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Laryngeal Anatomy

This section of notes now includes all intrinsic muscles and extrinsic muscles.

Learning Objectives for Laryngeal Anatomy

The student will know...

- Names and descriptors for all laryngeal structures including bones, cartilage, tissues and spaces
- Origin, insertion and function for all intrinsic laryngeal muscles
- Origin, insertion and function for all extrinsic laryngeal muscles

Functions and location of Larynx

Biological functions

1. Valve to prevent air from escaping—remember that we expand the thorax during lifting to make it rigid.
2. Prevents foreign substances from entering lungs
3. Coughs to expel foreign substances should they pass the epiglottis

Non-biological functions

- Generates sound for speech

Location

- Between hyoid bone and trachea—in front of cervical vertebrae
- Find thyroid notch by swallowing.

Laryngeal Anatomy

Hyoid bone.

- Unique floating bone located about one finger up from the thyroid notch.
- Floating means that it does not have joint with other bones, suspended by muscles from above and below. These muscles often called the hyoid sling.
- Has 2 pair of horns—greater and lesser.

Thyroid cartilage

- Largest cartilage.
- Has two laminae or flat shield looking surfaces.
  - Laminae = plural lamina = single
  - Name means shield
- The thyroid angle is different for men and women. (thryoid prominence)
  - Men's is a sharper angle. This is why you see men's Adam's apples and not women's
- Thyroid notch is a deep v at the thyroid angle.
- Superior and inferior horns
○ Inferior horns extend below to attach to the circled cartilage.
○ Superior horns do not attach to anything. Come closer to hyoid bone than rest of thyroid cartilage.

Cricoid cartilage.

- Ring shaped and sits on top of trachea. --
- Could be mistaken for trachea ring except that trachea rings are open in back and circled has large lamina on back.
- Called the posterior quadrate lamina (body)
- Articulatory facets are places where other cartilages articulate
  ○ Articulatory facets for the lower horns of thyroid cartilage are found on the sides of the circled--near the back
  ○ Articulatory facets for the arytenoid cartilages are found on the upper border of the circled lamina
- Can imitate circled and thyroid cartilages with hands. (show rocking of thyroid on circled.)

Arytenoid cartilages

- Seen from the back and from sagittal views. Laminae of thyroid prevent us from seeing them in an anterior view. When we do see them in sagittal views, one of the thyroid lamina have been removed
- Pair of cartilages. So far all others were single structures. this is a pair.
- Pyramid shaped
- Sit on the upper border of the cricoid lamina
- Has base and apex
- Vocal process is the point where the vocal folds attach.
- Muscular process is the bump at the back end
- Vocal ligament is not part of the cartilage but worth mentioning. It stretches from the vocal process to the inside of the thyroid notch. Is part of vocal folds.

Review

- This set of cartilages provides most of the framework of the larynx.
- They account for 2 very important movements.
  1. Lengthening the vocal cords. Achieved by rocking thyroid cartilage on cricothyroid joint. (Remember the lower horns of thyroid attach to articulatory facet of cricoid on the lateral surface.
  2. Opening the vocal folds. Achieved by the arytenoid cartilages pivoting on the articulatory facet of the cricoid cartilage.

Other cartilages of larynx.

Epiglottis.

- Large, leaf shaped cartilage. attached at the thyroid notch
- Closes over the larynx when we swallow. Acts as a gate to keep foreign matter out of the lungs.
- Difficult to see from many angles
- May see a bit sticking up over the hyoid bone
- Easily illustrated from back or from the side. (with the thyroid lamina removed).
- Back view shows that the epiglottis forms the anterior wall of the tube extending from the vocal folds up the throat.

Corniculate
• Tiny cone shaped cartilages sitting on top of the arytenoids

**Laryngeal Joints**

**Cricoarytenoid**

• This is the joint between the arytenoids and the cricoid cartilage. It is responsible for opening and closing the vocal folds.

• This is called adduction and abduction.
  
  o Add means put together. Means bring folds together
  
  o Abduct means to take away. Means to open the folds

• This joint allows for several types of movement. fig 5-14
  
  1. The arytenoids rock forward --tipping forward into the center of the cricoid ring
  2. The arytenoids glide laterally, moving away from each other in a rather oblique line
  3. The arytenoids rotate inward/outward so the vocal processes rotate toward or away from each other.

• Ligaments of the cricoarytenoid joint--
  
  o (Ligaments are what hold joints together. Roughly similar to tendons, but do not connect to muscles. They connect bone to bone. (or cartilage). Can ligaments contract?)

  o Posterior cricoarytenoid ligament
    
    ■ Seen on the posterior view.
    
    ■ Extends from outside surface of cricoid lamina, diagonally up to arytenoid.
    
    ■ Functions to restrict the forward movement of the arytenoid because it holds the arytenoid from the back.

  o .... cricoarytenoid ligament
    
    ■ Similar to posterior--extends from inside surface of cricoid lamina up to arytenoids.
    
    ■ Functions to restrict the backward movement of the arytenoid because it holds the arytenoid from the front.

**Cricothyroid joint**

• Is the juncture of the inferior horn of thyroid and the articulatory facet of the cricoid.

• Ligaments
  
  o Ceratocricoid ligament.
    
    ■ Divided into 3 sections. Anterior, lateral and posterior.
    
    ■ Each set connects at a different angle.
    
    ■ Remember that the movement of this joint is to rock or pivot.
    
    ■ This range of angles accommodates that pivoting movement

**Thyroepiglottic joint**

• Opens and shuts the epiglottis.

• The hyoepiglottic ligament extends from the anterior surface of the epiglottis to the body of the hyoid

• The thyroepiglottic ligament connects the "stem" of the epiglottis to the thyroid notch.

**Other tissues and structures**

**The vocal ligaments**

• Extends from the vocal process of the arytenoid to the thyroid notch. Each vocal ligament lies
inside the vocal fold and forms the medial portion of the vocal fold.

The **elastic membrane**

- A broad sheet of elastic ligament that essentially lines the whole larynx.
- One portion of this membrane is the conus elasticus. This begins at the cricoid and extends upward toward the vocal folds.
- Sheaths the arytenoid cartilages.
- In essence, binds them all together.
- Name comes from the cone shaped cavity below the vocal folds.

The **quadrangular membrane**

- A pair of membranes
- Large square shaped membranes
- Fibers run horizontally, attaches to the edge of the epiglottis and inserts along the arytenoids.
- Are fairly far apart at the top--near epiglottis attachment--and are closer together near the arytenoids.
- The upper border of this membrane makes the areipiglotic folds. These folds run from the arytenoid to the epiglottis, and will be discussed more when we talk about phonation.

**Mucous membranes**

- Line the whole cavity of larynx.

Excretes mucous which acts as a lubricant. Considering the amount of movement, lubrication is important.

**MUSCLES OF THE LARYNX**

- 3 groups--intrinsic, extrinsic and supplemental. We'll only talk about intrinsic and extrinsic.

**Intrinsic Muscles**

- may be viewed as adductors and abductors, tensors and relaxers
- adductors include
  - lateral cricoarytenoid
  - transverse arytenoid
  - oblique arytenoid
- abductors include
  - posterior cricoarytenoid
- tensors include
  - thyrovocalis
  - cricothyroid
- relaxers include
  - thyromuscularis

**lateral cricoarytenoid muscle (LCA)**

- Originate from side of cricoid cartilage
- Insert into muscular process, this time the outside corner
- Pull on the muscular process, which swings the vocal processes together.
- Primary muscles of adduction.
- Work in opposition to posterior cricoarytenoid.
Laryngeal Anatomy

- Innervation from Vagus--recurrent laryngeal nerve (RLN)
  
  **Transverse Arytenoid or Interarytenoid**
  
  - Originates along the lateral margin of posterior surface of one arytenoid
  - Insert along the lateral margin of posterior surface of the other arytenoid
  - Functions to adduct the arytenoids
  - Innervation from Vagus--recurrent laryngeal nerve (RLN)

  **Oblique Interarytenoid Muscles**
  
  - More superficial that is more on the outside
  - Originates from posterior surface of the muscular process
  - Inserts near apex of opposite cartilage. When viewed from behind they form an x.
  - Function = bring arytenoids together = adduction.
  - Innervation from Vagus--recurrent laryngeal nerve (RLN)
  - The posterior cricoarytenoid muscle
  
  **Posterior Cricothyroid (PCA)**
  
  - Flat muscles
  - Originate from center of back lamina or wall of cricoid cartilage
  - Insert into muscular process of arytenoid
  - Major muscles responsible abducting arytenoids
  - Works in opposition of the lateral cricoarytenoid
  - Innervation from Vagus--recurrent laryngeal nerve (RLN)

  **Thyroarytenoid**
  
  - Are the main mass of the vocal folds.
  - Originate from thyroid notch
  - Insert into the arytenoids
  - Divided into 2 parts, internal and external
    - **Internal** often called the vocalis--inserts into the vocal process,
      - This medial portion of the muscle makes up the vocal fold
      - The vocal fold is the portion which vibrates
      - The vocalis tenses the vocal folds. When contracted the vibrating part of the folds become shorter and stiffer. More resistant to vibration.
    - **External or thyromuscularis**
      - Is the lateral portion of the thyroarytenoid muscle
      - Insert into the lateral surface of the arytenoid, all the way down to the muscular process
      - Functions to bring the folds together. Does this because it pulls on the outside of the arytenoid --muscular process-- which swings the vocal processes of the arytenoids together
      - The muscularis may either shorten or lengthen the folds, depending on which portion of the muscle is active. If the lateral most portion (further away from the folds) shortens, the vibrating edge is actually lengthened.
      - If the medial-most portion shortens, this is the portion closest to the vibrating
folds, the folds themselves are shortened.
- Innervation from the X vagus nerve: the recurrent laryngeal nerve.

cricothyroid muscle (CT muscle)
- Two parts—one at an angle and one straight. Called pars oblique and pars recta, respectively.
- Originates from front of cricoid cartilage
- Inserts into lower border or thyroid cartilage
- Functions to pull the two cartilages together. Rocks the cricothyroid joint.
- When the thyroid cartilage is pulled down this stretches or lengthens the vocal cords.
- Also stiffens or tenses the vocal folds by stretching them.
- Functions to elongate the vocal folds and increase their tension. This action is necessary for pitch change.
- Innervation from the X vagus nerve: the recurrent laryngeal nerve.

Summary and Review

- new vocabulary to talk about laryngeal actions discussed so far. We can talk about
  1. effect on the shape of the glottis—adduct, abduct. Can group muscles by these functions—abductors and adductors
  2. When we talk about this action, we can talk about the force with which the vocal folds are brought together. Medial compression talks about the force with which the vocal folds are brought together.
  3. Can talk about the vibratory behavior of the vocal folds. Tensing and relaxing the vocal folds influences their ability to vibrate. So when we talk about this action, we talk about the force with which they are stretched = longitudinal tension can group muscles by these functions—tensors and relaxors. Longitudinal tension combines with the varying air pressure from the lungs to produce the whole range of human voice.

- thus, INTRINSIC MUSCLES are responsible for sound production
- summarize muscles by groups:
  - abduction—posterior cricoarytenoid muscle
  - adduction—lateral cricoarytenoid, transverse & oblique interarytenoids
  - tensors—vocalis, cricothyroid
  - Relaxers—thryomuscularis

Extrinsic Muscles (Suprahyoids & Infrahyoids)

- Primarily responsible for support, and for fixing its position
- sternothyroid muscle,
- thyrohyoid muscle
- sternothyroid

- originates on posterior, back surface of the manubrium & first costal cartilage.
- insert onto oblique line of the thyroid
- functions to draw thyroid downward

thyrohyoid muscle
• this muscle is deep into the neck and several other muscles have to be removed in order to see this one
• originates on the from oblique line of the thyroid lamina and
• inserts into the greater horn of the thyroid bone
• function-- when contracted it shortens distance between thyroid and hyoid--that means it elevates the larynx

other supplemental muscles which contribute to the larynx.

• --suprahyoid--meaning located above the hyoid bond
• --infrahyoid meaning located below the hyoid

suprahyoids

digastric -p 138 \( p \& k \)

• word means 2 bellied
• anterior belly originates at the mandible (chin) go through a loop or sling that is at the lesser horn of the hyoid
• the posterior belly, comes out of the mastoid process which is behind the ear and connects to the anterior belly at that loop
• because of the loop or sling attached to the hyoid, what happens when this muscle contracts is that the hyoid is lifted.
• how does lifting the hyoid affect the larynx?
  o contraction of anterior belly draws hyoid up & forward
  o contraction of posterior belly draws hyoid up & backward
  o if hyoid is fixed in place by other muscles, contraction can draw the hyoid down
• Innervation: Trigeminal/ Mandibular branch

the stylohyoid

• originates from the styloid process which is behind the ear.
• inserts into the hyoid bone at the angle of the corpus and the greater horn.
• see figure 37
• functions to draw the hyoid up and backward
• Innervation: Facial/ Motor branch

The mylohyoid muscle -p 138 \( p \& k \)

• forms the muscular floor of the mouth. Is a thin sheet of muscle that originates from a bony ridge on the interior surface of the mandible called the mylohyoid line. This ridge runs back as far as the molars. "Mylo" then is from a Greek word referring to the last molar.
• inserts into midline which means seam
• the fibers at the most posterior portion are connected to the hyoid bone
• functions:
  o If mandible is fixed it elevates the hyoid bone, the floor of the mouth and the tongue.
  o if hyoid bone is fixed this muscle may assist in depressing the mandible
• innervation: Trigeminal/Mandibular branch

the geniohyoid muscle
- genion is Greek for chin.
- located above--closer to the mouth--than the mylohyoid muscle
- 2 muscles (R and L) lie so close together they are sometimes a single muscle
- originates from the mandible--inside the chin area.
- Insert on the anterior surface of the hyoid bone.
- function: if mandible is fixed position this pair of muscles pulls the hyoid bone up and forward
- Innervation: Hypoglossal nerve and C1 spinal nerve

the Hyoglossus

- glossus refers to tongue.
- originates from greater horns of hyoid and courses directly upward to
- insert into the posterior and lateral regions of the tongue
- Innervation: hypoglossal/Motor branch
- Function: elevate hyoid; depress tongue

Genioglossus

- originates from the chin and spreads into the under surface of the tongue.
- some fibers attach to the hyoid
- may function to elevate hyoid bone & draw it forward; depress, retract, protrude tongue
- Innervation: motor branch of hypoglossal

Infrahyoid Muscles--Laryngeal Depressors

- sternohyoid, omohyoid, sternothyroid, and thyrohyoid
- often referred to as strap muscles because of their appearance
- muscles which support hyoid bone from below.

sternohyoid

- from the manubrium of the sternum and medial end of clavicle
- inserts into body of hyoid
- functions:
  - draw hyoid down
  - fix it in position when the lower jaw is opened
- Innervation: Spinal nerves C1-C3

Omohyoid

- omo = Greek word for shoulder
- attaches to top of scapular and body of hyoid
- has 2 bellies. First courses horizontally from shoulder to the intermediate tendon and 2nd courses vertically to the greater horn of the hyoid.
- muscles function to tense and stiffen the neck region.
- stiffness gives support for breathing
- in essence cushions or protects blood vessels in neck from being compressed by other structures when muscles of neck are contracted.
- Cranial nerves C1-3

sternothyroid
• originates on posterior, back surface of the maniubrium & first costal
cartilage.
• insert onto oblique line of the thyroid
• functions to draw thyroid downward
• Innervation: spinal nerves

thyrohyoid muscle  — only infrahyoid that elevates larynx.

• this muscle is deep into the neck and several other muscles have to be removed in order to see
  this one
• originates on oblique line of the thyroid lamina and
• inserts into the greater horn of the thyroid bone
• function-- when contracted it shortens distance between thyroid and hyoid—that means it
  elevates the larynx
• Innervation: Hypoglossal nerve
ANATOMY OF THE LARYNX

Larynx composed of cartilage and muscle, attached superiorly to the hyoid bone and inferiorly to the trachea.

I. Cartilages of the Larynx

Thyroid Cartilage (serves protective function) superior and inferior cornu (horns), thyroid notch, thyroid prominence, thyroid lamina, thyroepiglottic ligament.

Cricoid (signet shaped cartilage-two parts posterior cricoid lamina & anterior arch, attaches to thyroid by articular facet/joint cricothyroid joint (permits sliding and tilting of the thyroid cartilage), and paired arytenoids cartilages sit on articular facets on the top border of the cricoid (cricoarytenoid joints). Inferiorly cricoid attaches to first tracheal ring of the trachea by cricotracheal membrane.

Arytenoids (paired three-sided, pyramid shaped cartilages) which the vocal ligament/folds attach to. Three important parts: Muscular process (back), vocal process (vocal ligament attaches) and apex (top). Cricoarytenoid joint allows for rotation, sliding, tilting (rocking) motion of the arytenoids on top of the cricoid (very fine control for pitch/loudness control and breathing).

Epiglottis (flexible leaf like cartilage)- Body & petiole serves an important function during swallowing by covering entrance to larynx by dorsiflexion. Attached to larynx by the thyroepiglottic ligament and hyoid by hyoepiglottic ligament. Lingual and laryngeal surfaces.

Hyoid Bone (not attached to any bone in the skeleton)- bound in position by muscles and ligaments above and below, therefore quite mobile. Corpus (body), greater-major horns (cornu), lesser or minor horns (cornu). Articulates with the superior cornu of the thyroid cartilage (sites of exquisite sensitivity in some muscle tension patients).

Spaces-Thyrohyoid space (membrane), Cricothyroid membrane

II. Muscles of the Larynx:

Note: Muscles only shorten when they contract, and names involve origin and insertion (origin-immovable part, insertion more moveable part). In the larynx names usually are transparent and inform regarding origin and insertion and possible movement.

Extrinsic Muscles of the larynx (one attachment to structures outside of the larynx-position and support the larynx).

(1) Thyrohyoid Muscle- contraction decreases the distance between the thyroid and hyoid bone.
(2) Sternothyroid muscle—laryngeal depressor (i.e., draws the larynx downward and forward)—manubrium of sternum to inferior aspect of thyroid cartilage

Other supplemental muscles divided into suprathyroid and infrahyoid.

A. Suprathyroids—above hyoid, and lift larynx up via attachments above the larynx (Laryngeal elevators).

(1) Stylohyoid—styloid process of temporal bone, and hyoid bone (pulls larynx up and back).
(2) Mylohyoid—mandible and hyoid bone (lifts larynx up and forward).
(3) Geniohyoid—mandible and hyoid (lifts larynx up and forward).
(4) Paired digastrics—Anterior belly—lower border of the mandible and lesser horn of the hyoid—pulls hyoid up and anterior.
   Posterior belly—mastoid process of temporal bone, and hyoid—draws hyoid upward and back.

B. Infrahyoids—(below the hyoid, laryngeal depressors).

(1) Sternohyoid (manubrium of sternum and clavical and inserts on lower part of hyoid) draws the hyoid downward.
(2) Omohyoid—two parts (1) posterior belly (originates on the scapula (back part of the shoulder “omo”- Greek pertaining to shoulder and inserts on the hyoid)—(2) anterior belly attaches to sternum (lateral to sternohyoid) and hyoid bone (therefore a laryngeal depressor).

C. Intrinsic Muscles of the Larynx (have both attachments within the larynx).
Intrinsic muscles of the larynx are categorized by their effects on the shape of the glottis. Always act in pairs. In a health larynx the muscles on one side do not contract independently of the muscles on the opposite side.

ADDUCTOR muscles approximate the arytenoids cartilages for phonation and protective purposes.
ABDUCTOR muscles separate the arytenoids for respiratory activities.

Adductors-
LCA
TA (two parts maybe—thyrovocalis, thyromuscularis, principal function of the TA is regulator of longitudinal tension—pitch control—shorten vocal folds)
Interarytenoids (transverse & obliques)

Abductors
PCA—abduces vocal folds.
CRICOTHYROID- 2 parts (pars recta, and pars oblique) narrows distance between cricoid arch and thyroid cartilage, thyroid tilts like the visor on the helmet of medieval knight. Vocal folds elongate passively and stretch under tension, an action necessary for pitch elevation.

ENDOSCOPIC VIEW OF THE ENDOLARYNX
Cartilages of the Larynx

Epiglottis

Thyroid cartilage

Cricoid cartilage

Superior cornu

Laryngeal prominence

Lamina Angle

Inferior cornu

POSTERIOR VIEW

Anterior view

LATERAL VIEW

Anterior view

LATERAL VIEW

Anterior view

POSTERIOR VIEW

Anterior view

LATERAL VIEW

Anterior view

LATERAL VIEW

POSTERIOR VIEW

Facet for arytenoid

Arch

Lamina

Facet for thyroid

Facet for arytenoid

Muscular process

Vocal process

Cricoid cartilage

Apex

Cricoid cartilage

Muscular process

Cricoid cartilage

Apex

Muscular process
THE SUPRAHYOIDS

Mandibular symphysis
Anterior belly
Posterior belly
Intermediate tendon
Mastoid process
Styloid process

The Digastrics

Mylohyoid
Geniohyoid
Anterior belly of digastric

Stylohyoid

Mylohyoid
Geniohyoid
Anterior belly of digastric

Mylohyoid, Geniohyoid, Ant. Belly of Digastric
Summary of Extrinsic Muscles of the Larynx

POSTERIOR VIEW
- Stylohyoid m.
- Mylohyoid m.
- Hyoid bone
- Inner surface of mandible
- Mylohyoid m.
- Geniohyoid m.
- Hyoid bone
- Digastricus m. (posterior belly)

INFERIOR VIEW
- Digastricus m. (anterior belly)
- Stylohyoid m.
- Mylohyoid m. (posterior belly)
- Hyoid bone

- Sternocleidomastoid m.
- Omohyoid m. (superior belly)
- Omohyoid m. (inferior belly)
- Clavicular head
- Sternal head
- Sternohyoid m.
- Omohyoid m. (inferior belly)
- Thyroid cartilage
- Oblique line
- Sternothyroid m.
- Manubrium sterni
Basic Vocal Fold Histology

Understanding of the layered structure of the vocal folds helps you understand normal vocal fold oscillation/vibration—but also helps us understand the effect of pathology on voice production and vocal fold vibration. The extent (or how deeply) the pathology invades the vocal fold will affect the vibration and ultimately the voice quality and severity of the dysphonia.

- Layer structure of vocal fold (5 layer, 3 layers or two depending on what articles you read). When moving from the superficial layer to the deepest layers of the vocal fold, there is an increase in the stiffness of the mechanism (outmost layer loose and pliable, inner most is dense and

- Epithelium is stratified squamous cell epithelium, serves as a capsule to hold vocal fold together, superficial layer of lamina propria (loose gelatinous material) also called Reinke’s space. A site for accumulation of edema known as Reinke’s edema.

- Superficial layer of the lamina propria can become stiffed in the case of pathology, due to tumor, nodules. The epithelium and the slp form the cover of the vocal fold.

- The intermediate layer of the Ip is composed of elastic fibers (elastin) something like soft rubber bands, whereas the deep layer is like cotton thread. The intermediate and deep layers of the Ip form the vocal ligament (which the thyroartenoid m. attaches to). This area is also referred to as the transition.

Finally, the deepest layer of the vocal fold is the vocalis m. which is striated m.

This layered structure is also known as the cover and body. It is the existence of the loose pliable cover when combined with a denser muscle that is responsible for vocal fold oscillation when air is passed through the closed vocal folds.

Contract muscle creates loose cover, stretch muscle creates tight cover. These changes affect phonation, pitch, loudness and quality.

MicroHistology:

Basement Membrane Zone
FIGURE 1.13. Schematic of a coronal section through the right vocal fold, showing tissue layers.
Aerodynamic-Myoelastic Theory of Vocal Fold Vibration

Vocal Folds produce a constriction in the vocal tract (tube). The rate of airflow (velocity) through the tube will increase at the point of constriction, and air pressure will decrease at that point as well.

Bernoulli Effect: Given a constant volume flow of air or fluid, at a point of constriction there will be a decrease in air pressure perpendicular (at right angles) to the flow and an increase in velocity of the flow.