

Appendix B: Muscles of the Speech Production Mechanism

I. MUSCLES OF RESPIRATION

A. MUSCLES OF INHALATION (muscles that enlarge the thoracic cavity)

1. Diaphragm

Attachments: The diaphragm originates in a number of places: the lower tip of the sternum; the first 3 or 4 lumbar vertebrae and the lower borders and inner surfaces of the cartilages of ribs 7 - 12. All fibers insert into a central tendon (aponeurosis of the diaphragm).

Function: Contraction of the diaphragm draws the central tendon down and forward, which enlarges the thoracic cavity vertically. It can also elevate to some extent the lower ribs. The diaphragm separates the thoracic and the abdominal cavities.

2. External Intercostals

Attachments: The external intercostals run from the lip on the lower border of each rib inferiorly and medially to the upper border of the rib immediately below.

Function: These muscles may have several functions. They serve to strengthen the thoracic wall so that it doesn't bulge between the ribs. They provide a checking action to counteract relaxation pressure. Because of the direction of attachment of their fibers, the external intercostals can raise the thoracic cage for inhalation.

3. Pectoralis Major

Attachments: This muscle attaches on the anterior surface of the medial half of the clavicle, the sternum and costal cartilages 1-6 or 7. All fibers come together and insert at the greater tubercle of the humerus.

Function: Pectoralis major is primarily an abductor of the arm. It can, however, serve as a supplemental (or compensatory) muscle of inhalation, raising the rib cage and sternum. (In other words, breathing by raising and lowering the arms!) It is mentioned here chiefly because it is encountered in the dissection.

4. Pectoralis Minor

Attachments: Deep to pectoralis major, this muscle attaches to the coracoid process of the scapula and the anterior ends of ribs 2 - 5.

Function: This muscle is also not primarily for respiration. Its main function is to lower the shoulder. If the pectoral girdle is fixed, it may, however, cooperate with pectoralis major in raising the upper ribs. It has been found to be active in forced inhalation.

B. MUSCLES OF EXHALATION (muscles that decrease the volume of the thoracic cavity)

1. Internal Intercostals

Attachments: The internal intercostals run from the anterior limits of the intercostal spaces

to the angle of the ribs posteriorly. In front, they run inferiorly and laterally, and in back inferiorly and medially. Each muscle runs from the subcostal groove of one rib to the top of the rib immediately below it.

Function: The internal intercostals assist the external intercostals in strengthening the intercostal spaces. The internals are also the chief muscle in forced exhalation, for example during phonation. The internal intercostals - aided by the abdominal muscles - pull down the rib cage because of the direction of their fibers (opposite to the external intercostals). Note: as defined here, nerve fibers run within the internal intercostal muscles. Some researchers thus distinguish the 'internal' intercostal fibers, which are superficial to this nerve, from the 'innermost' intercostals, which are deep.

2. Internal Obliques

Attachments: The internal obliques originate in the lateral half of the inguinal ligament and the anterior half of the iliac crest. The fibers course almost vertically up to the lower borders of the cartilages of the last 3 or 4 ribs and the abdominal aponeurosis.

Function: The internal obliques assist other muscles in compressing the abdomen and thus raising the diaphragm and decreasing the vertical dimension of the thoracic cavity. They may also pull down on the lower three ribs.

3. External Obliques

Attachments: These muscles originate in the exterior surfaces and lower borders of ribs five to twelve. The fibers run in two directions: a) inferiorly and medially to the anterior half of iliac crest and near the midline of the abdominal aponeurosis and b) to the external layer of the abdominal aponeurosis.

Function: The external obliques compress the abdomen and draw the lower ribs downward. They may be used in forced exhalation.

4. Rectus Abdominis

Attachments: Rectus abdominis attaches at the crest of the pubis. The fibers run superiorly to the cartilage of the fifth, sixth and seventh ribs and the xiphoid process.

Function: This muscle is also used in forced exhalation. It can pull the ribs down and thus decrease the thoracic cavity and also push in on the abdomen forcing the diaphragm upwards thereby forcing air out of the lungs.

5. Transversus Thoracic

Attachments: Transversus thoracic originates on the inner surface of the lower part of the sternum. The fibers run superiorly and laterally to the lower borders and inner surfaces of ribs two to six.

Function: These muscles may help to depress ribs for exhalation and may also tighten the intercostal spaces to help maintain the rigidity of the thoracic wall.

II. MUSCLES OF LIP MOVEMENT

A. MUSCLES THAT CLOSE THE LIPS

1. Orbicularis Oris

Attachments: Orbicularis Oris is the sphincter muscle of the mouth, many of the other facial muscles blend in with it. Its fibers run in several directions. The intrinsic fibers extend from the incisive slips under the nose to the mental slips at the midline under the lower lip. The extrinsic fibers arise from the buccinator through the modiolus. The uppermost and lowermost fibers go directly across the upper and lower lips to the other side. The middle fibers cross each other, the upper ones going below the lower lip and the lower ones going above upper lip.

Function: On contraction, this muscle adducts the lips by drawing the lower lip up and the upper lip down, probably in conjunction with some of the other facial muscles. It may also pull the lips against the teeth. This muscle can also round the lips by its sphincter action.

B. MUSCLES THAT RAISE THE UPPER LIP

1. Levator Labii Superioris

Attachments: This muscle originates on the inferior orbital margin and parts of the zygomatic bone. The fibers course inferiorly and insert in the upper lip.

Function: As its name indicates, levator labii superioris raises the upper lip. It may be used to raise the upper lip in the production of labiodental fricatives.

2. Levator Labii Superioris Alaeque Nasi

Attachments: This muscle originates on the frontal process of the maxilla (the bone forming the upper jaw). The fibers run inferiorly and laterally along the sides of the nose and divide into two slips. One slip inserts in the alar cartilage (around nostril) and the other continues down to the upper lip.

Function: The muscle elevates the alar cartilages (dilates nostrils) and also elevates the middle part of the upper lip.

3. Zygomaticus Minor

Attachments: Zygomaticus minor originates on the facial surface of zygomatic bone. Running inferiorly and medially, the fibers insert into the modiolus and orbicularis oris, just lateral to the midline.

Function: Raises upper lip for [f] along with the muscles that raise the angles of the mouth.

C. MUSCLES THAT LOWER THE BOTTOM LIP

1. Depressor Labii Inferioris

Attachments: Depressor labii attaches on the oblique line of mandible near mental foramen. Fibers run superiorly and medially to orbicularis oris and the skin of the lower lip.

Function: Draws lower lip downward and laterally, useful in the release of bilabial

consonants.

D. MUSCLE FOR ROUNDING THE LIPS

1. Orbicularis Oris (see under muscles that close the lips)

E. MUSCLES THAT PROTRUDE THE LIPS

1. Mentalis

Attachments: Mentalis originates on the mandible near mental tuberosity (point of the chin). Fibers course superiorly, some reaching orbicularis oris, others inserting at different places along the way.

Function: On contraction, mentalis draws the skin on the chin upwards, at the same time everting and protruding the lower lip. In conjunction with orbicularis oris it helps round and protrude the lips for the high rounded vowels [u] and [y]. It also may help to close lips.

2. Orbicularis Oris--deep fibers (see under muscles that close the lips)

F. MUSCLES THAT RETRACT THE ANGLES OF THE MOUTH

1. Buccinator

Attachments: Buccinator attaches to the pterygomandibular raphe and lateral surfaces of the mandible and the maxilla (the upper jaw) opposite the molar teeth. The fibers course medially and insert in the modiolus, with some continuing on into the upper and lower lips, forming the more superficial fibers of orbicularis oris.

Function: The buccinator draws the lips back against the teeth and pulls the angles of the mouth laterally as an antagonist to the muscles of protrusion and rounding. This action is probably utilized in the production of labiodental and bilabial fricatives. If the lips are actively spread in pronunciation of vowels such as [i] and [e] (which seldom happens), this muscle may be used.

2. Risorius

Attachments: The risorius is sometimes regarded as an extension of the platysma. The fibers have their origin at the fascia of the masseter near the ramus of the mandible. The fibers run horizontally, parallel and superficial to the buccinator, inserting in the modiolus, some continuing on to the upper and lower lips.

Function: The risorius draws the mouth angles laterally to help spread the lips in the production of [i] and [e] (although note the comment in the discussion of buccinator.). It may also aid the buccinator and zygomaticus major in pulling back the angles of the mouth during labiodental and bilabial fricatives.

3. Zygomaticus Major

Attachments: Zygomaticus major attaches on the outer edge of zygomatic bone, just lateral to zygomaticus minor. In some cases it inserts into the more superficial connective tissue that extends to cover the temporalis muscle. The fibers course inferiorly and medially to insert into the modiolus and orbicularis oris of the upper lip.

Function: On contraction, this muscle draws the angle of the mouth upward and laterally. The upward movement probably works with levator anguli oris to achieve the raised upper lip in labiodental fricatives. The lateral movement may be used in the production of [s].

G. MUSCLES THAT RAISE THE CORNERS OF THE MOUTH

1. Levator Anguli Oris

Attachments: Levator anguli oris runs from the canine fossa on the maxilla coursing inferiorly and slightly laterally; most fibers insert in the modiolus with a few continuing on to insert in the lower lip.

Function: This muscle draws the corner of the mouth upwards and, because of the fibers that insert into the lower lip, may assist in closing the mouth by drawing the lower lip up, for the closure phase in bilabial consonants.

2. Zygomaticus Major (see under muscles that retract the angles of the mouth)

H. MUSCLES THAT LOWER THE ANGLES OF THE MOUTH

1. Depressor Anguli Oris

Attachments: Depressor anguli oris attaches to the oblique line of mandible. This muscle is superficial and lateral to depressor labii inferioris. It runs vertically upwards, interdigitating with the platysma, and inserts into the modiolus. Some fibers continue up to the upper lip.

Function: This muscle depresses the angles of the lips. This action may work with depressor labii inferioris to prevent the mouth from closing entirely when spreading for vowels like [i] and [e]. Because of the fibers that insert in the upper lip, this muscle may also aid in compressing lips by drawing the upper lip down.

2. Platysma

Attachments: Platysma originates in the fascia covering superior parts of pectoralis major and deltoid muscles. Fibers course superiorly and anteriorly, some inserting into the lower border of the mandible, blending with depressor labii inferioris and depressor anguli oris, some turn more medially and meet the corresponding fibers from the other side on the chin, some go up into the modiolus, and some even continue up to the zygomatic arch and orbicularis oculi.

Function: The platysma can aid depressor anguli oris and depressor labii inferioris to draw down and laterally the angles of the mouth.

III. MUSCLES OF MANDIBULAR MOVEMENT

A. MUSCLES THAT RAISE THE MANDIBLE

1. Masseter

Attachments: The masseter has its origin at the zygomatic arch. It inserts in the ramus of the mandible.

Function: This muscle closes the jaws by elevating and drawing forwards the angle of the mandible.

2. Medial Pterygoid

Attachments: The medial pterygoid originates in the pterygoid fossa and the medial surface of the lateral pterygoid plate. The fibers run inferiorly, laterally and posteriorly to the medial surface of the ramus and angle of the mandible.

Function: The medial pterygoid works with the masseter and temporalis to raise and protrude the mandible. It serves also as an antagonist to the anterior suprahyoid muscles to balance the lip position for labiodental fricatives and adjust the jaw position for [s].

3. Temporalis

Attachments: The temporalis originates from the entire temporal fossa. The fibers pass under the zygomatic arch to the anterior border of the ramus of the mandible.

Function: The function of this muscle is to raise the mandible (along with the masseter and the medial pterygoid). The posterior fibers retract the mandible slightly, assisted by the anterior suprahyoid muscles.

B. MUSCLES THAT LOWER THE MANDIBLE

1. Anterior Belly of the Digastric

Attachments: This muscle originates on the inside surface of the lower border of the mandible. The fibers course inferiorly and posteriorly to the intermediate tendon near the lesser cornu of the hyoid bone.

Function: The function of this muscle is to draw the hyoid bone up and forward. It also serves to bring the tongue forward and upward for alveolar and high front vowel articulations. In pulling up the hyoid bone, it may also pull up the larynx thereby tensing the stretching the vocal cords and raising the pitch. If the hyoid bone is fixed, the anterior belly of the digastric can serve to lower the jaw in conjunction with the geniohyoid, mylohyoid and lateral pterygoid muscles.

2. Genioglossus (see under Muscles of the tongue)

3. Geniohyoid

Attachments: Geniohyoid attaches on the anterior inner surface of the mandible at the mandibular symphysis (where the two halves of the mandible join). Fibers run posteriorly and inferiorly to the anterior surface of the body of the hyoid bone. It is close to the midline of the floor of the mouth.

Function: When the mandible is fixed, the geniohyoid (along with the lateral pterygoid, the anterior belly of the digastric and the mylohyoid) pulls the hyoid bone upward and forward. This will raise both tongue and larynx. The geniohyoid may also serve as an antagonist to the thyrohyoid, tilting the hyoid and with it the thyroid cartilage backward, for velar and uvular articulations. If the hyoid bone is fixed by other muscles, the geniohyoid can become an active jaw opener.

4. Mylohyoid

Attachments: The mylohyoid muscle originates from the mylohyoid line along the inner

surface of the mandible. Coursing medially and inferiorly, the fibers join those of the opposite side at the raphe and down to the corpus of the hyoid bone.

Function: When the mandible is fixed, the mylohyoid helps to elevate the hyoid and bring it forward and with it the floor of the mouth and the tongue. With the hyoid bone fixed, the mylohyoid may depress the mandible. It helps bring the tongue forward for alveolar articulations and, along with the posterior belly of the digastric, the stylohyoid and the medial pharyngeal constrictor, helps bulge the tongue up and back for velars. It is also active in high vowels whether front or back, in that it raises the whole body of the tongue.

5. Lateral Pterygoid

Attachments: This muscle attaches to the lateral portion of the greater wing of the sphenoid bone and the lateral surface of the lateral pterygoid plate. Running horizontally and posteriorly, the fibers insert in the pterygoid fossa and the temporo-mandibular joint.

Function: The lateral pterygoid muscle protrudes the mandible, causing the condyle to slide down and forward. This protrusion is useful in the articulation of [s] and [ʃ] and, for some people, [f]. It can also depress the mandible along with the other depressors discussed above.

IV. MUSCLES OF THE TONGUE

A. INTRINSIC MUSCLES THAT CHANGE THE SHAPE OF THE TONGUE

1. Superior Longitudinal

Attachments: This muscle originates at the median fibrous septum and mucous membrane at the root of the tongue (close to the hyoid bone). Some fibers go back to the epiglottal ligament. The fibers course anteriorly along the length of the tongue very superficially and insert in the mucous membrane at the tip of the tongue. Laterally, the fibers join with the longitudinal fibers of the styloglossus, hyoglossus and inferior longitudinal muscles.

Function: On contraction, this muscle shortens the tongue, perhaps widening it at the same time. It can also bulge the tongue upwards as it shortens it, probably with the help of the inferior longitudinal to pull the tip of the tongue downwards. Since the fibers are inserted in the tip, this muscle can probably also raise the tip of the tongue for tongue tip dental and alveolars and retract it a bit for retroflex articulations. The lateral fibers may (along with styloglossus and perhaps palatoglossus) help keep the sides of the tongue raised during grooved articulations such as [s] and [z].

2. Inferior Longitudinal

Attachments: This muscle originates at the hyoid bone and root of tongue. Fibers course anteriorly lateral to the midline on the inferior side of the tongue between the genioglossus and hyoglossus muscles and insert into the inferior part of the tongue tip, blending with the fibers of the genioglossus, hyoglossus and styloglossus.

Function: This muscle pulls down and retracts the tip of the tongue for the release of tongue tip stop consonants. It acts as an antagonist to superior longitudinal and styloglossus for delicate

control of tongue configuration as in grooving for [s]. By depressing the tip and bulging the tongue upwards, it helps from the articulations of back vowels and velar consonants.

3. Transverse

Attachments: These muscle fibers originate at the median fibrous septum. The fibers course laterally to the lateral margins of the tongue, mainly inferior to the superior longitudinal and superior to the inferior longitudinal muscles. They insert into the submucous fibrous tissue in a fan-like distribution. Near the tip of the tongue, where the median fibrous septum is not evident, they interdigitate with fibers of same muscle on the other side and with fibers of the superior longitudinal and inferior longitudinal muscles. At the root of the tongue they interdigitate with the palatopharyngeus muscle.

Function: On contraction, these fibers narrow and elongate the tongue. They draw the edges of the tongue upwards, aiding in grooving the tongue. They may also aid genioglossus in pushing the tongue forwards for front articulations when the tongue is coming from a back position.

4. Vertical

Attachments: These muscle fibers attach to the mucous membrane of the dorsum of tongue. The fibers course inferiorly and vertically on either side of the median fibrous septum, inserting in the mucous membrane on the ventral side of the tongue. Some fibers interdigitate with fibers from the transverse and inferior longitudinal muscles.

Function: On contraction, the vertical fibers flatten the tongue and push the tongue out laterally to make contact with the roof of the mouth in palatal and alveolar stops. This tongue position may also be used in high front vowels. It is also used in making a seal between the upper and lower teeth during the production of [s]. The median fibers may act independently to flatten the middle of the tongue for grooved articulations.

B. EXTRINSIC MUSCLES (muscles that change the position of the tongue in the mouth as well as shape the tongue to some extent)

1. Genioglossus

Attachments: Genioglossus runs from the superior mental spina on posterior surface of the mandibular symphysis. The lower most fibers course posteriorly back to the anterior surface of the hyoid bone. Other fibers curve and fan out anteriorly and superiorly to insert into the submucous fibrous tissue near the midline from the root of the tongue to near the tip. Some fibers may interdigitate with those of the superior pharyngeal constrictor.

Function: Contraction of posterior fibers protrudes the tongue when the mandible is fixed. This is useful in the production of nearly all sounds articulated in the front of the mouth. The anterior fibers retract the tongue on contraction and also depress the tip somewhat, and are probably used in the release of alveolar stop consonants. Besides its function as a muscle of the tongue, the genioglossus can also help to elevate the hyoid bone (and thus the larynx) when the mandible is fixed.

2. Hyoglossus

Attachments: This muscle originates on the greater horn and body of hyoid bone. The

posterior and medial fibers interdigitate with the styloglossus and the inferior longitudinal muscles at the lateral edges of the tongue. Some of the anterior fibers may attach to the mucous membrane at the tip of the tongue. One small bundle coming from the lesser cornu of the hyoid bone parallels the hyoglossus and inserts in the intrinsic muscles on the side of the tongue and the tip. This is sometimes considered a separate muscle: the chondroglossus (chondro = cartilage).

Function: When the hyoid is fixed, the hyoglossus can lower the tongue. The anterior fibers join with the genioglossus and inferior longitudinal muscles to retract the lower tongue tip. The posterior fibers (which insert on the lateral edges of the tongue) pull down the sides of the tongue on contraction, thus serving as antagonists to styloglossus and palatoglossus (when the soft palate is fixed) and contribute to the delicate adjustment of grooved fricatives. It may also work with styloglossus in the production of back vowels (tongue bunching with sides down) and the anterior fibers may balance the forward action of the posterior genioglossus fibers to position the tongue precisely in front vowels.

3. Palatoglossus

Attachments: This muscle attaches to the undersurface of the soft palate, interdigitating with the opposing fibers from the other side. The fibers continue inferiorly and laterally, forming the anterior pillars of the fauces and then insert at the edges of the tongue, interdigitating with the transverse, styloglossus and hyoglossus muscles.

Function: With the soft palate fixed, the palatoglossus muscle can assist styloglossus in raising the back of the tongue. In this it serves as an antagonist to the hyoglossus. It also aids the styloglossus and inferior longitudinal muscles to bulge the back of the tongue for velars. Because it inserts in the sides of the tongue and comes from a superior origin, it may also serve to groove the back of the tongue (used by some speakers in uvular trill and fricative production). Because of the connection created by this muscle, a low tongue position may draw down the velum slightly. If the tongue is fixed, it may serve as a depressor to the soft palate.

4. Styloglossus

Attachments: Styloglossus originates at the anterior and lateral surface of the styloid process and the stylomandibular ligament. The fibers fan out and course inferiorly and anteriorly, dividing into two parts. The lower part blends with the fibers from the hyoglossus muscle. The upper part courses along the lateral edges of the tongue and blends with the fibers from the inferior longitudinal muscle near the tip of the tongue.

Function: Styloglossus elevates and draws back the tongue, acting as an antagonist to genioglossus. These two muscles work together to position the tongue for most vowels. With the posterior part of genioglossus, it helps to bring the tongue up and back for velar articulations. Since the fibers insert on the sides of the tongue, contraction of styloglossus may also elevate the tongue margins to form a groove.

V. MUSCLES OF THE SOFT PALATE

A. ELEVATORS

1. Levator Palatini

Attachments: Levator palatini originates at the apex of the petrous portion of the temporal bone and the medial wall of the Eustachian tube and runs anteroinferiorly to the posterior surface of the soft palate.

Function: Levator palatini is the primary elevator of the soft palate and pulls it posteriorly for non-nasal articulations.

2. Musculus Uvulae

Attachments: Musculus uvulae runs from the posterior nasal spine of the palatine bones and the palatine aponeurosis. It courses medially and posteriorly along the length of the soft palate and inserts in the mucous membrane of the uvula.

Function: On contraction, it shortens and lifts the soft palate and the uvula. It may help to close off the nasal cavity and may play some role in positioning the uvula for a uvular trill.

B. TENSOR

1. Tensor Palatini

Attachments: Tensor palatini originates at the sphenoid bone and the lateral wall of the Eustachian tube. Fibers course inferiorly and anteriorly becoming tendonous as they wind around the hamulus and spread out along the palatine aponeurosis.

Function: Tensor Palatini spreads and tenses the soft palate, helping to close off the nasal cavity. It also pulls on the wall of the Eustachian tube and opens it up to equalize pressure.

C. DEPRESSORS

1. Palatoglossus (see under extrinsic muscles of the tongue)

2. Palatopharyngeus

Attachments: Palatopharyngeus arises from both the anterior hard palate and the midline of the soft palate with many fibers interdigitating with those from the opposite side. Some fibers arise from the edge of the auditory tube and form the salpingopharyngeus (which we will not discuss here since it has little, if anything, to do with speech). The fibers course inferiorly and laterally, forming the posterior pillar of the fauces, inserting into the stylopharyngeus, the lateral wall of the pharynx and the posterior border and greater cornu of the thyroid cartilage.

Function: When the thyroid cartilage and pharyngeal wall are fixed, contraction of this muscle will lower the soft palate. When the soft palate is fixed, the thyroid cartilage can presumably be raised (mostly for swallowing).

3. Passavant's Muscle

Attachments: This muscle is a part of the superior pharyngeal constrictor. It originates at the median pterygoid plate. The fibers course posteriorly along the wall of the nasopharynx and insert into the superior pharyngeal raphe.

Function: This pad of muscle is not recognized by all authorities. It forms a ridge (Passavant's Ridge) against which the levator palatini pulls the soft palate and helps form

a better seal.

VI. MUSCLES OF THE PHARYNX

A. PHARYNGEAL CONSTRICTORS

1. Superior Pharyngeal Constrictor

Attachments: This muscle has several different origins and a comparable number of names: a) Originating at the lower one-third of the medial pterygoid palate and the hamulus is the pterygopharyngeus; b) Originating at the pterygomandibular raphe is the buccopharyngeus; c) From the posterior part of the mylohyoid line and adjacent alveolar process of the mandible is the mylopharyngeus and d) a few fibers from the side of the tongue are sometimes called the glossopharyngeus. All fibers insert into the midline pharyngeal raphe.

Function: These muscles narrow the upper wall of the pharynx.

2. Medial Pharyngeal Constrictor

Attachments: This muscle can be said to consist of two minor muscles: (a) the ceratopharyngeus, which originates on the superior border of the greater horn of the hyoid bone and the stylohyoid ligament; b) the chondropharyngeus (mentioned before as part of the hyoglossus) is considered by some to be part of the medial pharyngeal constrictor. The fibers run superiorly and medially to the medial pharyngeal raphe. The superior fibers overlap those of the superior constrictor.

Function: These fibers contract the pharynx during swallowing. Since it attaches on the hyoid bone, it has a minor function as a larynx elevator along with the posterior belly of the digastric and the stylohyoid.

3. Inferior Pharyngeal Constrictor

Attachments: The part of the inferior pharyngeal constrictor that arises from the thyroid lamina and the superior cornu of the thyroid cartilage and inserts into the pharyngeal raphe may be called the thyropharyngeus. Fibers arising from the cricoid cartilage and the inferior cornu of the thyroid cartilage are called the cricopharyngeus. The most inferior fibers go obliquely downward to blend with the muscle fibers of the esophagus and form a sphincter.

Function: Cricopharyngeus becomes a pseudo-glottis in laryngectomized patients; it sets the aperture of the esophagus for esophageal speech. From a fixed larynx, the inferior constrictor can constrict the lower part of the pharynx for swallowing.

VII. EXTRINSIC MUSCLES OF THE LARYNX

A. ELEVATORS

1. Anterior Belly of the Digastric (see under muscles that lower the mandible)

2. Posterior Belly of the Digastric

Attachments: This portion of the digastric muscle attaches to the mastoid process of

the temporal bone. Fibers run inferiorly and anteriorly to meet the anterior belly at an intermediate tendon.

Function: The posterior belly of the digastric draws the hyoid bone superiorly and posteriorly and with it the larynx. It may also help bring the tongue into position for velar articulations.

3. Genioglossus (see under extrinsic muscles of the tongue)
4. Geniohyoid (see under muscles that lower the mandible)
5. Hyoglossus (see under extrinsic muscles of the tongue)
6. Mylohyoid (see under muscles that lower the mandible)
7. Medial Pharyngeal Constrictor (see under muscles of the pharynx)
8. Stylohyoid

Attachments: As the name implies, this muscle originates on the styloid process on the temporal bone. The fibers course inferiorly and anteriorly to insert in the greater cornu of the hyoid bone.

Function: Works with the posterior belly of the digastric to elevate and draw posteriorly the hyoid and with it the larynx. Because the fibers are attached to the greater cornu of the hyoid bone, contraction will cause the hyoid bone and the thyroid cartilage to tilt forward when the sternohyoid acts as a fixator. This may help bring the tongue forward for alveolar, dental and interdental articulations.

B. DEPRESSORS

1. Omohyoid

Attachments: This muscle's posterior belly originates on the upper border of the scapula, anterior belly on the intermediate tendon. The posterior belly inserts in the intermediate tendon, where the anterior belly takes over and runs vertically and slightly medially to the lower border of the greater cornu of the hyoid bone.

Function: The omohyoid lowers the hyoid and the larynx, similar to the sternohyoid.

2. Sternohyoid

Attachments: Sternohyoid attaches to the posterior surface of the manubrium of the sternum and the medial end of the clavicle. Fibers run vertically to the lower border of the body of the hyoid bone.

Function: The sternohyoid draws the hyoid bone inferiorly, which pulls the larynx forward, lowering F0 by increasing the superior-inferior thickness of the vocal folds. It also tilts down the anterior part of the hyoid bone for front articulations.

3. Sternothyroid

Attachments: This muscle attaches to the posterior surface of the manubrium of the sternum and the first costal cartilage. The fibers course superiorly and slightly laterally, inserting in the oblique line on the thyroid cartilage.

Function: The function of this muscle is under some dispute. Some investigators call it a hyoid depressor, others a larynx elevator, with some fibers also serving to stabilize, or perhaps raise, the thyroid cartilage.

4. Thyrohyoid

Attachments: This muscle attaches to the oblique line of thyroid cartilage. It runs vertically, deep to the omohyoid and the sternohyoid and inserts in the lower border of the greater cornu of the hyoid bone.

Function: On contraction, the thyrohyoid decreases the distance between the thyroid cartilage and the hyoid bone. When the thyroid cartilage is fixed, it depresses the hyoid bone. When the hyoid bone is fixed, it elevates the thyroid cartilage and raises the pitch. It also tilts the hyoid backwards, which may be appropriate for velar and uvular articulations.

VIII. INTRINSIC LARYNGEAL MUSCLES

A. SPHINCTER MUSCLES FOR LARYNGEAL INLET

1. Aryepiglottis

Attachments: This muscle attaches on the side of epiglottis. Fibers run from the sides of the epiglottis to the apex of each arytenoid.

Function: On contraction, the aryepiglottis pulls back the epiglottis (i.e. closes off the laryngeal inlet) by a sphincter action. This is to close off the laryngeal inlet for swallowing and may be used in production of lower pharyngeal articulations.

2. Thyroepiglottis

Attachments: Thyroepiglottis runs from the inner surface of the thyroid cartilage close to the angle superiorly and posteriorly to the aryepiglottic fold.

Function: This muscle depresses the epiglottis to close off the passage for swallowing. It probably has no function in speech.

B. ABDUCTOR

1. Posterior Cricoarytenoid

Attachments: This muscle attaches in the depression on the posterior surface of the cricoid cartilage. The fibers run superiorly and laterally to insert in the posterior surface of the muscular process of each arytenoid.

Function: On contraction, this muscle pulls the arytenoids inferiorly and medially on the shoulders of the cricoid cartilage and rotates them from lateral to posterior. The vocal processes are projected slightly upwards and abducted. EMG studies have shown activity in the production of voiceless stops and fricatives. These muscles are the sole abductors of the vocal folds

C. ADDUCTORS

1. Lateral Cricoarytenoid

Attachments: This muscle originates at the upper border of the arch of the cricoid cartilage. Fibers run superiorly and posteriorly along the rim of the cricoid cartilage to insert in the muscular process of the arytenoids.

Function: This muscle rotates the arytenoids inwards and downwards to approximate the vocal folds. When the vocal folds are already adducted, additional tension in the lateral cricoarytenoid will cause raising of the pitch. Further contraction is said to lead to a slight abduction at the arytenoid and of the folds--the proper position for the production of whisper.

2. Interarytenoids

a. Horizontal fibers (transverse arytenoid)

Attachments: Fibers attach to the posterior surface and lateral border of each arytenoid and the lateral edge and muscular process of the opposite arytenoid.

Function: On contraction, this muscle draws the arytenoids together by pulling them up on the shoulders of the cricoid cartilage and elevates them slightly. It may contribute to raising F.

b. Oblique arytenoid

Attachments: These fibers run from the lower posterior surface of each arytenoid and course superiorly and obliquely to insert in the apex and the lateral sides of the opposite arytenoid. The two sets of fibers cross each other.

Function: This muscle adducts the vocal folds by bringing the apexes of the arytenoid cartilages together. During forced contraction it can bring the false folds together for "ventricular voice". It also helps the aryepiglottis to close off the vestibule of the larynx.

D. TENSORS

1. Cricothyroid

Attachments: This muscle originates on the lower border and outer surface of the arch of the cricoid cartilage. The lower fibers run posteriorly and superiorly to insert into the anterior margin of the inferior cornu of the thyroid cartilage. The upper fibers course vertically upwards to insert into the inner part of the inferior margin of the thyroid cartilage.

Function: The basic function of this muscle appears to be to elongate and thus increase the tension in the vocal folds in order to raise the pitch. If the thyroid cartilage is fixed, it raises the anterior part of the cricoid towards the anterior part of the thyroid, while tilting the posterior part of the cricoid backwards. If the cricoid cartilage is fixed, the cricothyroid muscle tilts the anterior part of the thyroid cartilage downwards. In both cases, the distance from the angle of the thyroid cartilage and the arytenoids is increased, thereby stretching the vocal fold.

2. Vocalis

Attachments: Fibers originate in the posterior and inferior half of the angle of the thyroid cartilage. Coursing posteriorly, the fibers insert into the vocal processes of the arytenoids near the vocal ligament.

Function: The vocalis is actually part of the thyroarytenoid muscle. There is no physical