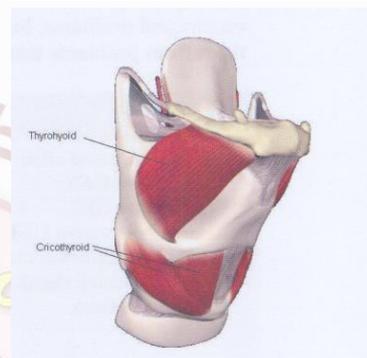


Laryngeal Anatomy

The Larynx

- * The larynx ("organ of voice") is a valve separating the trachea from the upper aerodigestive tract. It is placed at the upper part of the air passage. It is situated between the trachea and the root of the tongue, at the upper and forepart of the neck, where it presents a considerable projection in the middle line.
- * It forms the lower part of the anterior wall of the pharynx, and is covered behind by the mucous lining of that cavity; on either side of it lie the great vessels of the neck.
- * Its vertical extent corresponds to the fourth, fifth, and sixth cervical vertebrae, but it is placed somewhat higher in the female and also during childhood.
- * The framework of the larynx is made up of cartilages, which are connected by membranes and ligaments and moved by muscles. It is lined by mucous membrane.
- * The larynx provides a protective sphincter at the inlet of the air passages and is responsible for voice production. Above, it opens into the laryngeal part of the pharynx, and below, it is continuous with the trachea.
- * Purpose: →
 - Organ of communication (the "voice box")
 - Important regulator of respiration
 - Necessary for an effective cough or valsalva maneuver
 - Prevents aspiration during swallowing
- * Together, the muscles and cartilages create three levels of "folds," which serve as sphincters that provide both communicative and vegetative functions in the body [1]. →
 - 1) The aryepiglottic folds forms the upper rim of the larynx**
 - * It is a strong fibrous membrane that connects the lateral walls of the epiglottis to the arytenoids cartilage complex.
 - * When the epiglottis cartilage folds posteriorly and inferiorly over the laryngeal vestibule, it separates the pharynx from the larynx and offers the first line of defense for preserving the airway.
 - * The sphincter at the inlet is used only during swallowing. As the bolus of food is passed backward between the tongue and the hard palate, the larynx is pulled up beneath the back of the tongue.
 - * The inlet of the larynx is narrowed by the action of the oblique arytenoid and aryepiglottic muscles.



2) The second sphincter is formed by the ventricular fold:

- * It is called superior or false vocal cords
- * It is attached in front to thyroid cartilage, behind to the arytenoid cartilage.
- * It is not normally active during phonation but may become hyperfunctional during effortful speech production or extreme vegetative closure [1].
- * The ventricular folds are directly superior to the ventricle and the true vocal folds, forming a "double layer" of medial closure, if needed.
- * The principle function of the ventricular sphincter is to increase intrathoracic pressure by blocking the outflow of air from the lungs.
- * The ventricular folds compress tightly during rapid contraction of the thoracic muscles (e.g., coughing or sneezing) or for longer durations when building up subglottic pressure to stabilize the thorax during certain physical tasks (e.g. siftings emesis, childbirth, or defecation).
- * The ventricular folds also add airway protection.

3) The third and final layer of this "folding mechanism" is the true vocal folds

- * It is called inferior or true vocal cords
- * It is attached in front to the thyroid cartilage, behind to the vocal process of the arytenoids.
- * For speech communication, the vocal folds provide a vibrating source for phonation.
- * They also close tightly for non-speech and vegetative tasks, such as coughing, throat clearing, and grunting [1].
- * In coughing or sneezing, the rima glottidis serves as a sphincter. After inspiration, the vocal folds are adducted, and the muscles of expiration are made to contract strongly.
- * As a result, the intrathoracic pressure rises, whereon the vocal folds are suddenly abducted. The sudden release of the compressed air often dislodges foreign particles or mucus from the respiratory tract and carries the material up into the pharynx. Here, they are either swallowed or expectorated.
- * In abdominal straining associated with micturition, defecation, and parturition, the air is often held temporarily in the respiratory tract by closing the rima glottidis. The muscles of the anterior abdominal wall now contract, and the upward movement of the diaphragm is prevented by the presence of compressed air within the respiratory tract. After a prolonged effort the person often releases some of the air 'by momentarily opening the rima glottidis, producing a grunting sound.

Thus, in a mechanical sense, the larynx and vocal folds function as a variable valve, modulating airflow as it passes through the vibrating vocal folds during phonations closing off the trachea and lungs from foods and liquids during swallowing actions, and providing resistance to increased abdominal pressure during effortful activities.

Laryngeal cavities:

- * The mucous membrane of the larynx lines the cavity and is covered with ciliated columnar epithelium.
- * There are many mucous glands contained within the mucous membrane, and they are especially numerous in the saccules. Here, the secretion pours down onto the upper surface of the vocal folds and lubricates them during phonation [2].
- * The cavity of the larynx extends from the inlet to the lower border of the cricoid cartilage. It can be divided into three parts: (1) the upper part, or vestibule; (2) the middle part; and (3) the lower part.

1) Entrance is aditus larynges (The upper part): →

- * The vestibule of the larynx extends from the inlet to the vestibular folds. The latter are two thick folds of mucous membrane that cover the vestibular ligaments.
- * The vestibule has an anterior, posterior, and lateral wall. The anterior wall is formed by the posterior surface of the epiglottis, which is covered by mucous membrane. The posterior wall is formed by the arytenoid cartilages and the interarytenoid fold of mucous membrane, containing the transverse arytenoid muscle. The lateral walls are formed by the aryepiglottic folds, which contain the aryepiglottic muscle.
- * Below, the vestibule is narrowed by the pink vestibular folds, which project medially.
- * The rima vestibuli is the gap between the vestibular folds.
- * The vestibular ligament, which lies within each vestibular fold, is the thickened lower edge of the quadrangular membrane.
- * The ligament stretches from the thyroid cartilage to the side of the arytenoid cartilage.

2) The middle part of the larynx: →

- * It extends from the level of the vestibular folds to the level of the vocal folds. The vocal folds are white in color and contain the vocal ligaments. Each vocal ligament is the thickened upper edge of the cricothyroid ligament. It stretches from the thyroid cartilage in front to the vocal process of the arytenoid cartilage behind.
- * The rima glottidis is the gap between the vocal folds in front and the vocal processes of the arytenoid cartilages behind.
- * Between the vestibular and vocal folds on each side is a small recess, called the sinus of the larynx. It is lined with mucous membrane, and from it, a small diverticulum, called the saccule of the larynx, passes upward between the vestibular fold and the thyroid cartilage.

3) The lower part of the larynx: →

- * It extends from the level of the vocal folds to the lower border of the cricoid cartilage.
- * Its walls are formed by the inner surface of the cricothyroid ligament and the cricoid cartilage.

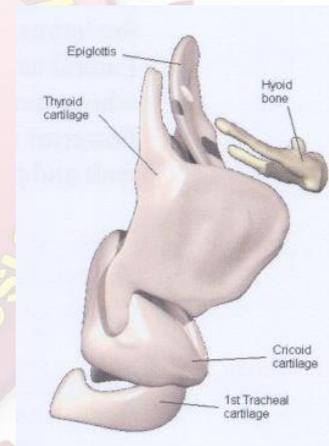
Vocal Fold Structure:

- * It consists of vocalis muscle, lamina propria, and epithelial layer.
- * **Vocalis muscle** (medial layer of thyroarytenoid muscle) is considered the “body” of the vocal fold
- * **Lamina Propria** covers the vocalis muscle; there are three layers of the Lamina Propria
 - Deep → Intermediate
 - Medial → Intermediate
 - Superficial → Cover
- * **Stratified Squamous epithelial cells** → Cover
- * Squamous epithelial cells and superficial lamina propria forms the cover of the vocal fold.
- * The superficial layer of the Lamina propria is covered by a surface of mucosal epithelium.
- * The zone between the superficial layer and the mucosal epithelium is an area where phonotrauma occurs. It is very sensitive to vocal abuse and misuse and will be the site of Reinke’s edema which may be the precursor to nodules and polyps.

The cartilages of the larynx:

4) The Thyroid cartilage:

- * The **thyroid cartilage** consists of two laminae of hyaline cartilage meeting in the midline in the prominent V angle of the Adam's apple.
- * The posterior border of each lamina is drawn upward into a **superior cornu** and downward into an **inferior cornu**.
- * On the outer surface of each lamina is an **oblique line** for the attachment of the sternothyroid, the thyrohyoid, and the inferior constrictor muscles.
- * The deep surface of the thyroid cartilage gives an attachment to the anterior end of vocal ligaments.
- * The lower border of the lamina of the thyroid cartilage give an insertion to the upper fibers of cricothyroid muscle.
- * The anterior border of the inferior cornu of the thyroid cartilage gives an insertion to the lower fibers of cricothyroid muscle.



5) The Cricoid cartilage:

- * The **cricoid cartilage** is formed from a complete ring of hyaline cartilage.
- * It is shaped like a signet ring and lies below the thyroid cartilage.
- * It has a narrow anterior **arch** and a broad posterior **lamina**.
- * On each side of the lateral surface there is a circular facet for articulation with the inferior cornu of the thyroid cartilage [3].
- * On each side of the upper border there is an articular facet for articulation with the base of the arytenoid cartilage.
- * All these joints are synovial joints.

- * From the side of the cricoid cartilage is the origin of cricothyroid muscle.
- * From the upper border of the arch of the cricoid cartilage is the origin of the lateral cricoarytenoid muscle.
- * From the back of the lamina of the cricoid cartilage is the origin of posterior cricoarytenoid muscle.

6) The Arytenoid cartilages:

- * The **arytenoid cartilages** are small, two in number, and pyramidal in shape.
- * The two small arytenoids cartilages are attached by the vocal folds and are attached to the cricoid cartilages through the cricoarytenoid joint. This joint permits circular and sliding movements.
- * They are situated at the back of the larynx, on the lateral part of the upper border of the lamina of the cricoid cartilage.
- * Each cartilage has an **apex** above and a **base** below. The apex supports the corniculate cartilage. The base articulates with the cricoid cartilage.
- * Two processes project from the base. The **vocal process** projects horizontally forward and gives attachment to the vocal ligament. The **muscular process** projects laterally and gives attachment to the posterior and lateral cricoarytenoid muscles, and gives an origin to the oblique interarytenoid muscle.
- * The back and medial surfaces of the arytenoids cartilage gives an origin and attachment of the transverse interarytenoid muscles.

7) The Corniculate cartilages:

- * It is also called the cartilages of **Santorini**².
- * The **corniculate cartilages** are two small nodules that articulate with the apices of the arytenoid cartilages and give attachment to the aryepiglottic folds.

8) The Cuneiform cartilages:

- * It is also known as the cartilages of **Wrisberg**².
- * The **cuneiform cartilages** are two small, rod-shaped pieces of cartilage placed so that one is in each aryepiglottic fold.
- * They serve as supports for the folds.

Laryngeal membranes and ligaments:

- * There are extrinsic and intrinsic membranes.
- * They connect cartilages with adjacent structures.

9) The Thyrohyoid membrane:

- * The **thyrohyoid membrane** connects the upper margin of the thyroid cartilage below to the upper margin of the posterior surface of the body and greater cornu of the hyoid bone above.
- * In the midline the membrane is thickened to form the **median thyrohyoid ligament**; the posterior borders are thickened to form the **lateral thyrohyoid**

ligaments. On each side the membrane is pierced by the superior laryngeal vessels and the internal laryngeal nerve.

10)The Cricothyroid ligament:

The lower part of the fibroelastic membrane is called the cricothyroid ligament.

The anterior part of the cricothyroid ligament is thick and connects the cricoid cartilage to the lower margin of the thyroid cartilage.

The lateral part of the ligament is thin and is attached below to the upper margin of the cricoid cartilage.

11)The Vocal ligaments:

- * The superior margin of the cricothyroid ligament is thickened and forms the vocal ligament on each side.
- * The anterior end of each vocal ligament is attached to the deep surface of the thyroid cartilage.
- * The posterior end is attached to the vocal process of the arytenoids cartilage.
- * The glottis is the variable opening. Anterior portion is membranous glottis; posterior cartilaginous. The glottis is varied by adduction and abduction, rotation and tilt of arytenoids, airstream against the vf, contraction of laryngeal muscles. They are covered with epithelial on outer surface. Between the epithelial and the muscle bundles is the lamina propria with three layers, the most superficial of which is Reinke's space. Mucosal wave travels across vf from medial to lateral edge in vibration. Scars would interfere with wave motion.

12)The Vestibular ligament:

It is the the lower margin of fibroelastic membrane of the larynx, which lies beneath the mucous membrane lining the larynx. The upper portion of fibroelastic membrane is called the **quadrangular membrane**.

13)The Cricotracheal ligament:

The cricotracheal ligament connects the lower margin of the cricoid cartilage to the first ring of the trachea

Muscles of the Larynx:

- * The muscles can be divided into two groups: (1) extrinsic and (2) intrinsic.

14)The extrinsic muscles:

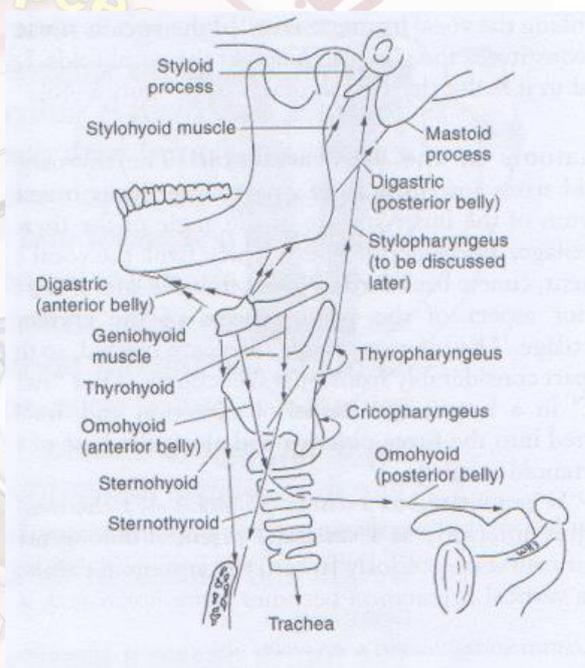
- * The extrinsic muscles of the larynx aid in hyoid and laryngeal excursion (elevation and depression).
- * They are commonly referred to as the strap muscles of the larynx.
- * These muscles include: →
 - **Digastrics, anterior belly** → elevates, protracts the hyoid bone
 - **Digastrics, posterior belly** → elevates, retracts the hyoid bone
 - **Stylohyoid** → elevates, retracts the hyoid bone

- **Mylohyoid** → elevates and protracts hyoid
- **Geniohyoid** → depresses jaw, elevates and protracts hyoid
- **Sternohyoid** → depresses the hyoid
- **Sternothyroid** → depresses the thyroid
- **Omohyoid** → depresses the hyoid
- **Thyrohyoid** → shortens distance between thyroid and hyoid bone

- * Since the hyoid bone is attached to the thyroid cartilage by the thyrohyoid membrane, it follows that movements of the hyoid bone are accompanied by movements of the larynx.
- * The larynx moves up during the act of swallowing and down following the act.
- * This action is particularly important during a swallows, when laryngeal elevation can help protect the airway from aspiration.
- * Clinically, laryngeal elevation during phonation may be a sign of excessive extrinsic laryngeal muscle tension and is often an accurate indicator of hyperfunctional voice use.²
- * They can be divided into two opposing groups, the elevators of the larynx and the depressors of the larynx.

Elevators of the Larynx (Supra-Hyoid muscles):

- * In addition to the external laryngeal muscles, the **stylopharyngeus**, the **salpingopharyngeus**, and the **palatopharyngeus**, which are inserted into the posterior border of the lamina of the thyroid cartilage, also elevate the larynx.



- * The external laryngeal muscles are:
 - Digastric, anterior and posterior bellies
 - Mylohyoid
 - Stylohyoid
 - Geniohyoid
- * These muscles perform two very important actions. During the act of deglutition they raise the hyoid bone, and with it the base of the tongue; when the hyoid bone is fixed by its depressors and those of the larynx, they depress the mandible. During the first act of deglutition, when the mass of food is being driven from the mouth into the pharynx, the hyoid bone and with it the tongue, is carried upward and forward by the anterior bellies of the Digastrici, the Mylohyoidei, and Geniohyoidei. In the second act, when the mass is passing through the pharynx, the

direct elevation of the hyoid bone takes place by the combined action of all the muscles; and after the food has passed, the hyoid bone is carried upward and backward by the posterior bellies of the Digastrici and the Stylohyoidei, which assist in preventing the return of the food into the mouth.

(i) Digastric, anterior and posterior bellies

- The anterior belly is attached to the belly and runs backward toward the hyoid bone where it becomes the digastric tendon.
- Fibers of the posterior belly run from the digastric notch just posterior to the mastoid process downward and insert in the same digastric tendon which is attached to the hyoid bone
- Contraction of the anterior belly pulls the hyoid toward the chin while the posterior belly elevates the hyoid bone and thereby the larynx; the whole muscle contracting in unison will pull the hyoid up and forward but its main action is to open the mandible (during chewing)
- Innervation of the posterior belly is by the facial nerve (CN. VII), innervation of the anterior belly is by the mylohyoid branch of the inferior alveolar.

(ii) Mylohyoid

- It is flat and triangular; is situated immediately above the anterior belly of the Digastricus.
- It *arises* from the whole length of the mylohyoid line of the mandible, extending from the symphysis in front to the last molar tooth behind. The posterior fibers pass medialward and slightly downward, to be *inserted* into the body of the hyoid bone.
- Contraction raises the floor of the mouth and aids in pulling the hyoid forward
- Innervation is by the mylohyoid branch of the inferior alveolar

(iii) Stylohyoid

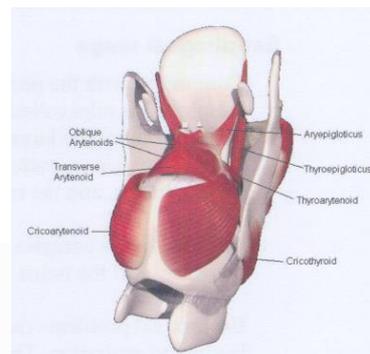
- The muscle attaches to the base of the styloid process and inserts into the hyoid bone
- Contraction pulls the hyoid (and with it the floor of the mouth and the base of the tongue) upward and backward
- As for the posterior belly of the digastric, the stylohyoid is innervated by the facial nerve (CN. VII)

(iv) Geniohyoid

- It *arises* from the inferior mental spine on the back of the symphysis menti, and runs backward and slightly downward, to be *inserted* into the anterior surface of the body of the hyoid bone; it lies in contact with its fellow of the opposite side.
- Contraction pulls the hyoid forward and is a weak depressor of the mandible
- Innervation is by spinal nerves C1 and C2, traveling with the hypoglossal nerve (CN. XII)

15) The intrinsic muscles can be divided into two groups:

- * Those that control the inlet into the larynx and those that move the vocal folds.
- * The intrinsic muscles are:
 - **Cricothyroid**
 - **Posterior Cricoarytenoid**
 - **Lateral Cricoarytenoid**
 - **Interarytenoid: Transverse and Oblique arytenoids**
 - **Thyroarytenoid**
 - **Aryepiglotticus**



Hyolaryngeal excursion

- * Hyolaryngeal excursion is a movement that occurs during the normal swallowing process.
- * The hyoid and thyroid are pulled together while both are pulled upwards and forwards.
- * This movement allows the epiglottis to invert over the entrance of the airway – the laryngeal vestibule – and also contributes to opening the upper esophageal sphincter to allow the bolus to enter the esophagus.
- * Hyolaryngeal excursion is comprised of 3 components:
 - 1) Thyrohyoid approximation,
 - 2) Hyoid protraction and
 - 3) Hyolaryngeal elevation.
- * The muscles responsible for shortening the pharynx mentioned above (**Salpingopharyngeus**, **Palatopharyngeus** and **Stylopharyngeus**) partly contribute to hyolaryngeal excursion, but the primary movers for this movement are the suprahyoid muscles together with the **thyrohyoid**.

Normal movement: the hyoid moves up $\frac{1}{2}$ to 1 cervical vertebra, moves forward to about halfway between anterior mandible and posterior mandibular ramus. The thyroid cartilage moves toward the hyoid so that the total vertical excursion is approximately 1-2 x the height of a cervical vertebra.

Depressors of the Larynx (Infra-Hyoid muscles):

- * The infrahyoid muscles are:
 - **Sternohyoideus.**
 - **Thyreohyoideus.**
 - **Sternothyreoideus.**
 - **Omohyoideus.**
- * **Action** → These muscles depress the larynx and hyoid bone, after they have been drawn up with the pharynx in the act of deglutition. The Omohyoidei not only depress the hyoid bone, but carry it backward and to one or the other side. They are

concerned especially in prolonged inspiratory efforts; for by rendering the lower part of the cervical fascia tense they lessen the inward suction of the soft parts, which would otherwise compress the great vessels and the apices of the lungs. The Thyreohyoideus may act as an elevator of the thyroid cartilage, when the hyoid bone ascends, drawing the thyroid cartilage up behind the hyoid bone. The Sternothyroideus acts as a depressor of the thyroid cartilage.

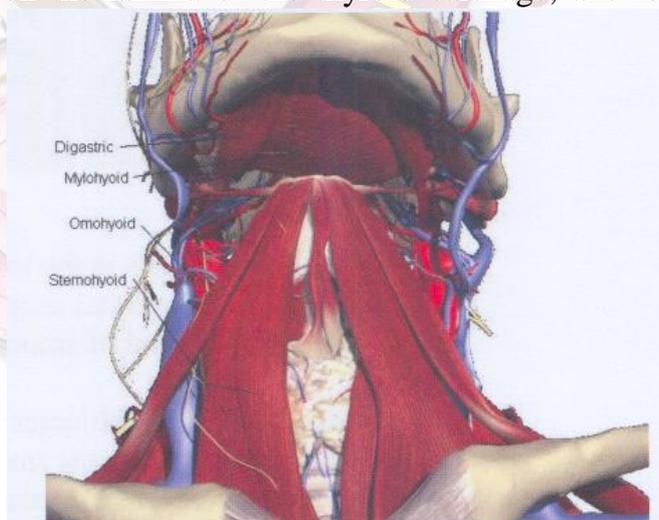
* **Nerves** → The Infrahyoid muscles are supplied by branches from the first three cervical nerves. From the first two nerves the branch joins the hypoglossal trunk, runs with it some distance, and sends off a branch to the Thyreohyoideus; it then leaves the hypoglossal to form the descendens hypoglossi and unites with the communicans cervicalis from the second and third cervical nerves to form the ansa hypoglossi from which nerves pass to the other Infrahyoid muscles.

(i) Sternohyoid muscle

- It is a thin, narrow muscle, which *arises* from the posterior surface of the medial end of the clavicle, the posterior sternoclavicular ligament, and the upper and posterior part of the manubrium sterni. Passing upward and medialward, it is *inserted*, by short, tendinous fibers, into the lower border of the body of the hyoid bone.
- Below, this muscle is separated from its fellow by a considerable interval; but the two muscles come into contact with one another in the middle of their course, and from this upward, lie side by side.
- It sometimes presents, immediately above its origin, a transverse tendinous inscription.

(ii) Thyrohyoid

- It *arises* from the oblique line on the lamina of the thyroid cartilage, and is *inserted* into the lower border of the greater cornu of the hyoid bone.
- Contraction pulls the hyoid bone and the thyroid cartilage together. The Thyreohyoideus may act as an elevator of the thyroid cartilage, when the hyoid bone ascends, drawing the thyroid cartilage up behind the hyoid bone.
- Innervation is by the hypoglossal nerve (CN. XII)



(iii) Omohyoid

- It *arises* from the upper border of the scapula, and occasionally from the superior transverse ligament which crosses the scapular notch, its extent of attachment to the scapula varying from a few millimetres to 2.5 cm. From this

origin, the inferior belly forms a flat, narrow fasciculus, which inclines forward and slightly upward across the lower part of the neck, being bound down to the clavicle by a fibrous expansion; it then passes behind the Sternocleidomastoideus, becomes tendinous and changes its direction, forming an obtuse angle. It ends in the superior belly, which passes almost vertically upward, close to the lateral border of the Sternohyoideus, to be inserted into the lower border of the body of the hyoid bone, lateral to the insertion of the Sternohyoideus.

- The Omohyoid not only depress the hyoid bone, but carry it backward and to one or the other side.
- They are concerned especially in prolonged inspiratory efforts; for by rendering the lower part of the cervical fascia tense they lessen the inward suction of the soft parts, which would otherwise compress the great vessels and the apices of the lungs.

(iv) The Sternothyroid

- Acts as a depressor of the thyroid cartilage.

Muscles Controlling the Movements of the Vocal Folds:

- * The vocal folds can be tightened or they can be relaxed.
- * They can be adducted or they can be abducted. The following muscles perform these actions.

(v) Cricothyroid (Tensor):

Origin: From the side of the cricoid cartilage.

Insertion: The muscle is triangular in shape. The upper fibers (Pars recta) pass upward and backward and are inserted onto the lower border of the lamina of the thyroid cartilage. The lower fibers (Pars oblique) run backward and are inserted onto the anterior border of the inferior cornu of the thyroid cartilage.

Nerve supply: External laryngeal nerve, and SLN that only innervates the cricothyroid muscle (serves to raise pitch)

Action: The vocal ligaments are tensed and elongated by increasing the distance between the angle of the thyroid cartilage and the vocal processes of the arytenoid cartilages. This is brought about by the muscle (1) pulling the thyroid cartilage forward and (2) tilting the lamina of the cricoid cartilage backward with the attached arytenoid cartilages.

(vi) Thyroarytenoid (Relaxor):

Origin: From the inner surface of the angle of the thyroid cartilage.

Insertion: The fibers lie lateral to the vocal ligament and are inserted onto the anterolateral surface of the arytenoid cartilage. Medial portion of the thyroarytenoid

run alongside the vocal ligament and are attached to the vocal process of the arytenoid cartilage, and it called the vocalis muscle. The lateral portion of the thyroarytenoid muscle is called thyromuscularis.

Nerve supply: Recurrent laryngeal nerve.

Action: Pulls the arytenoid cartilage forward toward the thyroid cartilage and thus shortens and relaxes the vocal ligament.

(vii) Lateral Cricoarytenoid (Adductor):

Origin: From the upper border of the arch of the cricoid cartilage.

Insertion: Into the muscular process of the arytenoids cartilage.

Nerve supply: Recurrent laryngeal nerve.

Action: Pulls the muscular process of the arytenoids cartilage forward, causing rotation of the arytenoid, so that the vocal process moves medially, and the vocal folds are adducted.

(viii) Posterior Cricoarytenoid (Abductor):

Origin: From the back of the lamina of the cricoid cartilage.

Insertion: The fibers pass upward and laterally, to be inserted into the muscular process of the arytenoids cartilage .

Nerve supply: Recurrent laryngeal nerve.

Action: Pulls the muscular process of the arytenoids cartilage backward, causing rotation of the arytenoid, so that the vocal process moves laterally, and the vocal fold is abducted.

Muscle Controlling the Laryngeal Inlet:

- * The Interarytenoid muscles are composed of two separate bellies, the **transverse** and the **oblique** portions.
- * When these muscles contract, they shorten the distance between the arytenoids cartilages, thus serving as adductors and contributing to forceful closure of the posterior glottis.

(ix) Oblique Interarytenoid:

Origin: From the muscular process of the arytenoids cartilage.

Insertion: Into the apex of the opposite arytenoid cartilage. Some of the fibers continue beyond the apex of the arytenoid cartilage and reach the epiglottis via the aryepiglottic fold. The latter fibers form the aryepiglottic muscles.

Nerve supply: Recurrent laryngeal nerve.

Action: The two muscles contracting together serve as a sphincter to the laryngeal inlet. They approximate the arytenoid cartilages to one another and draw them forward to the epiglottis. The laryngeal inlet opens as the result of a relaxation of the oblique arytenoid muscle and the elastic recoil of the ligaments of the joints of the arytenoids cartilages and the cricoid cartilage.

(x) Transverse Interarytenoid:

Origin: From the back and medial surface of the arytenoid cartilage.

Insertion: The muscle fibers bridge the interval between the arytenoid cartilages. The fibers are attached to the back and medial surface of the opposite arytenoid cartilage.

Nerve supply: Recurrent laryngeal nerve.

Action: Approximates the arytenoid cartilages and closes the posterior part of the rima glottides (adduct the glottis).

Airway closure muscles:

(xi) Lateral cricoarytenoid

- This muscle originates from the lateral side of the superior border of the arch of the cricoid cartilage; its fibers run posteriorly to attach to the muscular process of the arytenoid cartilage
- Contraction rotates the arytenoid cartilages, thereby closing the airway
- Innervation is by the recurrent laryngeal nerve (branch of Vagus, CN. X)

(xii) Transverse (or inter-) arytenoids

- This is a single, unpaired muscle running between the two arytenoid cartilages
- Contraction adducts the arytenoid cartilages, thereby closing the airway
- Innervation is by the recurrent laryngeal nerve (branch of Vagus, CN. X)

Nerve supply of the Larynx:

- * The sensory nerve supply to the mucous membrane of the larynx above the vocal folds is from the *internal laryngeal branch* of the *superior laryngeal branch* of the vagus nerve.
- * Below the level of the vocal folds, the mucous membrane is supplied by the *recurrent laryngeal nerve*.
- * The motor nerve supply to the intrinsic muscles of the larynx is the recurrent laryngeal nerve, except for the cricothyroid muscle, which is supplied by the external laryngeal branch of the superior laryngeal branch of the vagus.
- * Two characteristics of the SLN and RLN ensure the ability of the intrinsic laryngeal muscles to move quickly and with great fine motor control.²
 - First, the laryngeal nerves have a high conduction velocity (second only to the eye) which allows rapid contractions.
 - Second, the innervation ratio is low, meaning that many cells (estimated at 100 to 200) are innervating a single motor unit, allowing very fine motor control.
- * Evidence suggests that afferent information sent from sensory receptors in the larynx to the C.NS are transmitted by the internal branch of the superior laryngeal nerve, through the vagus to terminate in a region of the medulla called the **Nucleus Tractus Solitarius (NTS)**. This region contains areas that are involved in the control of respiration, laryngeal maneuvers, and swallowing.²

Laryngeal Reflexes

- * Sensory receptors in the larynx are located in mucosal tissue, articular joints, and muscle.
- * The sensory receptors in mucosal tissue respond to touch, vibration, changes in air pressure, and liquid stimuli. These receptors have the ability to elicit tight sphincteric closure to close off the trachea and lungs from foreign material in the upper airway.
- * Muscle receptors are located most predominantly in the vocalic muscle and are also present in other intrinsic laryngeal muscles.
- * The laryngeal reflex contracts rapidly to protect the airway from foreign materials or aspiration. Accordingly, these reflexes are triggered by receptors described above in the mucosal tissue, articular joints, and muscles.
- * An extreme glottic closure reflex, called **laryngospasm**, can be triggered by stimuli reaching sites closer to the glottic level, and prolongation of this vocal fold adduction can pose a threat to ventilation.
- * A respiratory reflex that opens the vocal folds in rhythmic coordination with the diaphragm contraction has also been identified. In long-term tracheotomized patients, this rhythmic respiratory reflex appears to be suppressed.

Blood supply and lymph drainage of the larynx:

- * The arterial supply to the upper half of the larynx is from the superior laryngeal branch of the superior thyroid artery.
- * The lower half of the larynx is supplied by the inferior laryngeal branch of the inferior thyroid artery.
- * These arteries branch from the external carotid artery in the neck.
- * Venous return is transmitted through the jugular vein.

Work cited

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