

8. The Larynx

The purpose of this dissection is to open up the larynx and observe the vocal folds. Adjustments of the larynx have multiple and interacting functions in speech, not all of which are well understood. The major movements that are relevant for speech production are the following.

(a) Abducting/Adducting vocal folds. To abduct means to move away from the midline of the body, and thus to open or pull apart, to adduct means to bring toward the midline, and thus to close or bring together (Latin 'ab' from, 'ad' to). The vocal folds can be fully adducted, for a glottal stop, or loosely adducted so that they vibrate for voiced sounds. The main muscles involved in adduction are the interarytenoid muscles, which bring the posterior ends of the vocal folds together by moving the arytenoid cartilages together. In production of voiceless sounds the vocal folds are abducted by moving the vocal folds apart. This is principally achieved by using the posterior cricoarytenoid muscles to separate the arytenoid cartilages.

(b) Lengthening/Shortening vocal folds. The pitch of voiced sounds is largely controlled by varying the length of the vocal folds. As the folds are lengthened their mass per unit length is reduced, and consequently they vibrate faster. The folds are attached to the thyroid cartilage at the front and to the arytenoid cartilages, which ride on the cricoid cartilage, at the rear so their length is largely controlled by moving the thyroid and cricoid cartilages relative to each other. EMG studies suggest that lengthening the vocal folds is mainly achieved by using the cricothyroid muscles. It is also observed that the whole laryngeal structure tends to rise as pitch rises, therefore external laryngeal muscles must also be strongly involved in pitch raising. It is unclear how much active shortening of the folds is possible; most likely pitch lowering is mainly achieved by relaxation of muscles used to reach a higher pitch.

(c) Raising/Lowering of larynx. Apart from the role that larynx raising plays in pitch control, the larynx is also raised or lowered to provide the initiation for glottalic sounds, such as ejectives (raising) and implosives (lowering), and to adjust the volume of the pharyngeal cavity. In this way the pharyngeal cavity is often enlarged for voiced obstruents and for advanced tongue root [+ATR] vowels and contracted for retracted tongue root [-ATR] vowels.

(d) Tensing/Relaxing vocal folds. Since the vocal folds consist in part of muscle (the vocalis portion of the thyroarytenoid muscle), they can also be inherently tensed and relaxed. It is probable that the degree of contraction of the vocalis fibers contributes to different modes of phonation.

Further comments on some of these functions will be made in the course of viewing and dissecting the intrinsic laryngeal structures described in this section.

Dissection

In this dissection you will first identify the previously exposed extrinsic muscles of the larynx. Then you will expose and explore the intrinsic muscles of the larynx.

The extrinsic muscles of the larynx

Most of the extrinsic muscles have been revealed in earlier dissections, particularly the dissection of the strap muscles of the neck and the dissection of the tongue.

1. Review the location of the seven hyoid and laryngeal elevators

Anterior and posterior bellies of the digastric (the posterior belly originates on the mastoid process of the temporal bone and runs through a sling at the hyoid bone; the anterior belly originates on the inside of the mandible and runs through the same sling at the hyoid bone).

Stylohyoid muscles (originates on the styloid process of the temporal bone and inserts into the hyoid bone).

Mylohyoid muscles (originates on the underside of the mandible and inserts into the hyoid bone).

Geniohyoid muscles (originates on the inside of the chin and inserts into the hyoid bone).

Genioglossus muscles (originates on the inner surface of the mandible, superior to the geniohyoid muscle and inserts into the tongue and the anterior surface of the hyoid bone).

Hyoglossus muscles (arises from the greater horns of the hyoid bone and inserts into the sides of the tongue).

Thyropharyngeus muscles (arises from the back of the pharynx muscles and inserts into the horns of the thyroid cartilage).

2. Review the location of the four hyoid and laryngeal depressors

The sternohyoid muscles (originate at the top of the sternum and inserts into hyoid bone).

The superior and inferior bellies of the omohyoid muscles (the inferior bellies originate at the shoulder blades, the superior bellies originate at the side of the hyoid bone and they are joined by a tendon).

The sternothyroid muscles (originate at the sternum and the first cartilaginous rib and inserts into the thyroid cartilage).

The thyrohyoid muscles (originate at the thyroid cartilage and insert into the greater horn of the hyoid bone). This muscle both raises the larynx and depresses the hyoid bone.

The intrinsic muscles of the larynx

1. Locate the thyroid cartilage (Figure 8.1). On the lateral border observe the cricothyroid muscle which arises from the arch of the cricoid cartilage and has two parts: one part inserts into the lower border of the thyroid cartilage, and the other is inserted diagonally into the anterior border of the inferior horn of the thyroid cartilage.

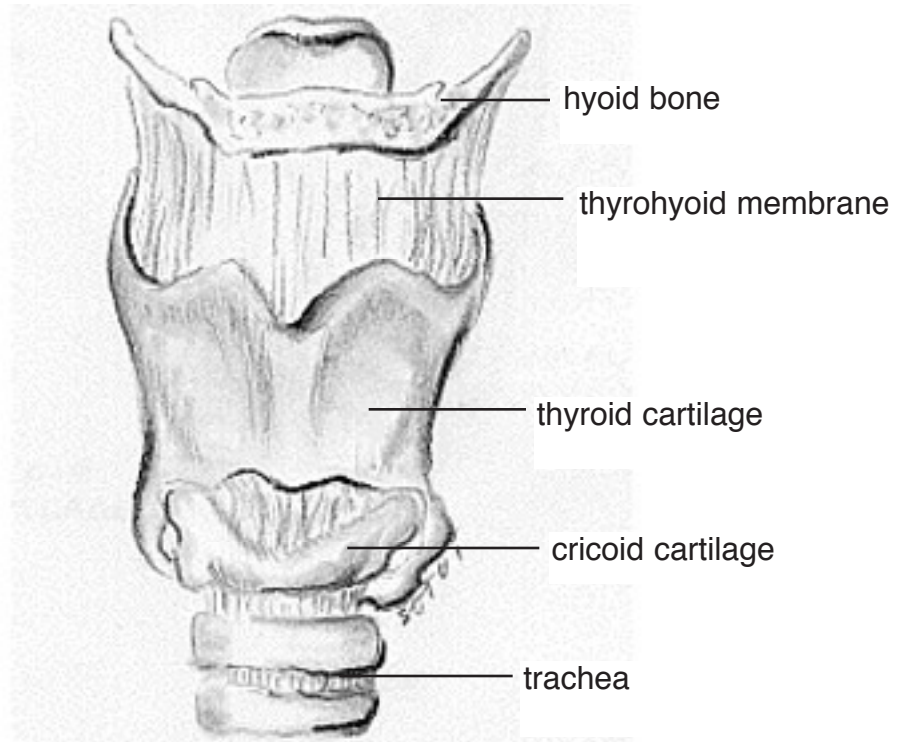


Figure 8.1. The laryngeal region, anterior (front) view. The cricothyroid muscle has been removed.

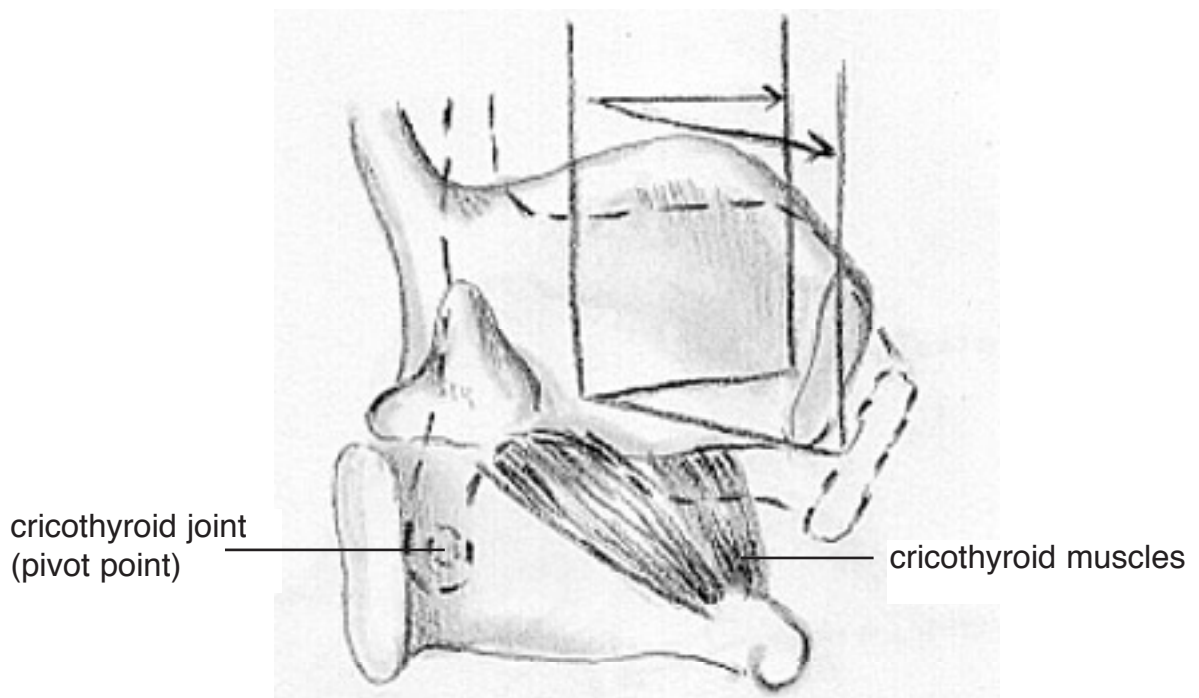


Figure 8.2. Action of the cricothyroid muscles (after Netter).

2. Locate the cricothyroid joint. The cricothyroid joint allows for rotation of the thyroid

cartilage around a transverse (horizontal) axis which runs between the inferior horns of the thyroid cartilage. In this manner, the front of the thyroid cartilage draws either towards or away from the front of the cricoid cartilage. Contraction of the cricothyroid muscle rotates the thyroid cartilage forward and relaxation allows other muscles to rotate the thyroid cartilage backward, as shown in figure 8.2. Tilt the thyroid and cricoid cartilages back and forth and observe the effects on the vocal folds,

3. Locate the vocal folds. The vocal folds run from the front of the thyroid cartilage to slightly above the back of the cricoid cartilage. Therefore, forward rotation of the thyroid cartilage lengthens and tenses the vocal folds while backward rotation shortens and relaxes them.
4. Remove the mucous membrane which surrounds the posterior aspect of the larynx by using a pair of fine forceps and scissors. Lift the membrane away from the underlying structure with the forceps and cut the fascia which anchors the mucous membrane to the muscles below, which are shown in figure 8.3.
5. Place your finger into the larynx and palpate for the arytenoid cartilages, which are sitting on top of the cricoid cartilage. The arytenoid cartilages are triangular in shape and there are three processes (angles). The muscular process is connected to the cricoid cartilage by the posterior cricoarytenoid muscle. The vocal process is connected to the thyroid cartilage by the vocal folds and thyroarytenoid muscle. The third angle is called the apex. Each apex has a tiny corniculate cartilage sitting on top of it.

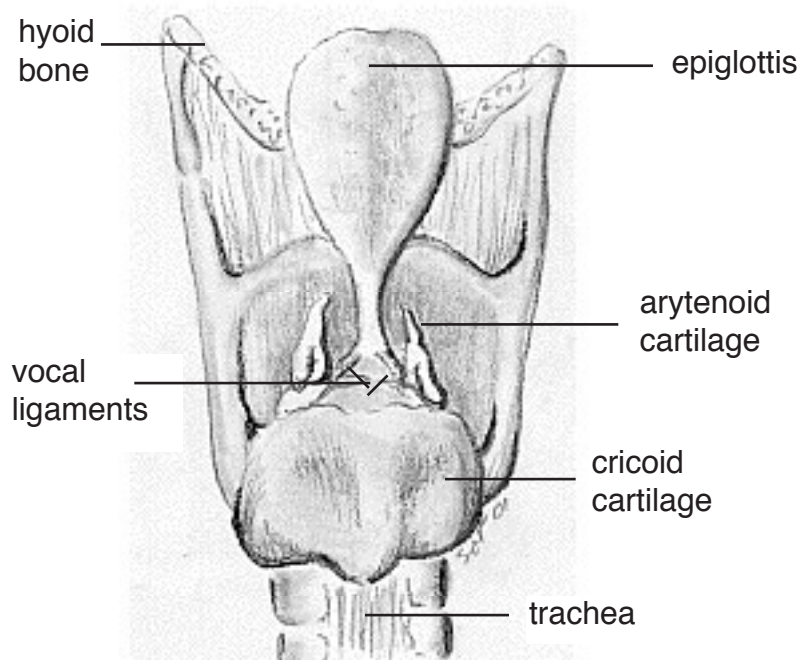


Figure 8.3. The larynx viewed from the back, after the removal of the mucous membrane that surrounds the posterior aspect of the larynx.

6. Locate the posterior cricoarytenoid muscles, fan shaped muscles which arise from both

sides of the midline of the posterior aspect of the cricoid cartilage. These muscles insert into the muscular processes of the arytenoid cartilages.

The cricoarytenoid joint is saddle shaped. Imagine a saddle (each arytenoid cartilage) fitting over a cylinder. This type of joint affords two kinds of motion: the saddle can slide along the cylinder's axis or it can slide around the cylinder - rotating about the cylinder's axis. The posterior and lateral cricoarytenoid ligaments constrain the sliding motion which the arytenoid cartilage can make.

Contraction of the posterior cricoarytenoid muscle exerts a posteroinferior (back and downward) force on the muscular process of the arytenoid cartilage. This rotates the arytenoid posteriorly over the top of the cricoarytenoid joint. The two arytenoid cartilages thus rotate outward and away from one another. This abducts (pulls apart) the vocal folds.

7. Locate the oblique arytenoid muscles superior to the posterior cricoarytenoid muscles. Each one of these muscles runs from the medial half of the muscular process of the arytenoid cartilage diagonally across to the apex of the opposing arytenoid cartilage on the other side of the larynx, forming an "X".
8. Locate the transverse arytenoid muscle deep to the oblique arytenoid muscles. The transverse arytenoid muscle is an unpaired muscle.

Contraction of both the oblique arytenoid muscles and the transverse arytenoid muscle—often referred to jointly as the interarytenoids—acts to adduct (pull together) the vocal folds. The oblique arytenoid muscles draw the apex of each arytenoid cartilage toward the muscular process of the other arytenoid cartilage. Because of the character of the cricoarytenoid joint, the arytenoid cartilages must rotate forward to allow such an approximation. This rotation, in turn, adducts the vocal folds. Contraction of the transverse arytenoid muscle will have a similar effect.

To better visualize this motion, cross your hands at the wrists and make "mirror Ls" with your thumb and forefinger. Your thumbs represent the muscular processes of the arytenoid cartilages and your forefingers represent the vocal processes of the arytenoid cartilages with invisible vocal fold extending from them. To adduct the "vocal folds" rotate your forefingers inwards and downwards in imitation of the action of the arytenoid cartilages.

9. Split the thyroid cartilage down the midline using a sharp scalpel.
10. Dislocate the joint formed by the inferior cornu of the thyroid cartilage with the cricoid cartilage by prying the thyroid cartilage away from the cricoid cartilage with your finger. You should now be able to pull forward half of the thyroid cartilage and examine the lateral external aspect of the larynx.
11. Locate the lateral cricoarytenoid muscles which originate from the superior aspect of the back of the cricoid cartilage and run posterosuperiorly (from the back and upwards) to attach to the muscular processes of the arytenoid cartilages. Contraction of these muscles pulls the muscular processes of the arytenoid cartilages forward and medially. This action causes adduction and/or lengthening of the vocal folds.

12. Open the laryngeal cavity along the split in the thyroid cartilage to view the inside of the larynx.
13. Locate the laryngeal vestibules inside the larynx. These are longitudinal furrows between two folds in the laryngeal wall. The superior fold is the vestibular fold, also known as the false vocal fold. The inferior fold is the true vocal fold.
14. Locate the true vocal folds. They may be yellowish along the edge where the muscle gives way to ligament. The thyroarytenoid muscles lie beneath the vocal folds and attach the posterior aspect of the thyroid cartilage to the vocal process of the arytenoid cartilages. The thyroarytenoid muscle has an antagonistic effect to that of the cricothyroid muscle. The thyroarytenoid muscle tilts the thyroid cartilage backwards, thus shortening the vocal folds.
15. Remove the mucosa from a true vocal fold, exposing the vocalis muscle beneath. The vocalis muscle is a subset of the muscle fibers of the thyroarytenoid muscle which lie directly beneath the true vocal folds. It is not practical to try to make this distinction between thyroarytenoid and vocalis muscle fibers during the dissection.

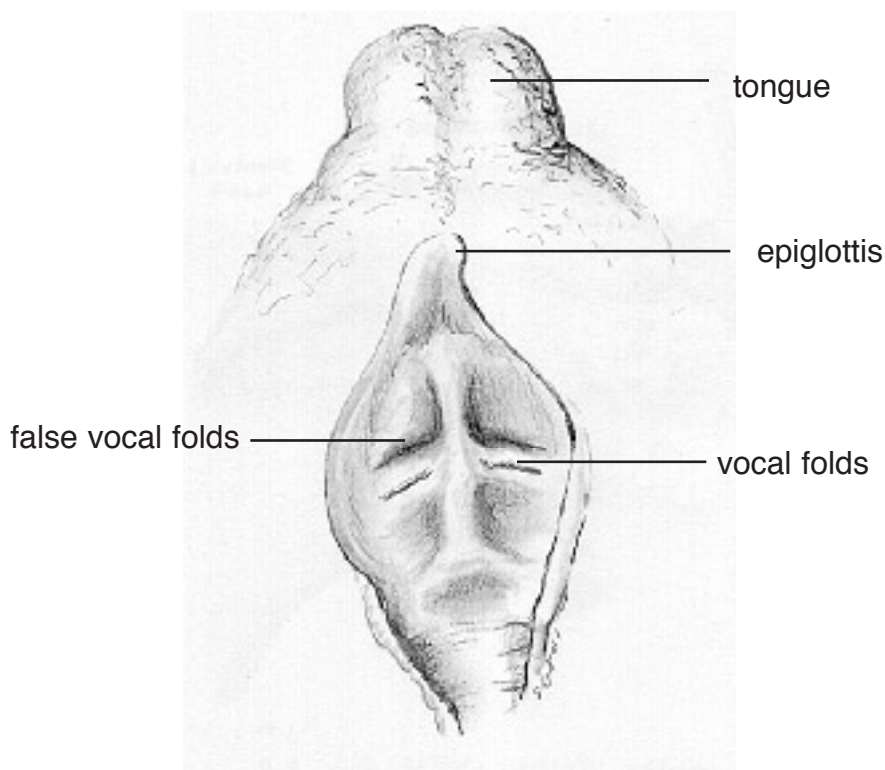


Figure 8.4. The larynx opened from behind.

16. Cut the interarytenoid muscles and the posterior cricoarytenoid muscles away from the muscular process of the arytenoid cartilage on one side of the cricoid cartilage. Locate the muscular process of the arytenoid cartilages.
17. Rotate the arytenoid cartilages forward and backward on the cricoid cartilage, observing

how this movement affects the vocal folds. (Figure 8.5.)

18. Remove an arytenoid cartilage from the larynx by detaching any of its remaining muscular attachments. Clean off all remaining bits of muscle. Identify the vocal and muscular processes. On the cricoid cartilage, locate the joint that the arytenoid cartilage makes with it. Inspect the shape of the facets on the cricoid and arytenoid cartilages, verifying that the joints allow the rotational movements described above.

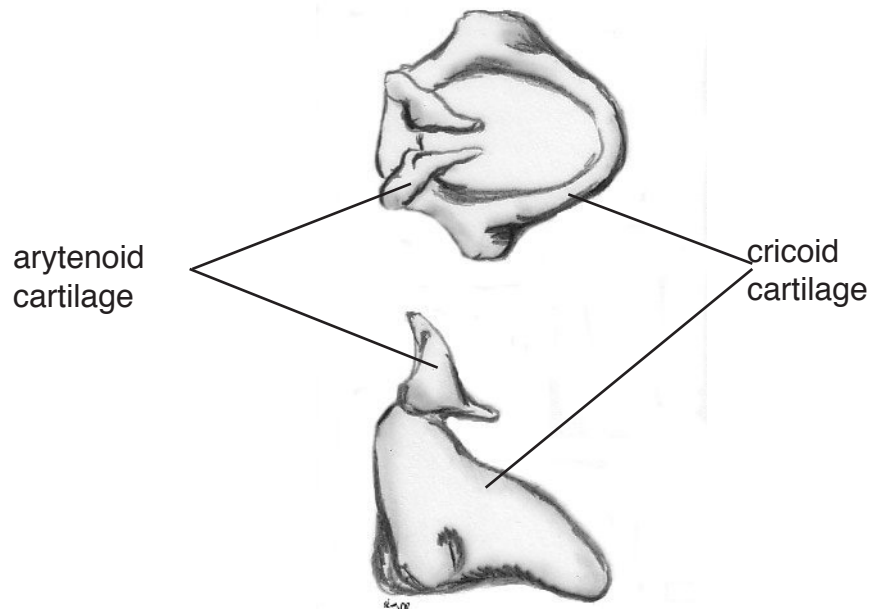


Figure 8.5. Articulation of the cricoid and arytenoid cartilages.
Superior view (top) and lateral view (side); anterior to the right of figure.

19. Detach any remaining muscles from the hyoid bone so that the thyrohyoid membrane can be observed (see figure 8.1). When the hyoid bone is raised, as the result of raising the tongue in the production of high vowels, this connection may result in an upward pull on the anterior portion of the thyroid cartilage. This will in turn lengthen the vocal folds and raise the pitch of the vowel.