medically-related Etiologies:

Medically-related etiologies: are **medical/surgical *interventions*** which *directly* cause a voice disorder

- **Medical/health *conditions*** may *directly* or *indirectly* contribute to the development of a voice disorder

<u>Surgical Trauma</u>:

- ***Directly*** causes a voice disorder
  - **laryngectomy** of any kind → an operation to remove all of **the larynx**
    - Example: cancer
  - **Glossectomy** → a surgery done to remove part of or all of **the tongue**
  - **Mandibulectomy** → a surgery to remove all or part of **your jaw** (mandible)
  - **Palatal surgery** → it corrects **obstruction (blockage)** in the area behind the soft-palate located in the roof of the mouth
  - **other head and neck combinations**

- ***Indirectly*** causes a voice disorder
  - **Thyroidectomy** → a surgical removal of all or part of **the thyroid gland**
  - **Cardiac** → heart surgery could cause a lot of **fatigue**
  - **Carotid** → a surgery to treat **carotid artery disease**
  - **Laminectomy** → a surgery that creates space by removing the lamina – it enlarges your spinal canal to relieve **pressure** on the **spinal cord** or **nerves**
    - This can affect posture and thus it affects position
  - **Lung** → respiration
  - **Hysterectomy** → a surgical procedure to remove **the womb** (uterus)
  - any **intubation** → a standard procedure that involves **passing a tube into a person's airway**

Chronical illness / disorders:

- **Sinus**
- **Allergies**
- **Respiratory illness** (laryngeal dyskinesia)
- **Frequent URI** → upper respiratory infection
- **Gastrointestinal disorder** → GERD
- **Emotional disorders** → psychophysiology
- **Psychological** → example: selective mutism
- **Hormonal imbalance**

Incompetency: it's weak [has to do with the muscle function while it has good length and etc.] → **function**

Insufficiency: it's not enough [ex: it's too short] → **structure**

- **Arthritis**
- **Smoking**
- **Alcohol/drug abuse**

Primary Disorder Etiologies:

Primary disorder etiologies: Major disorders with *secondary* vocal symptoms

- **Cleft palate**:
  - It will cause nasality [hard or soft]
  - It's harder to treat the hard palate [because it's hard and has bones → it has to have surgeries and etc.]

- **Velopharyngeal insufficiency**:
  - When the **soft palate** does not close tightly against the back of the throat, leading to air coming out the nose (characterized by hypernasality and/or nasal air emission) during speech
  - This can cause speech that is difficult to understand

- **Deafness/HOH**:
  - hard of hearing

- **Cerebral palsy**:
  - is a group of disorders that affect a person's ability to **move** and **maintain balance** and **posture**

- **Neurological disorders**:

Personality-related etiologies:

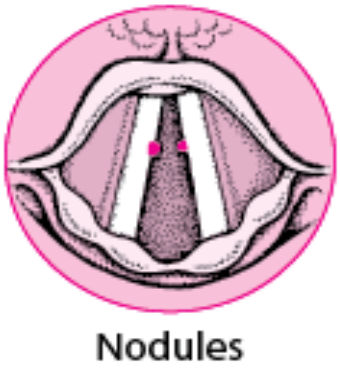
Personality-related etiologies: **tensions** and **stresses** of daily life may contribute *directly* to the abnormal functioning of the sensitive vocal mechanism

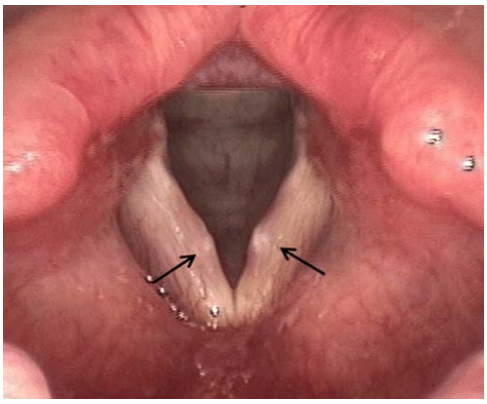
- environmental stress
- psychological conversions
- identity conflict

Laryngeal pathologies:

A. **Vocal Nodules**: *Incidence of 21.6%*

- They are caused by **continuous abuse** of the larynx and **misuse** of the voice
- Nodules are *generally* **bilateral**, **whitish protuberances** on the glottal margin of each vocal fold
- there can be considerable variation of vocal nodules in the:
  - size
  - number
  - location
- The **open glottal chink** [produced by the nodules coming together in exact opposition to one another] results in a **lack of complete vocal fold adduction**
  → This faulty approximation leads to **breathiness in the voice and air wastage**, the perception of which *increases* as nodule size *increases*

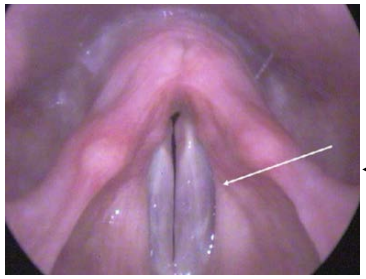




B. **Edema**: *Incidence of 14.1%*

- is characterized by the **"sac-like" appearance** of the **fluid-filled vocal cords**
- is usually **bilateral** but can be more pronounced on *one* side
- It is associated strongly with *smoking*
- The **swelling of the vocal folds** causes the voice to become **deep** and **hoarse**
  → Therefore, the major symptom of Reinke's edema is a **hoarseness** similar to **laryngitis**

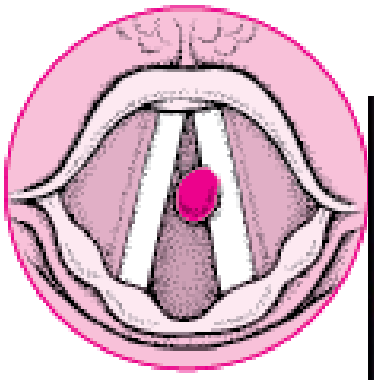
Both Vocal folds

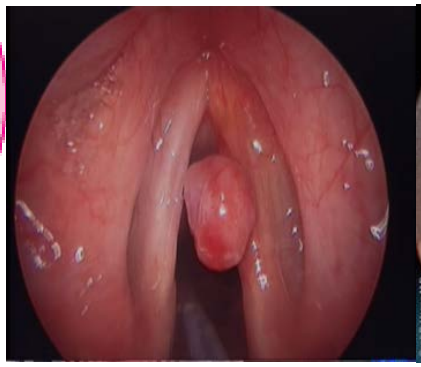


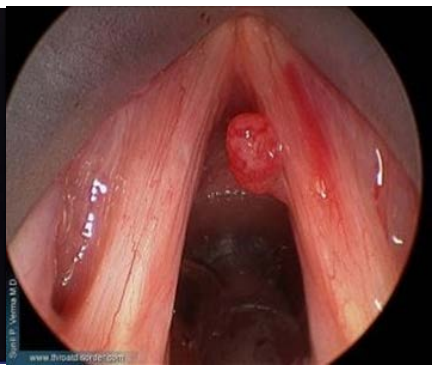
Left vocal fold

C. **Polyps**: *Incidence of 11.4%*

- **noncancerous (benign) growths** that cause **hoarseness** and a **breathy** voice
- usually at the **same site** where **vocal fold nodules occur**
- Vocal fold polyps are *usually **unilateral*** → but a reactive lesion is often found on the vocal fold immediately across from the polyp
- Vocal cord polyps are often the **result of an acute injury**
  → *Example: from shouting at a football game*

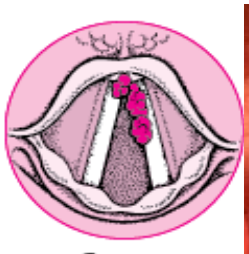






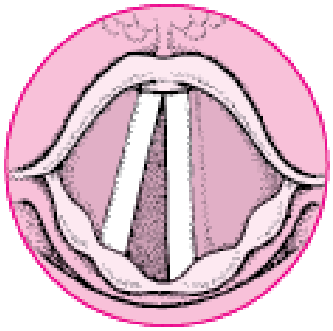
D. **Cancer**: *Incidence of 9.7%*

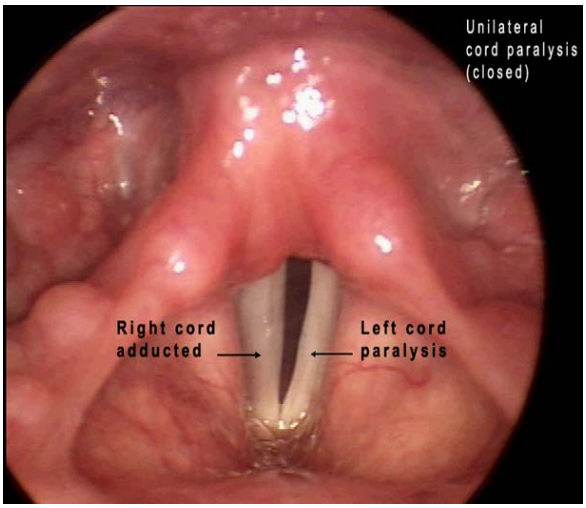
- begins as small areas of **abnormal cells** that can grow out of control
- is a **life-threatening disease** that requires comprehensive **medical–surgical management**
- laryngeal cancers can be classified into **three groups** [depending on the site of the lesion]:
  (1) **supraglottal** → involving structures such as the **ventricular** and **aryepiglottic folds**, the **epiglottis**, and the **arytenoid cartilages**
  (2) **glottal** → from the **anterior commissure** to the **vocal process ends of the arytenoids**
  (3) **subglottal** → involving the **cricoid cartilage** and **trachea**
- ***treatment*** → combines **radiation therapy** and **surgery** for small to moderate lesions → extensive cancer requires perhaps a laryngectomy



E. **Paralysis**: *Incidence of 8.1%*

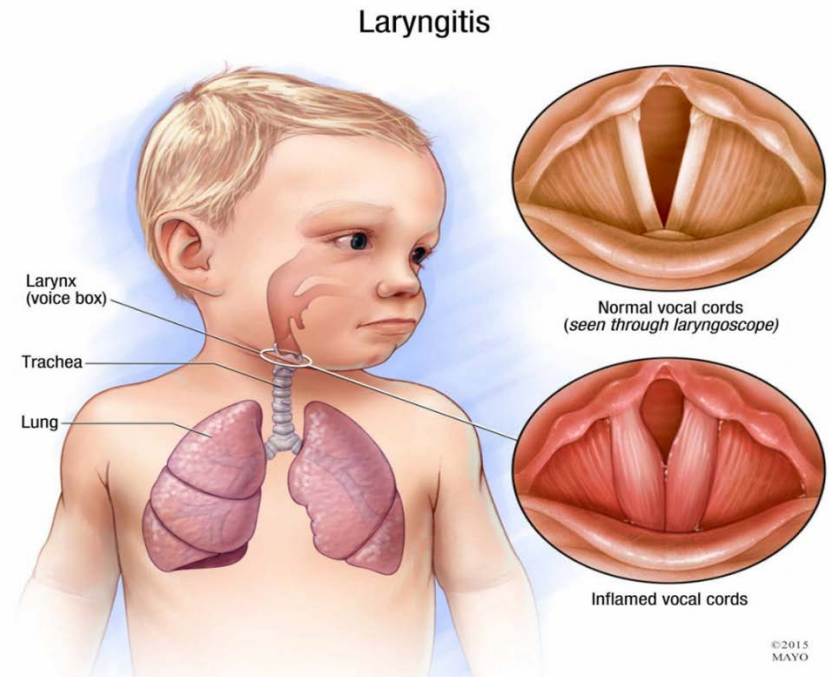
- occurs when the **nerve impulses** to the voice box (larynx) are disrupted
- Vocal cord paralysis can affect the ability to **speak** and even **breathe**
- can **be unilateral (one-sided)** or **bilateral (two-sided)**
- ***Treatment*** → **voice therapy**, **bulk injections**, **surgery** or a **combination of treatments**





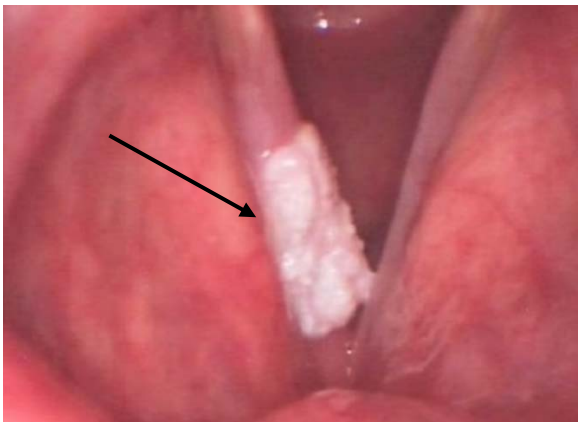
F. **Laryngitis**: *Incidence of 4.2%*

- when the **voice box** or **vocal cords** in the throat become **irritated** or **swollen**
- It usually goes away by itself within 1 to 2 weeks
  → *Example: common cold*



G. **Leukoplakia**: *Incidence of 4.1%*

- **"white plaque"**
- Leukoplakia may cause symptoms such as **hoarseness**
- may be found incidentally during an examination
- Risk factors include exposure to **chronic irritation** such as **cigarette smoking**, **alcohol abuse**, **HPV infection**, **oral thrush**
- ***Treatments*** → as **laser surgery**



H. **Psychogenic**: *Incidence of 2.6%*

- The **emotional** and **psychological state** of the individual can affect voice production
- The patient's **psychological trauma** or **conflicts** may be strong enough to cause and maintain the vocal symptoms

I. **No visible pathology** → *incidence of 7.9%*

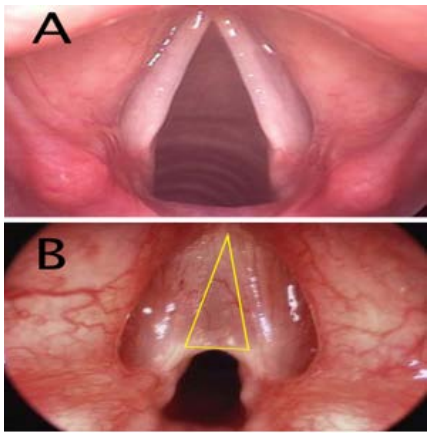
Pathology Classifications:

Pathology classifications:

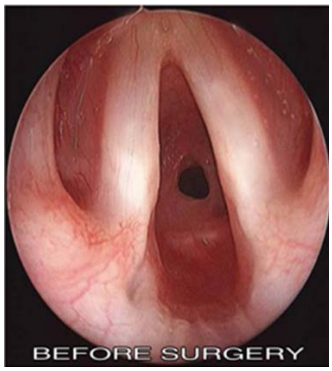
- **Congenital laryngeal pathologies** → they were born with it
- **Pathologies of the vocal fold cover**
- **Neurogenic laryngeal pathologies** → nerves
- **Pathologies of muscular dysfunction** → **structure** is fine but **function** isn't

1) Congenital laryngeal pathologies:

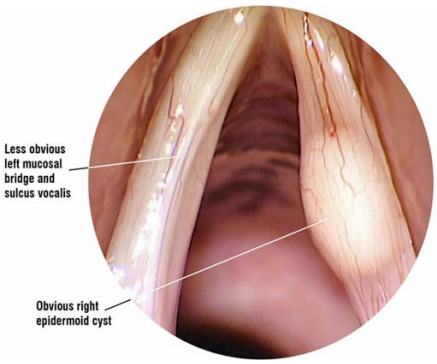
- **congenital web**
  - it's a web that connects the vocal folds together
  - they do surgery in order separate them and widens the opening of the vocal folds



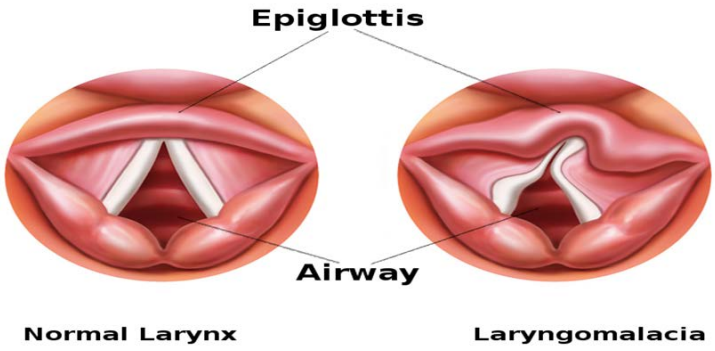
- **congenital subglottic stenosis**
  - A child is born with a smaller than normal airway



- **congenital cyst**
  - usually located at the **supraglottis**
  - can be **bi** or **uni** [on one or both] on Vocal folds
  - if it passed a certain point then surgery will be needed



- **laryngomalacia**
  - laryngeal structure is **malformed** and **floppy**, causing the tissues to fall over the airway opening and partially block it



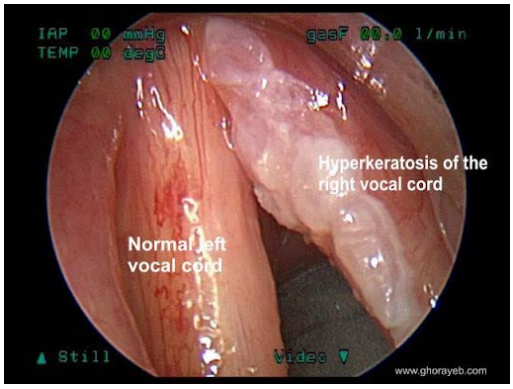
- **laryngotracheal cyst**
  - It has a tendency to progressively enlarge and if left undiagnosed, it can cause life-threatening acute airway obstruction

2) Pathologies of the Vocal fold Cover:

- **acute laryngitis**:
  - a **short-term inflammatory condition** affecting the larynx, or voice box
  - lasts less than 3 weeks
- **chronic laryngitis**:
  - an **inflammatory condition** affecting the larynx (voice box)
  - persists for more than 3 weeks
- **nodules**:
  - growths that form on the vocal cords
  - benign (noncancerous)
- **polyp**:
  - noncancerous growths or bumps like calluses on your vocal cords
- **Reinke's edema**:
  - degeneration of one or both vocal folds within Reinke's space
- **cyst**:
  - are enclosed, sac-like structures
  - typically of a yellow or white colour
  - They occur unilaterally on the midpoint of the medial edge of the vocal folds
- **contact ulcer**:
  - occur when too much force is used in speech
  - also caused by gastroesophageal reflux → acidic
- **granuloma**:
  - masses that result from irritation

- **Nodules**: Symmetric masses
  → Appear in **pairs one on each vocal cord**
- **Polyps**: Blister-like bumps
  → Appear on **one or both vocal cords**
- **Cysts**: Fluid-filled sacs that
  → Appear on **one vocal cord**

    - non-cancerous,
- **papilloma**:
    - They are caused by human papilloma virus (HPV)
    - if they grow large enough they can impair the ability to breathe
- **leukoplakia**:
    - "white plaque"
- **Hyperkeratosis**:
    - an overgrowth of irregular margins on the vocal folds



- **carcinoma (cancer)**:
    - caused by chronic irritation of the laryngeal epithelium and mucosa
    - caused by tobacco, smoke, and alcohol
- **hemorrhage**:
    - is the **result of phonotrauma** → the physical stresses caused by voicing, upon the tiny blood vessels of the vocal fold
    - may rupture and bleed after:
        → loud voicing,
        → sustained voicing
        → when they are more fragile than normal [when they are swollen during laryngitis]
- **varix**:
    - prominent, dilated, and commonly tortuous vein found on the surface of the vocal fold
- **sulcus vocalis**:
    - a groove or infolding of mucosa along the surface of the vocal fold

3) Neurogenic Laryngeal Pathologies:

- **spasmodic dysphonia**:
  - causes involuntary spasms in the muscles of the voice box or larynx
  - causes the voice to break and have a tight, strained or strangled sound
- **essential laryngeal tremor**:
  - central nervous system disorder that is characterized by rhythmic movements (tremors) of various body parts, which can include the larynx
- **vocal fold paralysis**:
  - the nerve impulses to the voice box (larynx) are disrupted

4) Pathologies of Muscular Dysfunction:

- **ventricular phonation**:
  - the sound is from false vocal folds instead of the true vocal folds
- **conversion aphonia/dysphonia**:
  - usually happens with women
  - **dysphonia** → hoarseness in sound
  - **Aphonia** → no sound
- **functional falsetto**:
  - a functional voice disorder that is characterized by the habitual use of a high-pitched voice after puberty
- **juvenile voice**:
  - weakness in voice/vocal fatigue
  - higher pitch
- **laryngeal myasthenia**:
  - muscle fatigue and doesn't move correctly

The Diagnostic Voice Evaluation:

The diagnostic voice evaluation:

- is a **primary therapy tool**
- The **effectiveness of the evaluation** will dictate the **success** or **failure** of therapy
- If you messed up here, then everything else will be wrong
- **Primary objectives** of voice evaluation:
  - **Identify** the causes
  - **Describe** the present vocal components
  - **Develop** the management plan

- **Secondary objectives**:
  - Patient **education**
  - Patient **motivation**
  - **Establish credibility** of voice pathologist

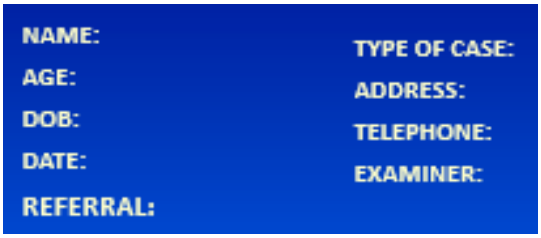
- **Referral Sources**:
  - otolaryngologists
  - other medical specialists
  - speech-language pathologists
  - vocal coaches
  - singing teachers
  - former patients
  - family
  - friends

- **Professional relationships**:
  - **Evolution** of the voice team → people are strong in different areas
  - **Complementary** relationships → work together
  - **Comments** on medical speech pathology

- **The medical examination**:
  - **Indirect laryngoscopy** → mirror (not directly) used a reflected picture
  - **Fiberoptic laryngoscopy** → nasal
  - **Direct laryngoscopy** → looking at them directly
  - **Laryngeal videostroboscopy**

- **The voice pathology evaluation**:
  - **Patient interview**
  - **Subjective voice assessment** → *Example: hoarseness, hypernasality*
  - **Instrumental assessment** of vocal function → *tongue depressor, mirror, nasometer, etc.*
  - **Laryngeal videostroboscopy**

❖ In the Voice evaluation form:



The beginning of the form

- Reason for referral:
  - We have to know **who referred them**
  - We have to know **the exact reason why they were referred**
  - We have to **establish patient understanding of the referral**
  - We have to **develop knowledge of the voice disorder**
  - We have to **establish the credibility of the examiner** [us]

- History of the problem:
  - **Establish chronology** of problem
  - **Seek etiological factors** associated with the history
  - **Determine patient motivation**

- Medical History:
  - **Seek medically-related etiologic factors**
  - **Establish awareness** of patient

- Social history:
  - **Environments** → *work, home, recreational*
  - **Discover** emotional, social, family difficulties
  - **Seek more etiological factors**

- Oral-Peripheral examination:
  - **Determine physical condition** of oral mechanism
  - **Observe whole body tension**
  - **Observe laryngeal area tension**
  - **Check** for **swallowing difficulties**
  - **Check** for **laryngeal sensation**

❖ Perceptual Evaluation:

- General Quality:
  - **Describe voice quality** using description terms
    - *Example: nasal, hypernasal, breathy, hoarse* → may use scale system
  - **Examine inappropriate** use of voice components

- Respiration:
  - **Describe** type of **breathing pattern**
    - **supportive** → power [there is sound]
    - **nonsupportive** → no power [barely any sound]

- **s/z ratio**:
  - ❖ the maximum phonation of /s/ **OVER** the maximum phonation of /z/ and that should be equal to 1 [or close to 1]
- **Maximum phonation** time

➢ Phonation:

- **Hard glottal attacks**
  - ❖ *example: when someone scares you and you make a quick sound [Oh, agh, egh]*
- **Glottal fry**
  - ❖ very low voice
- **Breathiness**
- **Diplophonia:**
  - ❖ echo [like two voices together] → **False** and **true** vocal folds together

➢ Resonation:

- **Hyper**nasal
- **Hypo**nasal
- **Assimilative nasality**
- **Cal de sac** nasality:
  - ❖ has to do with the cavities [even though there is no problem with them] → there is no cause
- **Inappropriate tone focus**

➢ Pitch:

- **Test present pitch range**
- **Describe conversational** inflection
- **Make subjective judgment of appropriateness** (optimum pitch)

➢ Loudness:

- Too loud, soft, appropriate
- **Check ability** to shout/talk softly

➢ Rhythm and rate:

- Too fast
- Too slow
- Interrupted
- Throat clearing
- Coughing
- Unusual laugh

} Non speech abuses

- **<u>Impressions</u>**: **Summarize** the **etiologic factors** associated with the development and maintenance of the voice disorder
- **<u>Prognosis</u>**: **Analyze** the **probability of improvement** through voice therapy
- **<u>Recommendations</u>**: outline the **management plan**

Instrumental Measurement of Voice: Clinical Utility

Instrumental measurement of voice [clinical utility]:

- **Detection** → identify the existence of a voice problem
- **Severity** → assess the severity or stage of progression of the voice problem
- **Diagnosis** → identify the differential source of voice problem

Instrumental measures in the voice laboratory:

- **Laryngeal videostroboscopy**:
- **Acoustic recording and analysis**
- **Aerodynamic assessment**
- **Electroglottography**
- **Electromyography**

A. Laryngeal Videostroboscopy:

- **Demonstrates** the gross movements of the laryngeal structures
- **Provides** immediate image of **presence** or **absence** of pathology and a permanent visual record
- **Demonstrates** the **characteristics** of vocal fold vibration and the integrity of the mucous membrane fold covering
    - <u>Principles of Stroboscopy</u>:
        - Talbot's law:
            - Talbot's law states that once an image is presented to the eye, it persists on the retina for 0.2 sec → 1/5th cycle per second
            - A rabidly rotating or vibrating object cannot be seen if the speed of repetition of movements exceeds 5 images per seconds
        - It is a **special method** of examination of a vibrating or fast-moving object, such as the vocal folds.
        - A **bright flashing light** lasting a fraction of a second (10µs) is used to **illuminate the vocal folds**.
        - This flash **'freezes'** the movement of the **vibrating vocal folds**.
        - By taking **multiple snapshots** at **different phases** of the vibratory cycle, it is possible to see details of the change in shape of pliable surface of the vocal folds (i.e. the mucosa) with time.

- Stroboscopy and Talbot's law:
  - vocal fold vibration is **too rapid** to be perceived by the human eye
  - **strobe light flashes** on the vibrating vocal folds
  - each light pulse **illuminates a point** of the vibratory cycle
  - **illuminated points** are visually fused providing an **averaged vibratory pattern** over successive cycles
  - when the flashes are emitted at the **same frequency as phonation**, they optically occur at the **same phase point** in the successive cycles and the images appear frozen
  - when flashes are **slightly slower (2 Hz)** than the frequency of phonation, they optically occur at **different phase points** in successive cycles yielding a simulated slow-motion effect of the vocal folds vibration

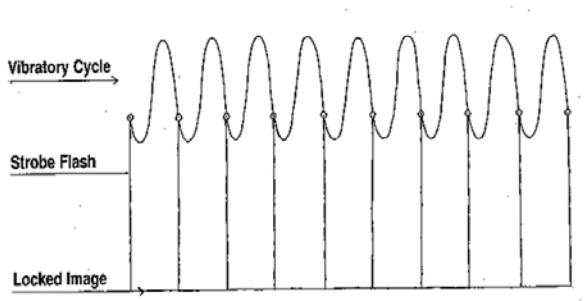


Figure 6–5. Strobe flash at the same point in the vibratory cycle: still image.

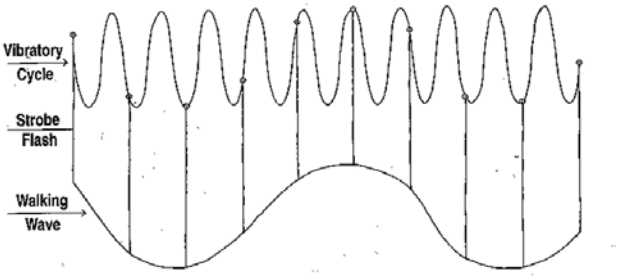


Figure 6–6. Strobe flashing at different points in the vibratory cycle: travelling image.

- **Instrumental components of Stroboscopy**:
  - stroboscope
  - *rigid* or **flexible** endoscope
  - video camera
  - video recorder
  - video monitor
  - video printer
  - computer interface

- **Assessment of Stroboscopy Parameters**:
  - **Glottis closure**
    - → Observed during vibration of the vocal cords
  - **Supraglottic activity**
    - → Venticular Fold compression
    - → Anterior posterior compression
  - **Vertical level approximation**
    - → modified by superior laryngeal nerve paralysis
    - → modified by large mass lesion such as polypoid degeneration
  - **Vocal fold edge**

- **Amplitude of vibration**
  - → Lateral excursion of the vocal folds
- **Mucosal wave**
  - → May be affected by pathology, scarring, pitch, loudness, hyperfunction, hypofunction, anxiety, subglottic driving force
- **Non-vibrating portions**
  - → Scarring or lesion or paralysis
- **Phase closure**
  - → Closed and open phase time should be equal
- **Phase symmetry**
  - → Mirror image

- **<u>Stroboscopy Procedure</u>**:
  - How to get successful stroboscopic image
  - Recording protocol
  - Report writing
  - Artifacts *[not naturally present but occurs as a result of the preparative or investigative procedure]*
    - → Not real time (very fast)
    - → Image seen through optical devices
    - → Speech sample may not be a representative

B. Acoustic Recording and Analysis:

- provides an **imperfect**, **non-invasive measure** of vocal function
- it can discriminate normal from pathologic voice
- is **inconsistent agreement** between **acoustic measures** and **audio-perceptual** ratings of voice quality
- can measure **change in vocal production** across time

➢ <u>Routine Voice Acoustic Measures</u>:

❖ **fundamental frequency [f0]**:

- **directly reflects the vibration rate** of the vocal folds [pitch]
  - → **unit of measurement:** Hertz (Hz) or cycles per second
  - → **normative data** = 100 - 150 Hz males / 180 - 250 Hz females
  - → **Measured by**: from sustained vowels, reading, or conversation
  - → **Purpose**: useful to **estimate the appropriateness** of [f0] for sex and age and for demonstrating *pre* and *post*-treatment change

- **frequency variability**:
  - **pitch sigma**: is the **standard deviation** of the fundamental frequency
    - → reflects the **degree** of an **individual's variability**
    - → **assesses** and **documents variation** of [f0] during speech production

- **phonation range**:
  - **range of frequencies** from the highest to the lowest that a patient can produce
    - → **Unit**: may be **expressed in Hz or semitones**
    - → In general, normal young adults have about **a three octave range** → may vary with practice *[example: singing]*

- **frequency perturbation** [pitch break]:
  - the **change of frequency** from **one successive period** to the **next**
    - → **unit of measurement**: jitter
      - ✓ **Normative data for jitter**: percent is less than 1.00%
    - → **measured by:** must be made from **sustained vowels**
    - → may **represent variation of**:
      - ✓ vocal fold mass
      - ✓ tension
      - ✓ muscle activity
      - ✓ neural activity
        - all of which may effect the **periodicity** of vocal fold vibration

- **Intensity [I0]**:
  - **directly reflects** the **sound pressure level** (SPL) of voice *[loudness]*
    - → **unit of measure is**: the logarithmic decibel (dB) scale
    - → **measured by**: from sustained vowels, reading, or conversation
    - → useful as *pre* and *post-treatment* measure

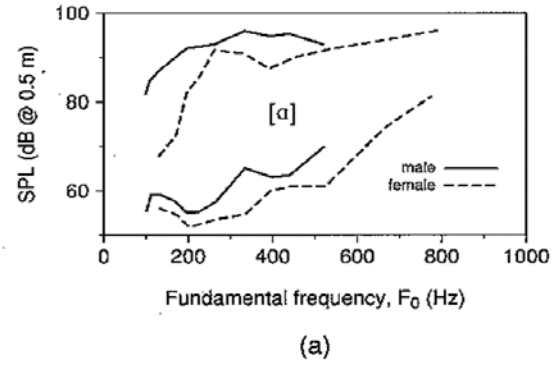
- **overall SPL**:
  - average SPL in dB
    - → indication of the **strength of vocal fold vibration**
    - → **Normal conversations**: 75 – 80 dB

- **amplitude variability**:
  - standard deviation of the SPL during **connected speech**
    - → reflects **loudness variability**

- **Dynamic range**:
  - **range of vocal intensities** that a person can produce
  - **Normal**: 50 – 115 dB SPL

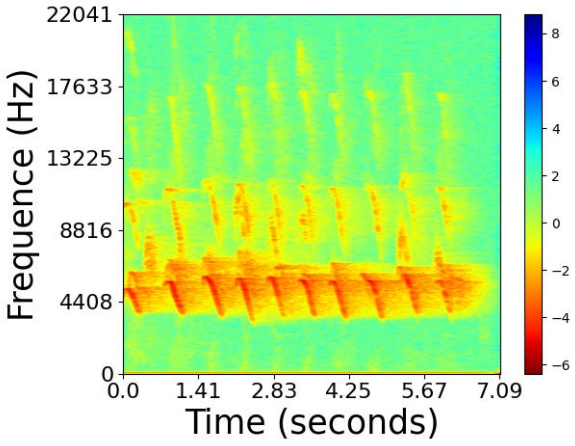
- **Amplitude perturbation**:
  - small **cycle to cycle** changes of the amplitude of the vocal fold signal
    - → **Unit of measurement**: shimmer
      - ✓ **Normative data for shimmer**: less than 35 dB
    - → **Measured by**: sustained vowels
    - → may **represent variation of**:
      - ✓ vocal fold mass
      - ✓ tension
      - ✓ muscle activity
      - ✓ neural activity
        - all of which may effect the **amplitude** of vocal fold vibration
- **Harmonics to Noise Ratio**:
  - measures the ratio between **periodic** and **non-periodic** components of a speech sound *[voice signal / noise signal]*
    - → **greater signal** or **harmonic energy** in the voice reflects **better voice quality**
    - → **large noise energy** represents more **abnormal function**

- **Voice Range Profile (Phonetogram) [VRP]**:
  - plots **maximum** and **minimum intensities** for entire frequency range
    - → **resulting plot**: ellipsoid-shaped
    - → **frequency/intensity** profile and the dimensions are expressed in semitones
    - → most useful in *pre* and *post-treatment* of professional voice users



(a)

- **Spectral Analysis**:
  - a **sound spectrogram** displays the **glottal sound source** and **filtering characteristics** across time
    - → both **formant frequency energy** (vocal tract resonance) and noise components (aperiodicity) represented in a three-dimensional scale
    - → **horizontal axis** = time
    - → **vertical axis** = frequency (lowest band = fo; formants are above)
    - → **gray scale** (darkness) represents intensity change



- <u>Acoustic Recording considerations</u>:
  - must be a **quasi-periodic**, **stable sound source**
  - **most measures** are taken from the **stable vowel /a/**
  - measures must be *at least* **1 second in length**
  - the **greater the dysphonia (hoarseness)** → the **less confidence** in the acoustic measures
  - **variations in [f0], [I0], and vowel** will affect measurements
  - number of trials must be adequate to represent speech behavior

- must attend to **intrasubject variability** by controlling for **intensity** and **frequency** in the **re-test condition**

Intrasubject variability:

The range of possible values for any measurable characteristic, **physical or mental**, of a human being, analyzed, examined, investigated, experimented upon, or treated in the course of particular study.

C. Aerodynamic Analysis of Voice:

- **Aerodynamic measurement** of voice production concerns measurements of air pressures and air flows that are meaningful in clinical diagnosis and treatment.
- These measures may help interpret:
    - Changing activity of the larynx
        - → **vocal fold structure**
        - → **vocal fold configuration**
        - → **vocal fold movement**

➢ <u>Instruments for measuring pressure and flow</u>:

- **U tube manometer**
- **wet spirometer**
- **hot wire anemometer**
- **magnetometers**
- **pnuemotachograph**

➢ <u>Common aerodynamic measures</u>:

- **airflow volume:**
    - **volume of air in the lungs** available to drive the vocal folds for voice production
    - **measurement**: liters
    - will vary with age, sex, size, health
- **airflow rate:**
    - **rate at which air passes** between the vocal folds during phonation
    - **measurement**: liters/sec
    - **normal rate** = 50 – 200 ml/sec
- **maximum phonation time**:
    - **maximum time** that a vowel may be sustained while using maximum airflow volume
    - will vary with lung capacity, age, sex, size, health

- **subglottal air pressure (Psub):**
  - **measure of air pressure beneath** the vocal folds necessary to overcome the resistance of the approximated folds to initiate and maintain phonation (to open the vocal cords)
    - → ***direct measure*** *is necessary through needle puncture into trachea*
    - → **measurement**: cm/H20
    - → **norm for conversational voice**: 3 – 7 cm/H20
    - → **intraoral pressure** measures reflect **subglottal pressure**
    - → **Factors** that will influence Psub:
      - ✓ vocal fold stiffness,
      - ✓ hypo/ hyper function,
      - ✓ incomplete glottic closure

- **phonation threshold pressure**:
  - a measure of the **effort** needed to **initiate phonation**
  - **measurement**: is estimated *indirectly* using **intraoral air pressure** measured at the *exact* moment of **voice onset** for barely audible phonation
  - speakers with **vocal pathologies** often require **greater effort to initiate phonation**

- **laryngeal (glottal) resistance:**
  - This is a combination measure that utilizes measures of pressure and flow in a ratio.
  - **Laryngeal resistance**: is the **quotient** of *peak intraoral air pressure* (from unvoiced plosive) divided by the *peak flow rate* (measured from a vowel)
    - → *Example: /pi/pi/pi/*
    - → *measured from a* ***repeated consonant*** *+* ***vowel syllable***
  - **Purpose**: estimates the **overall resistance of the glottis** and therefore the valving characteristics:
    - → too tight
    - → too loose
    - → normal

- Aerodynamic Recording Considerations:
    - **requires airtight seals** around the lips or mask to face
    - **as much natural speech as possible** must be encouraged in this foreign environment
    - **multiple trials** are necessary to ensure a stable baseline
    - **instrument calibration** is required prior to each examination session

D. Electroglottography (EGG)

- using an electrical current passing through the neck
- **EGG measures**: vocal fold contact across time

E. Electromyography (EMG)

- The **only direct measure** of laryngeal function.
- **Needle electrodes** are inserted into the **laryngeal muscles** and the pattern of electrical activity is measured

Advantage of Voice assessment

For clinician:

- extends the *ear* and *eye* of the observer
- **objectifies** the analysis of the observations [official]
- **supplements the perceptual judgements** [proof of suspicions]
- **aids** in the appraisal of vocal mechanics [helps in estimation]
- **helps to establish** management strategies
- **establishes a baseline** for measuring treatment effects helps in giving treatment]

For patient:

- **provides permanent record** and **documentation**
- **forces** care-givers to be **accountable**
- provides **objective documentation** for healthcare companies
- facilitates **the understanding of the relationship between the voice perception and the underlying physiology of the voice production** [the patient can observe and understand what is happening with them]
- tests are **generally easy** for the patient to perform
- provides **immediate results** and **feedback**
- provides **visual image of the voice problem**
- essentially non-invasive
- **management** often proves to be more cost-effective
- **provides a record** against which the patient may measure management progress over time

Chapter Four: Pediatric Voice

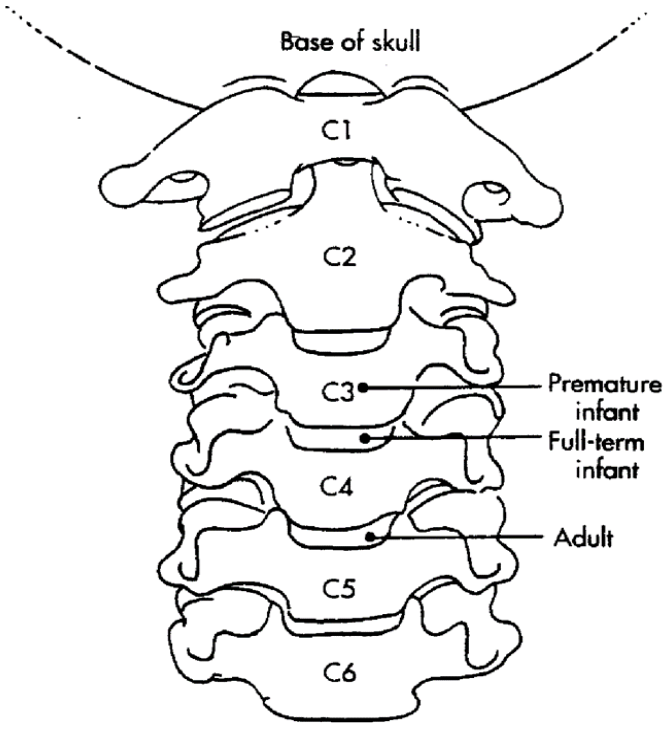
Pediatric Voice

The most important consideration when it comes to the pediatric population is → **the preservation of the airway**.

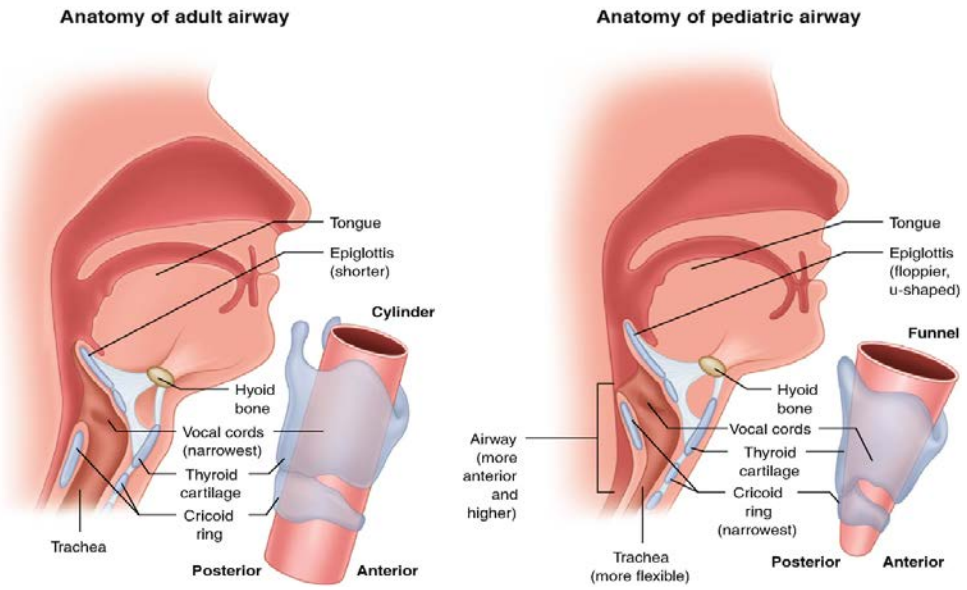
- The larynx/airway is almost the **most important system** of the entire infant

The differences between **adult** laryngeal anatomy and pediatric laryngeal anatomy is *more significant* than the mere size of the structures.

Position of the Larynx		
Infant (between 8 days and 2 years old)	**Child (Between 2 and 11 years old)**	**Adult (12 years old +)**
the larynx can rise as high as **first** or **second** cervical body during swallowing	the larynx sits opposite approximately the **fourth** cervical vertebral body	the larynx sits opposite approximately the **fifth** or **sixth** cervical vertebral body

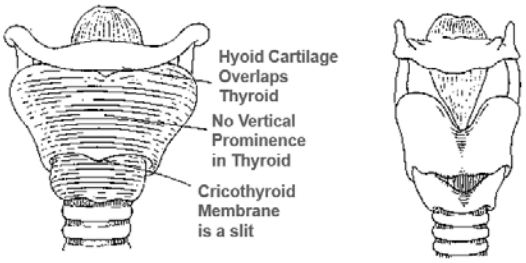


Laryngeal Structures	
Pediatric	**Adult (12 years old +)**
The **thyroid notch** is **not prominent** like it is in the adult larynx. It is obscured by the overlapping hyoid bone	the **cricothyroid membrane** can be felt as a depression between the **thyroid** and the **cricoid** ➔ however, in the pediatric larynx it is just a little slit
The **thyroid cartilage** is **not prominent** as it is in the adult → **more rounded** with **no midline vertical ridge**	
The **cricoid cartilage** is also **not prominent**	
The pediatric **trachea** is 4 – 5 mm in diameter	x
The **aryepiglottic folds** and the **arytenoid cartilages** are **large relative** to other laryngeal structures	x
It is estimated that **50% of infant epiglottis** are omega shaped	x
The **larynx** takes a **curved shape**	Starting from the **base of the tongue** → the airway takes a rather **straight vertical shape**
x	the angle of the **epiglottis** is somewhat vertical and in alignment with the trachea (not in the pediatric larynx)



Immature

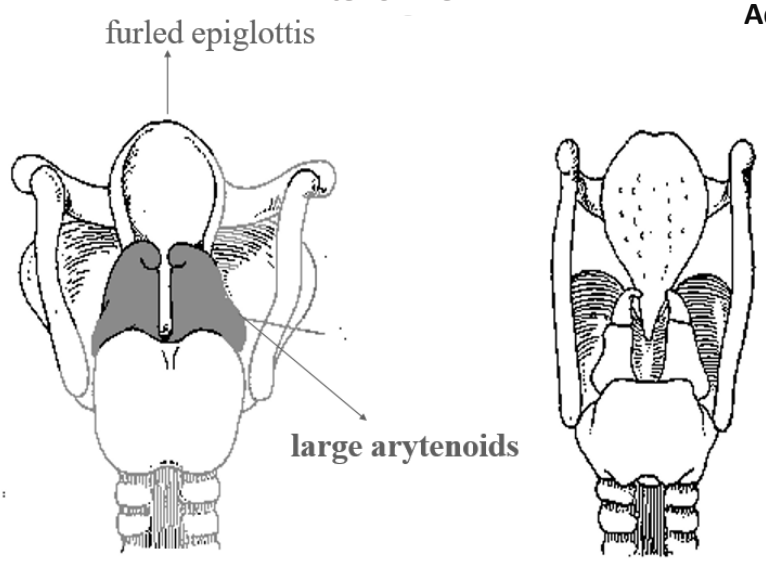
Mature

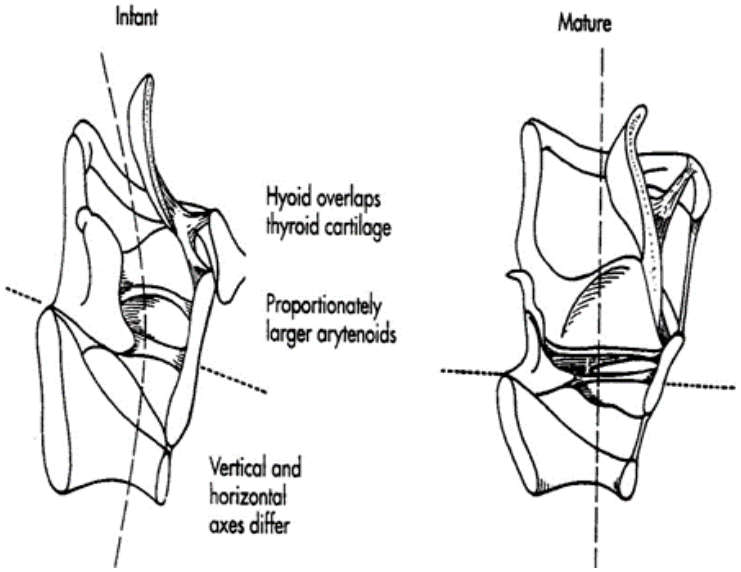


Pediatric

Anterior View

Adult





In general:

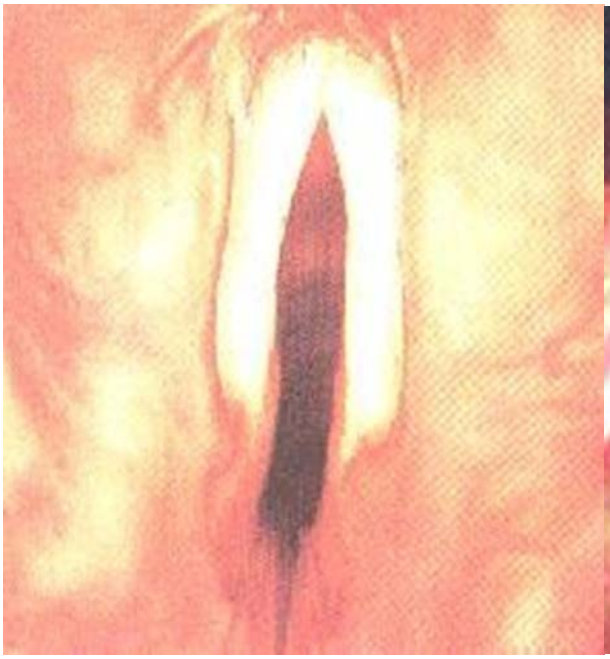
	Infant	Adult
Head	Large, prominent occiput	Flat occiput
Tongue	Relatively larger	Relatively smaller
Larynx	Cephalad position Opposite to C2–C3	Opposite to C4–C6
Epiglottis	Omega-shaped & soft	Flat and flexible
Vocal cords	Short & concave	Horizontal
Narrowest portion	Cricoid ring, below cords	Vocal cords
Cartilage	Soft	Firm
Lower airways	Smaller, less developed	Larger, more cartilage

Chapter Four (part two): The Vocal folds (material 4)

Vocal Folds

The length of the vocal folds:

- **Pediatric**:
  - → Length of the entire vocal fold in newborns is about **2.5 – 3.0 mm**
  - → There is no gender difference up until the age of 10
- **Adult**:
  - → in **males**: **17 – 21 mm**
  - → in **females**: **11 – 15 mm**



Adult Vocal Folds (normal)

Pediatric Vocal Folds (normal)

Anatomical – Clinical consequences:

- Because of the **pliable tissue lining the pediatric larynx** → normal respiratory pressure may be enough to deform the laryngeal structure (e.g. Laryngomalacia and Tracheomalacia)
  - → ***Laryngomalacia*** is a common cause of noisy breathing in infants. It happens when a baby's larynx (or voice box) is soft and floppy. When the baby takes a breath, the part of the larynx above the vocal cords falls in and temporarily blocks the baby's airway.
  - → ***Tracheomalacia*** is a rare condition that happens when the cartilage of the windpipe, or trachea, is soft, weak and floppy. This can cause the tracheal wall to collapse and block the airway, making it hard to breathe.
- The **curved shape of the pediatric airway** should be considered while conducting **laryngoscopy, stroboscope** and **intubation**
- The **narrowness of the cricothyroid membrane depression** in the pediatric larynx should be taken into consideration while considering a **cricothyrotomy** or a **cricothyroid puncture.** It is also important if a **botox injection** is considered.
  - → ***Cricothyrotomy*** is a procedure that involves placing a tube through an incision in the cricothyroid membrane (CTM) to establish an airway for oxygenation and ventilation
- The **large size of arytenoid cartilages** obscures much of the vocal folds

Vocal Abuse/Misuse

Laryngeal hypertension:

- ***Nodules***
- ***Polyps***
- ***Contact Ulcers***
- ***Cysts***

Whenever misuse occurs:

- It reduces the phonatory mechanism's ability to work efficiently
- It also disrupts coordination of the supporting parts

Inappropriate pitch level:

- ***Puberphonia*** →it is a functional voice disorder that is characterized by the habitual use of a high-pitched voice after puberty
- ***persistent glottal fry*** → is the lowest vocal register and is produced through a loose glottal closure that permits air to bubble through slowly with a popping or rattling sound of a very low frequency
- ***lack of pitch variability*** → lacking in changing the pitch

Excessive talking misuse depends on:

- how much
- how fast
- how loud

Other types of misuse:

- ***Ventricular phonation*** → Ventricular phonation happens when the ventricular folds, also known as the false vocal folds, compress and squeeze over the true vocal folds.
- ***aphonia*** or ***dysphonia*** of a psychological origin

Increased tension and strain misuse:

- ***hard glottal attack***
- ***high laryngeal position***
- ***anteroposterior laryngeal squeezing***

Benign lesions:

- Hoarseness
- Epithelial Lesion
- Abnormal Tissue Growth
- ***Leukoplakia***, ***Hyperkeratosis***

- ***Leukoplakia*** → plaque like
- ***Papillary keratosis*** → warty like

Trauma:

- Attempted strangulation, blunt or penetrating neck wound
- Laryngeal fracture/crush
- Surgical reconstruction

Ventricular Phonation:

- DX (diagnosis) is usually made during the laryngoscopic examination
- Determine compression versus vibration

Stroboscopic Signs:

- **Abnormal symmetry** and **periodicity**
- **Reduced amplitude** of **excursion**
- **Reduced mucosal wave**

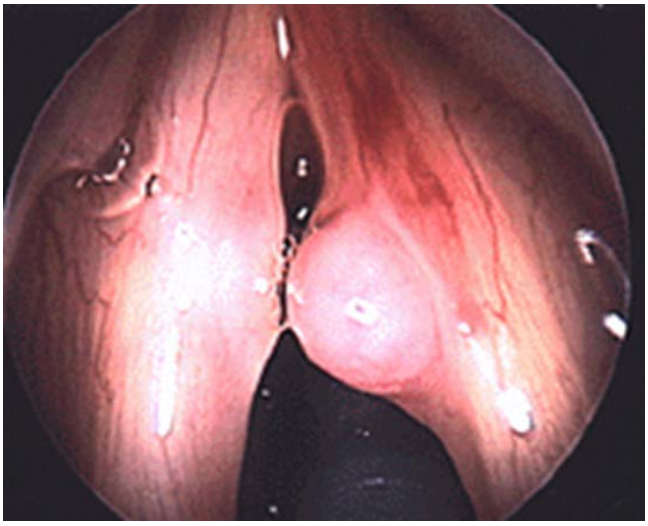
Edema:

- **Fluid buildup** and **retention**
- Location: Typically on **superficial layer**
- Cause: Related to **abuse** and **smoking**

❖ **Laryngoscopic and Stroboscopic Signs**:
- Fluid filled
- Usually bilateral
- Greater mucosal wave
- Increased mass
- Decreased stiffness

Intracordal Cysts:

- **Hoarsness**
- Margin of folds
- Location: **Superficial layer of lamina propria**
  - → *retention cyst*
  - → *epidermoid cyst*
- Affects **young women** and **professional voice users**



❖ **<u>Stroboscopic Signs</u>**:

- **Absence** of **mucosal wave** over the cyst
- **Reduced glottal closure**
- **Asymmetry**
- **Mass** and **stiffness** affected

Sulcus Vocalis:

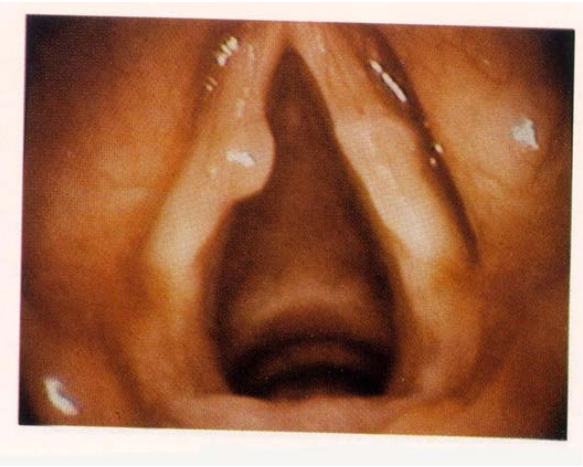
- **Hoarseness**
- Furrow/groove along upper medial edge of the epithelium
- Location: **Superficial layer of lamina propria**
- Varies in **length** and depth
- etiology uncertain:
  - → abuse
  - → congenital
  - → trauma

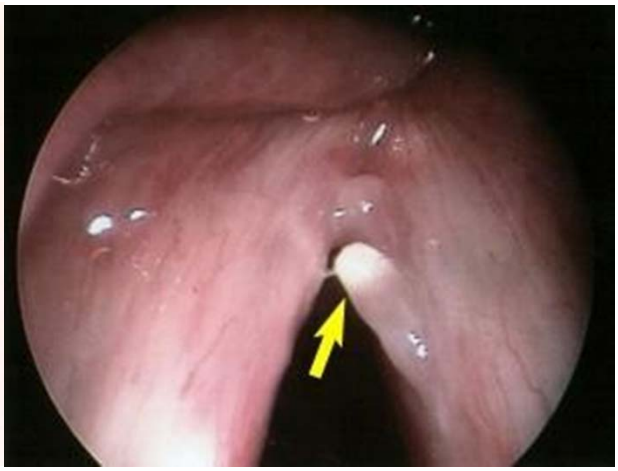
❖ **<u>Laryngoscopic and Stroboscopic Signs</u>**:

- Depression along edge of fold
- Diminished vibrational amplitudes
- Little mucosal wave along edge of fold

Polyps:

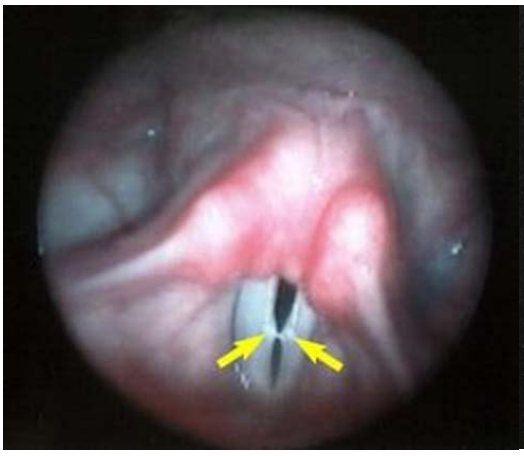
- **Hoarseness**
- Very **similar to nodule** in **etiology**
- Different in terms of pathophysiology
  - → Larger
  - → more vascular
  - → Inflammatory

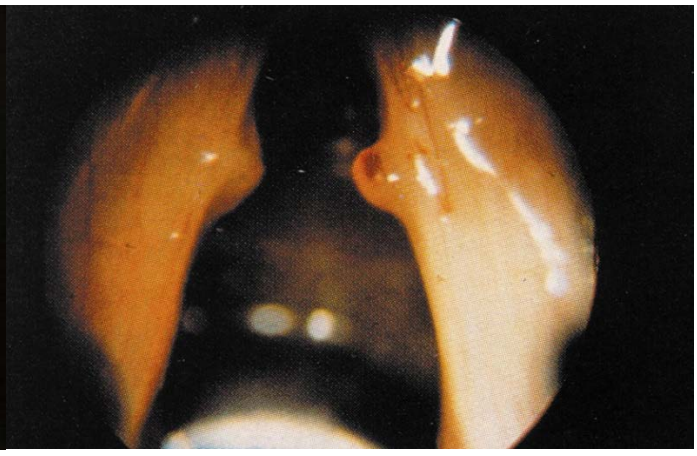




Vocal Nodules:

- **Hoarseness**
- **Benign growths**
- Reaction to compression forces on folds
- **Acute** vs. **chronic condition**
  - → *vascular/edema* vs. *hyalinization/fibrosis*





❖ **Who and Why?**

- Children and women
- Alcohol and smoking
- Personality

❖ **Where?**

- Reinke's space

❖ **Laryngoscopic Signs**:

- Midpoint or anterior 1/3 posterior 2/3 junction
- **Incomplete** glottal closure
- Varying degrees of size

Puberphonia:

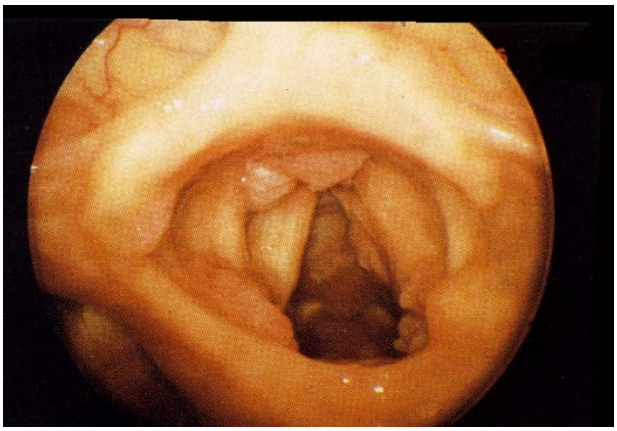
- Adolescent falsetto, Pubescent falsetto, Incomplete mutation, Mutational falsetto
- **Persistence of a high pitched voice** beyond the age at which the male voice change is expected to have occurred

Papilloma:

- **Lesions** may exist in the **subglottal, glottal** or **supraglottal** areas
- **Tracheotomy** may be necessary
- No acoustic & aerodynamic data
- Laryngoscopy shows **whitish cluster** of tissue
- **Reduced** or **absent** mucosal wave
- Altered biomechanics
- **Increased VF mass**

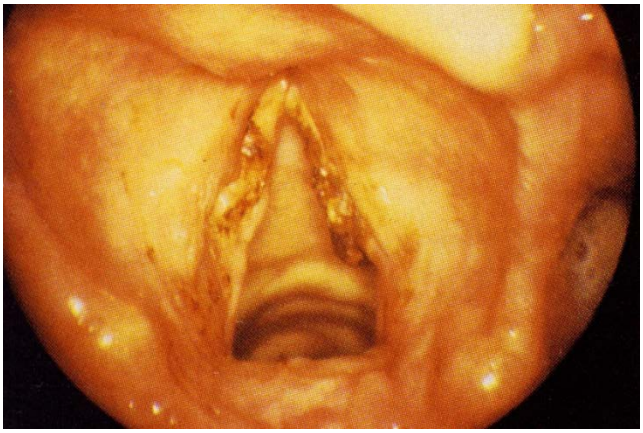
- **Hoarseness**
- Epithelial lesion
- Fairly common
- Possible viral etiology
- Affects both **children** and **adults**
- Resistant to Tx (treatment)
- **Obstruction of airway** - proliferation

laryngeal papilloma



Keratosis:

- **Pre-malignant tissue growth** on the **vocal folds**
- **Originates on the epithelium** → but may enter the **superficial layer of the lamina propria**
- **Other terms**: *leukoplakia, hyperkeratosis*
- 2 kinds of lesions:
  - → **flat, white plaque-like lesions** (leukoplakia)
  - → **warty lesions** (papillary keratosis)



- **Cause**:
  - → smoking, environmental pollutants, GERD
- Lesions may be **unilateral** or **bilateral** and **asymmetric** in appearance
- **Rough glottal edge**
- **Perceptual signs**:
  - → hoarseness or roughness

Vascular Disorders:

- ***Hemorrhage***
  - → **hoarseness**, **aphonia** and **loss of pitch range**
  - → usually **unilatera**l
  - → reddish color → dark on visual exam, prominent vessel
  - → stem from **trauma**, **steroid use**, **anti-coagulant**
  - → **pain**
  - → **vocal fatigue**

- ***<u>Varix & Ectasia</u>***
  - → **<u>VARIX</u>** - Prominent blood vessel *distended* (swollen)
  - → **superior surface** or edge
  - → **associated many times** with **polyp**
  - → **abuse/trauma**
  - → **<u>ECTASIA</u>** - *Dilation* of small blood vessel

Ankylosis of the CA Joint:

- **Hoarseness/ breathiness**
- Fixation of CA joint:
  - → *arthritis*
  - → *trauma*
- Similar to VF paralysis
- **Pain** = **differentiating symptom**
- No acoustic & aerodynamic data

❖ **<u>Laryngoscopy & Stroboscopy</u>**:

- **Lack of movement** of **impaired arytenoid**
- **Incomplete glottal closure**
- **Bilateral** versus **unilateral** signs
- **Edema**, **irritation of the joint**

Thermal Trauma:

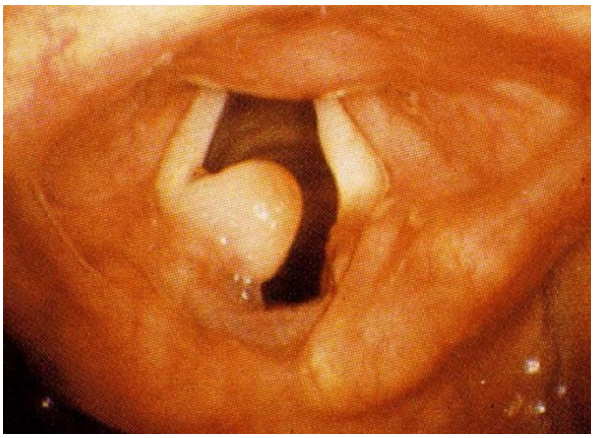
- Chemical tracheobronchitis
- **Edema**
- **Airway obstruction**
- **Tracheotomy** required
- Intubation → double dose of irritation
- Stridor → an abnormal, high-pitched, musical breathing sound

❖ **<u>Etiology</u>**:

- **Smokers** Vs. **non-smokers**
- **Secondary smoke**
- **Environmental pollutants**
- Premalignant Sign?

Granulomas:

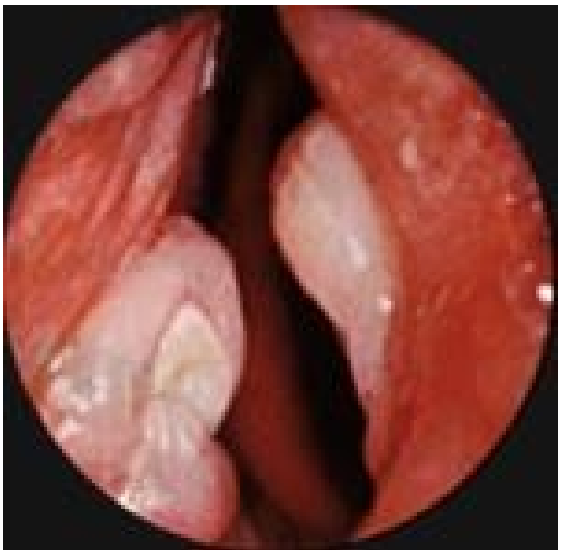
- **Frequency of occurrence** is **small**
- Dependent mostly on **intubator's skill** and **duration of intubation**
- Foam and Cuff developed by Weymuller (1988)



- **Hoarseness**
- Due to **intubation/extubation**
- **Life threatening** airway limitation
- **Anesthesia application**
- **Mucoperichondrium** becomes irritated
- **Ulcer** results
- **Granulation** tissue covers

Contact Ulcer/Granuloma:

- **Stomach secretions** or **secretions from nose**
  - → ***PND (posterior nasal drip)***
- **Fatigue**
- **Throat clearing**
- **Slight hoarseness** possible
- **Throat pain** – hyoid
- **Medial surface** of **vocal process**
- **Ulceration/bacteria**
- **Irritation** on **<u>both</u> processes**
- Etiology:
  - → *abuse*
  - → *closure pattern*
  - → *gastric reflux*
- Adult males



Chapter Five: Material Five

Diagnostic Approach to the Patient with a Voice Disorder:

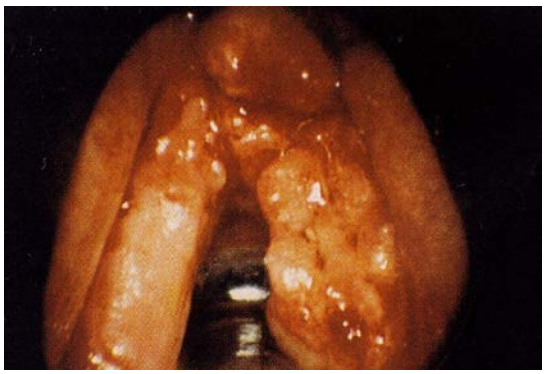
- **A multidisciplinary approach**:
  - Neurologists participate in the evaluation of most patients with:
    - → *vocal fold paresis*
    - → *vocal fold paralysis*
    - → *neuromuscular diseases*
    - → *movement disorders*
  - The **neurologist** and **laryngologist** work together to perform *laryngeal electromyography* and treat patients with **laryngeal movement disorders**
  - **Speech Pathologists**:
    - → They evaluate **vocal function** and they should be well trained to do so
    - → they have an **educational** and **counseling** role
    - → they also have a **pre-post-surgery role**

Organic Voice Disorders:

- **Organic voice disorders**:
  - Not related to how the voice is used
  - **Tx (treatment)** is either **surgical** or **medical**

Carcinoma:

- **Lump** in the **neck**
- **Tenderness** in **neck**
- **Hoarseness**
- **Dysphagia**
- **Dysphagia**
- **Dyspnea**
- **Biopsy** required for DX



- **Incidence**
  - → 2-5% of all malignancies
- **Persistent hoarseness**
- Smoking, environmental irritation, chemicals, metabolic disturbances, unknown
- **50 - 70%** of **laryngeal cancers** are associated with **smoking**
- **Synergistic effect** with **alcohol**

❖ *American Joint Committee for Cancer Staging and End Results Reporting*:

- **T** = site of primary tumors
- **N** = lymph node involvement
- **M** = metastasis (transfer of disease)
- Lower number = less involvement

Neurogenic Voice Problems:

- Differentiate between **CNS** and **PNS** problem
- **Function of CNS** - initiation and coordination of function
- **Function of PNS** - carries instruction of CNS to muscles and various organs

❖ **<u>Role of the Nervous System</u>**:

- ***Lateral Precentral Cortex***
  → Motor area in the CNS thought to control function
- **Dysphagia**, **aphasia**, **dysarthria**
- **Anterior Cingulate Gyrus**
  → akinetic mutism
- **Basal Ganglia**
  → diminish coordination
  → tremor

❖ **<u>Peripheral Nerve Lesion</u>**:

- SLN vs. RLN
- Intrinsic muscles that are involved predict dysfunction
- Unilateral vs. Bilateral
- Adductor vs. Abductor

❖ **<u>The vagus nerve</u>**:

- Cell bodies found in **nucleus Ambiguus**
- Controls neck, thorax and abdomen
- Important to voice production are the **Superior Laryngeal Nerve** and the **Recurrent Laryngeal Nerve**
- **SLN**: primary sensory nerve for the larynx
  → ***external branch*** → ***motor***: cricothyroid muscle (increasing the vocal pitch)
  → ***Internal branch*** → ***sensory***: mucous membrane of the larynx down to the true vocal fold
- **RLN:** Recurrent Laryngeal Nerve
  → ***motor***: all intrinsic laryngeal muscles except the Cricothyroid
  → ***sensory***: sensation below the true FV are innervated by the RLN

❖ **Role of Cerebellum**:

- **Cerebellum**: responsible for control of **voice attributes** such as **pitch** and **loudness** but not initiation of phonation or speech

❖ **Organization of Central Pathway**:

- Precentral Cortex (gyrus)
- Corticobulbar tract formed (descending pathway)
- Form into pyramidal tracts
- decussate
- Synapse on Nucleus Ambiguous in medulla
- Nucleus Ambiguous houses 9, 10 and 11 cranial nerves
  - → 9 → **Glossopharyngeal**: sensory & motor; medulla
  - → 10 → **Vagus**: sensory & motor; medulla
  - → 11 → **Accessory**: motor; medulla

Nervous System Malfunction:

- **Disease**
- **Trauma**
- **Abnormal growths**
- **Initiation malfunction** vs. **control malfunction**
- **Speech/voice** is an action requiring both **initiation** and **control**

❖ **Extrapyramidal System**:

- Function to coordinate phonation
  - → Corpus Striatum
  - → Caudate and Lenticular Nucleus
  - → Globus Pallidus
  - → Substantia Nigra

❖ **Lower Motor Neuron Damage**:

- **Brainstem** and **Medulla**
- **Nucleus Ambiguous damaged** → impairs function of SLN and RLN simultaneously
- Damage to PNS
- **Injury to SLN or RLN** → unilateral or bilateral
- **Internal branch of SLN** → no sensation in the upper part of lx
  - → foreign bodies to the trachea
- **External branch of SLN** → paralysis of cricothyroid (no pitch variation, weak voice)

- **Injury to one RLN** → unilateral paralysis
- **Injury to both RLN** → bilateral paralysis

❖ **<u>Upper Motor Neuron Diseases: Pseudobulbar Palsy:</u>**

- **Harshness/hoarseness**
- Damage to **Pyramidal Pathways**
  - → Spasticity, weakness, limitation of range, and slowing of movement
  - → **Bilateral progressive lesions** to corticobulbar tracts
  - → Strokes, MS, Cerebral Palsy
  - → Speech & Swallowing

❖ **<u>Laryngoscope & Stroboscopic Signs</u>**:

- ***Hypertonicity*** vs. ***Hypotonicity*** - limited data about them
- Hypotheses can be drawn depending on the impairment of movement
- Hyperactive in PCA, LCA, TA, etc.

❖ **<u>Extrapyramidal Disorders: Parkinson's Disease:</u>**

- **Monopitch**
- Disease of the **Basal Ganglia** (Substantia Nigra)
- Rigidity, tremor, reduced range of movement
- Hypokinesia
- **Voice symptoms**:
  - → ***Dysarthria***
    - Prosodic disorders
    - Monopitch, monoloud, reduced stress, short phrases
    - Harsh voice, strain, pitch breaks
- **Parkinson's**:
  - → Monopitch
  - → Excessive low pitch
  - → Harshness
  - → **Speech rate altered**
  - → **Breathiness**
  - → **Roughness**
  - → **Tremulousness** (unsteadiness)

❖ **<u>Other UMN diseases</u>**:

- **Shy Drager** → Hoarseness
- **ALS** → Hoarseness
- **Huntington's Chorea** → Hoarseness

❖ **Multiple Sclerosis**:

- **Disease affecting myelin**
- Affects CNS
  - → *Pyramidal*
  - → *Cerebellar*
  - → *Brainstem*
- Vertigo (25%)
- Dysarthria (20%)
- Dysphagia (10-15%)
- **Multiple scarring of the white matter of brain stem** and **Schwan Cells**
- More than half tend to have normal speech performance (D.A.B. 1972)
  - → 68 patients → 29% with minimal speech impairments
- **Speech & Vocal Symptoms**:
  - → **Reductions in vocal loudness**
  - → **Harshness**
  - → **Misarticulation**
  - → **Reduced pitch** control
  - → **Hypernasality**
  - → **Breathiness**
- **Laryngoscopy & Stroboscopy**:
  - → Breathiness = Bowing
  - → Reduced air intake = bilateral abductor paralysis
  - → Increased incoordination
  - → Spasticity and/or weakness

❖ **Essential tremor**:

- CNS disorder → age related
- Tremor of head, tongue, palate, neck, larynx (VF)
- At rest typically, but can be associated with movement of task
- Extrapyramidal
- **Pathophysiology**:
  - → Rhythmic alteration in muscle activity of the **intrinsic laryngeal muscles**
  - → Typically affects adductor muscles
  - → Etiology of ADSD?
- **Laryngoscopy**:
  - → Normal structure typically
  - → Rhythmic movement at rest or with phonation
  - → No data exists on stroboscopic signs

❖ **Myasthenia Gravis**:

- Cranial Nerve involvement
- **Striated Muscle**
- Disease of the **NMJ (Acetylcholine)**
- **Females**
- Rare in relation to other disorders we have discussed
- Bulbar symptoms (brainstem)
- **Perceptual Voice Symptoms**:
  - → **Hoarseness**
  - → **Breathiness**
  - → **Hypernasality**
  - → **Increase** in the **severity of symptoms** with the duration of the task
- **Physiological signs**:
  - → **Decreased EMG activity** with use
  - → **Greater opening** durations
  - → **Reductions** in **closing phase**
  - → **Reductions** in **VF movement**
- **Differential symptoms**:
  - → Fatigue
  - → Fluctuations in Functions
  - → Return after Rest