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Anatomy and Physiology of Respiration and Swallowing

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Disclosures

- FINANCIAL
- Nancy B. Swigert received an honorarium for giving this presentation
- Receives royalties on The Source for Dysphagia (ProEd)
- NON-FINANCIAL
- Has presented and published previously on this topic
- Serve on Medical Advisory Board for National Foundation on Swallowing Disorders

Goals for the presentation:

- 1.) Discuss relationship between respiration and swallowing
- 2.) Describe neurophysiology of swallowing and breathing
- 3.) State oral and pharyngeal structures involved in swallowing and breathing
- 4.) Match cranial nerves to motor and sensory functions in swallowing and breathing
- 5.) Perform a basic cranial nerve exam as part of clinical swallow evaluation

Why learn about the structures?

- The structures are the architecture on which breathing and swallowing are built
- Provide the framework for the highly coordinated movements of respiration and swallowing

Why learn about cranial nerves?

- The cranial nerves are responsible for the sensory input to the structures and movements of the muscles of the:
  - Oral cavity
  - Hypopharynx
  - Pharynx
  - Larynx
  - Respiratory System
- Understand the reason for the impaired swallow

Why learn about respiration-swallowing coordination?

- Shared muscles and structures
- A significant impact of pharyngeal dysphagia is aspiration and possible aspiration pneumonia
  - Understanding the interrelated mechanism of breathing and swallowing helps understand how aspiration can occur

Why is understanding neurophysiology important?

- You might select the wrong treatment techniques for the problem
  - A sign/symptom may have more than one possible physiologic cause
- You might select a treatment technique or method which doesn't even make sense for the problem (e.g. treating a delay when the problem is reduced laryngeal elevation)
- You might select a treatment technique that could do more harm than good

One "symptom" can have more than one cause

Sign/symptom	Different physiologic causes	Functional short term goal
Patient has residue in the pyriforms after the swallow	Reduced laryngeal elevation	Patient will **increase laryngeal elevation** to reduce the amount of food remaining in the pyriforms which could fall into the airway
	Reduced anterior movement of hyolaryngeal complex	Patient will **increase anterior movement of hyolaryngeal complex** to reduce the amount of food remaining in the pyriforms which could fall into the airway

Why assess cranial nerves?

- To enhance your understanding of what is causing the swallowing disorder in this client
- To give you insights into the areas of swallowing you might want to assess in more depth

CNS control of the swallow

- Before the bolus enters the mouth, the individual recognizes the bolus (through sight and smell), this is registered by the cortical structures, which prepare the swallowing system for that particular bolus.

CNS control of the swallow

- The bolus enters the oral cavity, and is sensed by the peripheral nerves, which send sensory (afferent) information to the brainstem (nucleus tractus solitarius).
- The brainstem 'communicates' with the cortical structures to ultimately determine the precise physiological nature of the swallow.

CNS control of the swallow

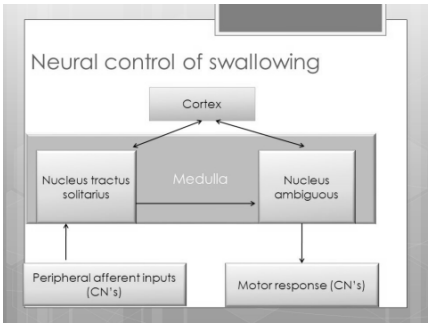
- The reflexive part of the swallow is triggered by sensory stimulation i.e. bolus contact on the faucial arches, tonsils, soft palate, posterior pharyngeal wall and deep muscle receptors in the base of tongue.

CNS control of the swallow

The Nucleus Tractus Solitarius (where all the sensory information accumulates) in the brainstem then instructs the Nucleus Ambiguus (also in the brainstem) to execute the motoric swallowing response.

The nucleus ambiguus sends efferent (motor) excitation to the oral, pharyngeal and esophageal muscles.

- SWALLOW!



Nucleus tractus solitarii

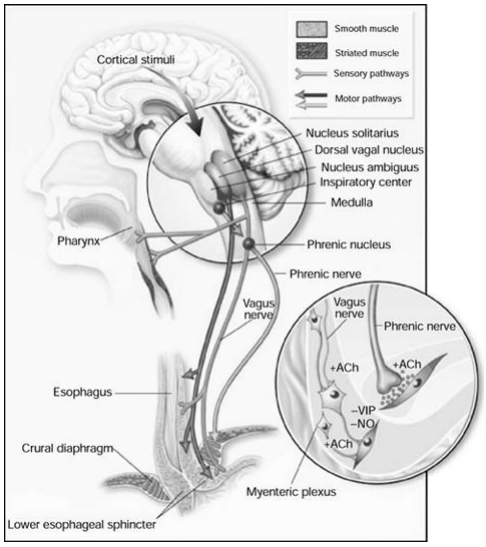
- The nucleus of the solitary tract, or NTS (Latin: ***nucleus tractus solitarii***), is located along the length of the medulla (with a small portion in the lower pons).
- The solitary tract runs in the middle of the nucleus, creating a speck of white matter(axons of the tract), surrounded by grey matter (the nucleus).
- This stands out on a stained section, which is where the name solitary comes from.

Central control of breathing and swallowing

- Swallowing thought to be under control of Central Pattern Generator (Meltzer 1899, 1907; Doty, 1967, 1968)
  - Input arm – peripheral afferents
  - Organizing arm – commanding interneurons
  - Output arm – motor neurons
- Center must have a filtering arrangement
  - Swallow only when stimuli match the code
  - Because other reflexive activities (cough, gag) recruit the same muscles but are filtered out by center
- Afferent pathways (CN IX and X) also carry info from sensory end organs for control of respiratory rhythm

Central control of breathing and swallowing

- Afferent pathways from peripheral swallowing and respiratory regions ascend to nucleus tractus solitarius (NTS) in medulla
- Different animal models have shown different locations in the medulla
  - Dorsal region: NTS
  - Ventral region: around the Nucleus Ambiguous (NA)



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Central control of breathing and swallowing

- Efferent portal
- Swallow-related motor output to muscles of mouth, pharynx, and larynx is transmitted by axons with cell bodies in brainstem
  - Trigeminal motor nucleus
  - Facial motor nucleus
  - Nucleus Ambiguous
    - Has interneurons but also large motor neurons
  - Hypoglossal Motor Nucleus

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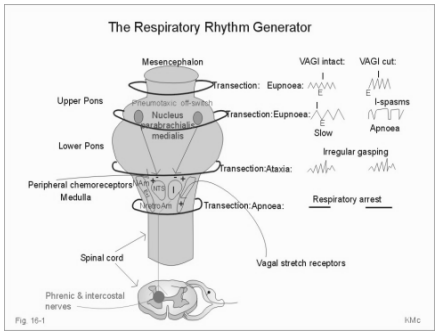
Central control of breathing and swallowing

- Production of basic respiratory rhythmicity also occurs in medulla
  - Dorsal respiratory group (sensory neurons)
  - Ventral respiratory group (motor neurons)

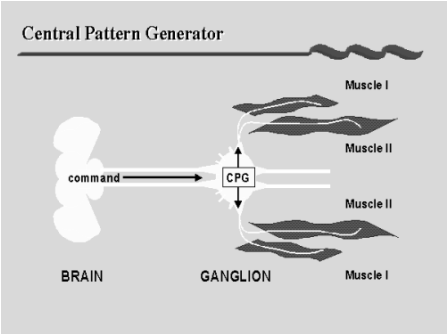


Cortical control

- Increasing evidence that cortical structures play a role in coordination of swallowing and breathing.
  - Compensatory movements for swallowing (e.g. supraglottic) involve recruitment of pre-motor and motor cortex

Is shared control a good thing?

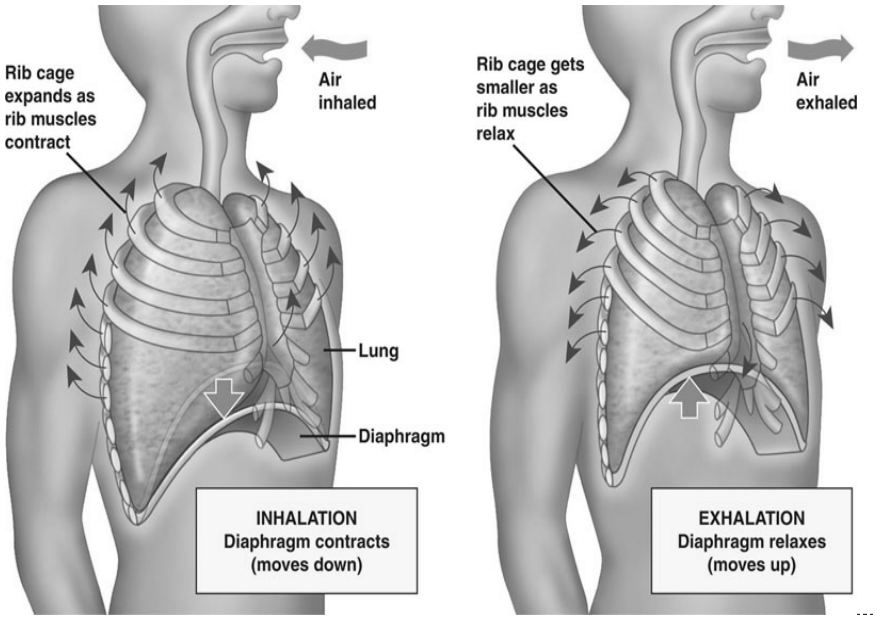
- If there is injury to swallowing CPG, and there are other neurons common to both respiration and swallowing, it may reduce overall impact of injury on swallowing function or vice versa
- OR, If one CPG contains neurons common to both functions, may place the individual at functional disadvantage, and at greater risk, for both processes to be affected in case of isolated injury



Breathe? Swallow?

- Excerpts from Martin-Harris, B. (2006) Coordination of respiration and swallowing *GI Motility Online* Part 1 Oral cavity, pharynx and esophagus

- Two physiologic functions that cannot occur at the same time
- However, the functions complement one another and overlap
  - Some techniques for impaired swallowing modify both swallow physiology and breathing
- Changes in respiration, ventilation and swallowing occur with normal development and aging
  - And with many different disease processes



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Coordination of breathing and swallowing in humans

- Most studies investigated relationships:
  - Phase(s) of respiration associated with swallowing
  - Duration of apneic period
- Methodologies varied
- Difficult to draw conclusions

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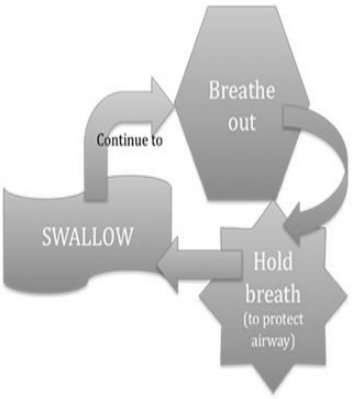
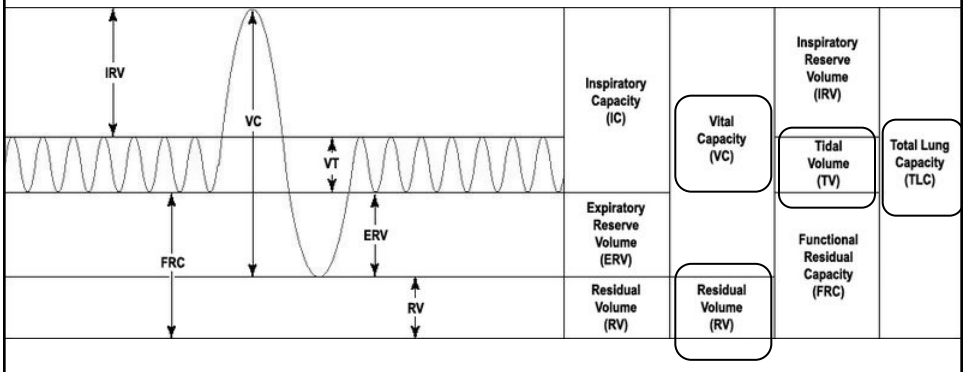
Coordination of breathing and swallowing in humans: phases

- Expiratory phase of respiration is favored part of the respiratory cycle for the swallow
  - Apneic period occurs most frequently in at some point in expiratory phase
- EX-EX
- IN/EX
- Rarely: EX/IN or IN/IN
- *In infants, spontaneous swallows equally distributed b/t EX and IN phases*
  - *? Related to neural structures, neural development and maturation, H&N anatomy*



Review of respiration



Swallowing can affect respiration

- Spontaneous and water-induced swallows during expiration increased expiratory time and total time of swallow breath.
- Tidal volume of post-swallow breath immediately after was increased.
- Increased expiratory time in pre- and post-swallow breaths when compared to basal respiration
- Swallows produced a "true" resetting of the respiratory rhythm

Coordination of breathing and swallowing in humans-phases

- Patients with advanced age and diseases associated with aging favor inspiration phase
  - Neurologic disease
  - COPD
  - H&N Cancer
- Switch of EX to IN preference did not relate to occurrence of aspiration pneumonia in patients with stroke
- Did relate to higher Pen-Asp scores

Coordination of breathing and swallowing in humans-apnea

- Apneic period always accompanies swallow
- Triggered before or after initial bolus transit through oral cavity
- Onset of apnea highly variable
- Apnea duration increased with liquid bolus volume
  - Other studies do not support this finding
- We need to know…..because…

Coordination of breathing and swallowing in humans-apnea

- If increasing volumes of liquid up to 25 ml (bolus size of average liquid intake in healthy adults) does result in longer apnea…then…
  - Challenge may stress the respiratory capability of patients with dysphagia + pulmonary disease
    - May interfere with extent and duration of airway closure required to prevent aspiration

Coordination of breathing and swallowing in humans-apnea

- Average length of apnea 0.5 to 3.5 s, typically 1.0 to 1.5 s in healthy adults
- Apnea offset not always a post-swallow gesture
  - May occur during descent of larynx during exhalation

Relationship of respiration and swallowing

- Breath phase at which swallow is initiated determines volume of the swallow
  - Near end of inspiratory-expiratory phase = largest volumes
  - That is, large swallows are found when lungs remain inflated at end of tidal breath
  - Allows more oxygen reserves to be available for blood O2 saturation (Paydarfar, et al 1995)

Relationship of respiration and swallowing

- Swallow breathing pattern can be altered by either swallowing or breathing (Martin-Harris, 2005)
  - E.g. Increase in ventilatory drive during hypercapnia (increased CO2) decreases swallowing frequency
  - Swallow during hypercapnia associated with increased incidence of aspiration and laryngeal irritation (Nishino et al 1989; Kijimo et al 2000)

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Relationship of respiration and swallowing

- Swallowing can alter breathing
  - E.g. During repetitive swallowing, there are greater inspiratory-expiratory times, yet tidal volume and minute ventilation are maintained
    - (Issa & Porostocky 1994)
      - *minute ventilation = Tidal volume X breaths per minute*

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Relationship of respiration and swallowing

- Swallow breathing pattern can be volitionally modified
  - Subjects instructed to breathe out to residual volume and then swallow – overall duration of swallow was prolonged (slower swallows)
  - Swallows at total lung capacity were shorter in duration (faster swallows)
    - Gross et al 2008

Aerodigestive Tract: note the common muscles to swallowing

- During quiet inspiration
  - Genioglossus, styloglossus, stylopharyngeus, cricopharyngeus
  - The first three counterbalance airflow resistance through upper respiratory tract by stiffening and enlarging the upper airways during breathing
    - During swallowing, essential for bolus propulsion
  - CP is tonically active during quiet breathing to keep air from entering the esophagus
    - During a swallow, CP relaxes

Aerodigestive Tract

- Sternothyroid and omohyoid muscles
  - Return the larynx to rest following hyolaryngeal excursion
  - Stabilize the larynx during quiet inspiration
  - Omohyoid prevents collapse of the lung apices and vessels during deep inspiration

Aerodigestive Tract

- Velopharyngeal port
  - Open for respiration
  - Closed for swallowing to prevent backflow of material into nasal passages
- Posterior tongue in swallowing keeps bolus in oral cavity
- Tongue base puts pressure on bolus tail
  - Base of tongue is ventral wall of respiratory pharynx and is critical to airway maintenance

Aerodigestive Tract

- Larynx
  - Opens at glottis and supraglottis for breathing
    - Abducted glottis remains during inspiration, but TVF slightly adduct to paramedian position during expiration
      - Accomplished by PCA which increases the horizontal diameter of the glottic opening and CT which increases the A-P dimension of opening
  - Closed tightly for swallowing

The Six Cranial Nerves Involved in Speech and Swallowing

- CN V - - Trigeminal nerve
- CN VII - - Facial nerve
- CN IX - - Glossopharyngeal nerve
- CN X - - Vagus nerve
- CN XI - - Spinal accessory nerve
- CN XII - - Hypoglossal nerve

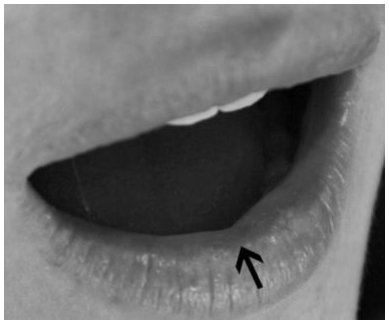
Mnemonic for the Cranial Nerves

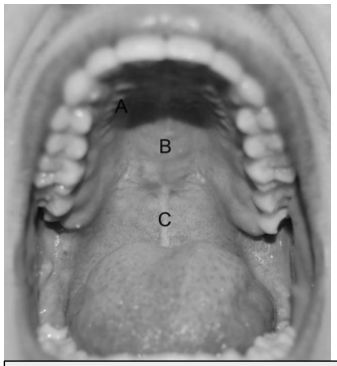
On	(olfactory)	Some	(sensory)
Old	(optic)	Say	(sensory)
Olympus'	(oculomotor)	Marry	(motor)
Towering	(trochlear)	Money	(motor)
Top	(trigeminal)	But	(both)
A	(abducens)	My	(motor)
Finn	(facial)	Mother*	(motor)
And	(auditory)	Says	(sensory)
German	(glossopharyngeal)	Bad	(both)
Vended	(vagus)	Business	(both)
At	(accessory)	Marry	(motor)
Hopps	(hypoglossal)	Money	(motor)

Oral cavity

- First part of the digestive tract
- Initiates digestive process
  - Mixes saliva
  - Start propulsion of bolus
- A quick review of the structures

Lips, tongue, teeth, hard and soft palate

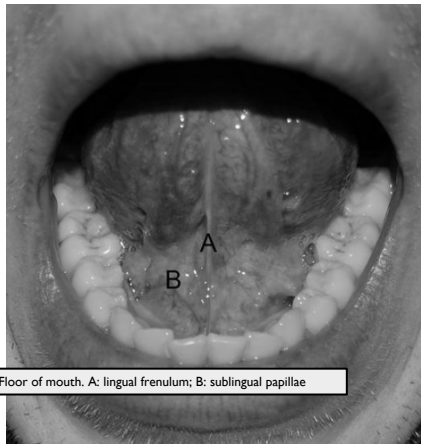




Hard and soft palates. A: transverse rugae of hard palate; B: median raphe of hard palate; C: median raphe of soft palate.

http://emedicine.medscape.com/article/1899122-overview#a2

Cheeks, gums, floor of mouth



Floor of mouth. A: lingual frenulum; B: sublingual papillae

Pharyngeal structures (review)

- Tongue
- Pharynx
- larynx

Let's look at muscles and innervations for motor and sensory for:

- Lips
- Cheeks
- Tongue (oral and pharyngeal function)
- Soft palate
- Pharynx
- Hyoid and Larynx
- Intrinsic larynx

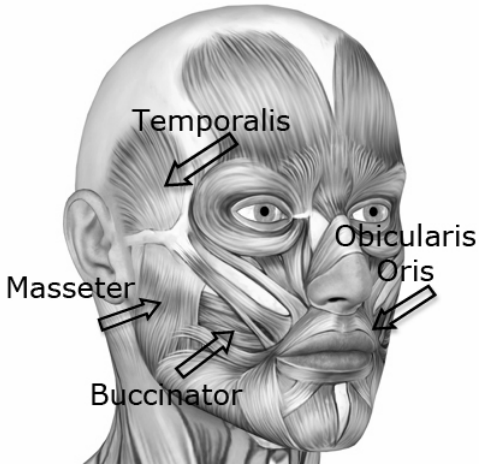
Lips

- Close on utensils:
  - Spoon
  - Cup
  - Straw
- Keep bolus in the mouth

Lips

Muscle	Function	Innervation - Motor	Innervation –Sensory
Buccinator	Compresses lips Pulls corners of lips tight	VII Facial	*V Trigeminal Nerve: Maxillary branch to upper lip* *Mandibular branch to lower lip*
Orbicularis oris	Closes, opens, protrudes, inverts and twists lips	VII Facial	

Muscles of lips



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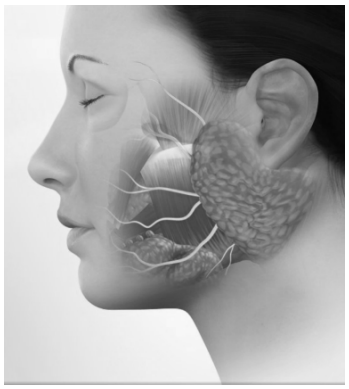
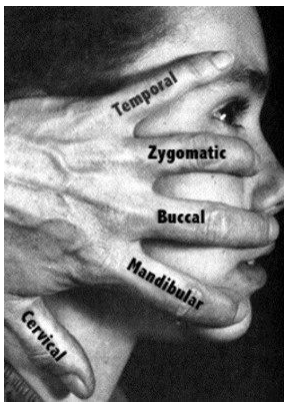
Innervation to lips





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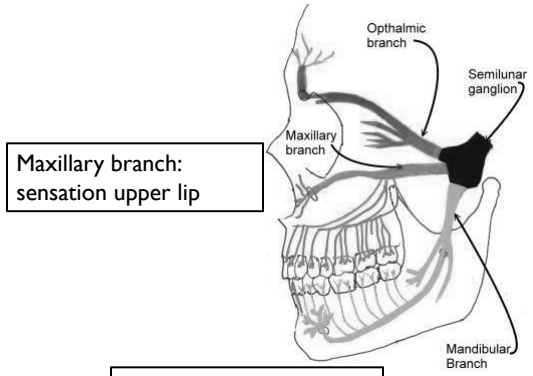
Sensory innervation to lips: Trigeminal



Maxillary branch: sensation upper lip

Mandibular branch: sensation lower lip

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IMPAIRED PHYSIOLOGY OF LIPS: IMPACT ON SWALLOWING

What physiologic problem might you observe if impairments in lip muscles	What symptoms might it cause
Inability to compress lips	Can't close on spoon Can't drink from straw Loses liquid anteriorly when drinking from cup Can't keep bolus in mouth
Can't invert lips	Can't invert top or bottom lip to use teeth to clean lips

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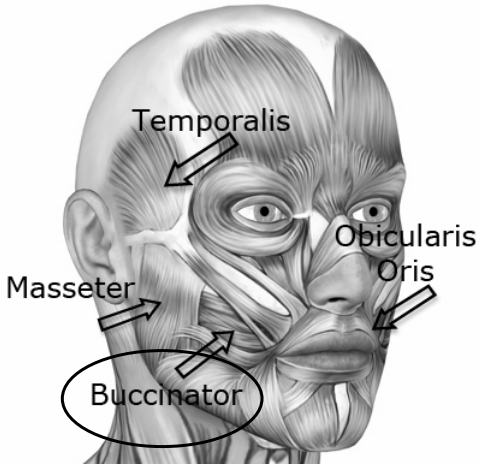
Cheeks

- Cheeks press tightly against gums/teeth to keep food out of buccal cavities
- Compress to help with sucking

Cheeks

Muscle	Function	Innervation-Motor	Innervation-Sensory
Buccinator	Flattens and tightens cheeks	CN VII Facial	CN V Trigeminal Maxillary branch

Muscle of cheeks



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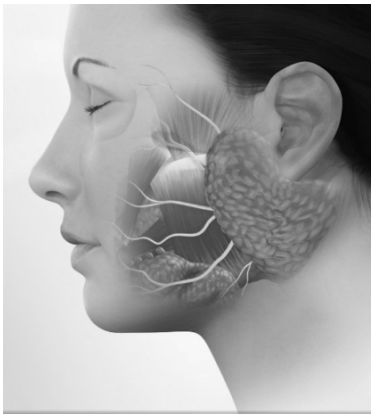
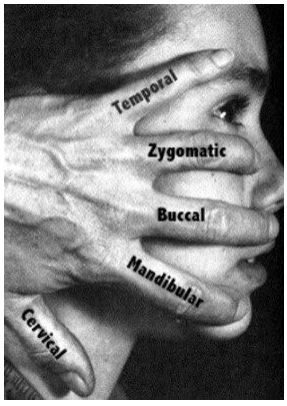
Innervation to cheeks





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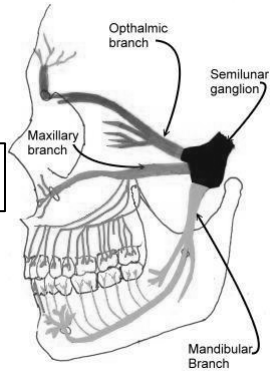
Sensory innervation to cheeks: Trigeminal

Maxillary branch: sensation cheeks



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IMPAIRED PHYSIOLOGY OF CHEEKS: IMPACT ON SWALLOWING

What physiologic problem might you observe if impairments in cheeks	What symptoms might it cause
Inability to tighten the cheeks	Reduced ability to suck from straw Food and liquid pool in buccal cavities

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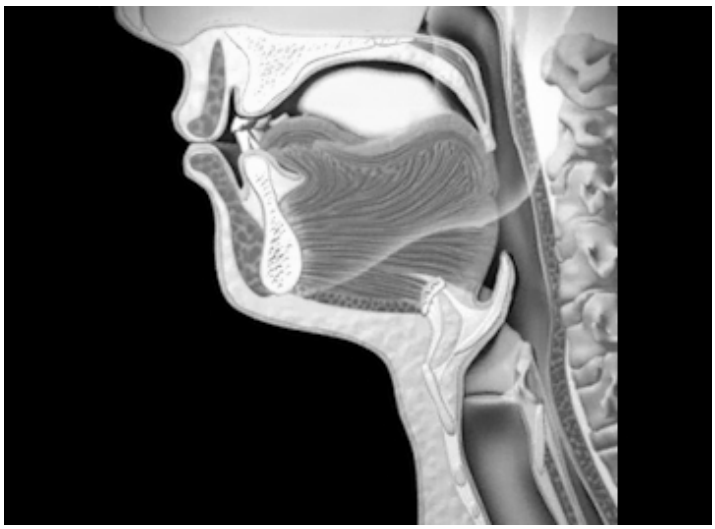
Animation of oral phase

Tongue

- Maintains seal with the soft palate
- Squeezes bolus posteriorly
- Helps initiate the pharyngeal phase

Animation of tongue lateral view



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Tongue extrinsic muscles

Muscle	Function for swallowing	Function for breathing	Innervations - Motor	Innervations – Sensory
Genioglossus	Protrusion; press tongue to teeth or alveolar ridge (posterior fibers) Retraction (anterior fibers) Draw tongue downward (all fibers)	Counterbalance airflow through upper respiratory tract by stiffening and enlarging upper airways	CN XII Hypoglossal	CN V Trigeminal– anterior 2/3 general VII Facial -anterior 2/3 taste IX Glossopharyngeal posterior 1/3 general and taste X Vagus posterior general
Styloglossus	Pulls tongue up and back		CN XII Hypoglossal	
Palatoglossus	Pulls tongue back to make the groove		CN X Vagus (pharyngeal branch) CN XI Accessory	
Hyoglossus	Retracts or depresses tongue; elevates hyoid		CN XII Hypoglossal	

Tongue: intrinsic muscles

Muscle	Function for swallowing	Innervations - Motor	Innervations –Sensory
Superior longitudinal	shortens tongue or may turn tip and lateral margins upward to create concave appearance lateralizes tongue	XII Hypoglossal	
Inferior longitudinal	shortens tongue or pulls tip downward lateralizes tongue		
Transverse	Narrows and elongates tongue		
Vertical	flattens the tongue		

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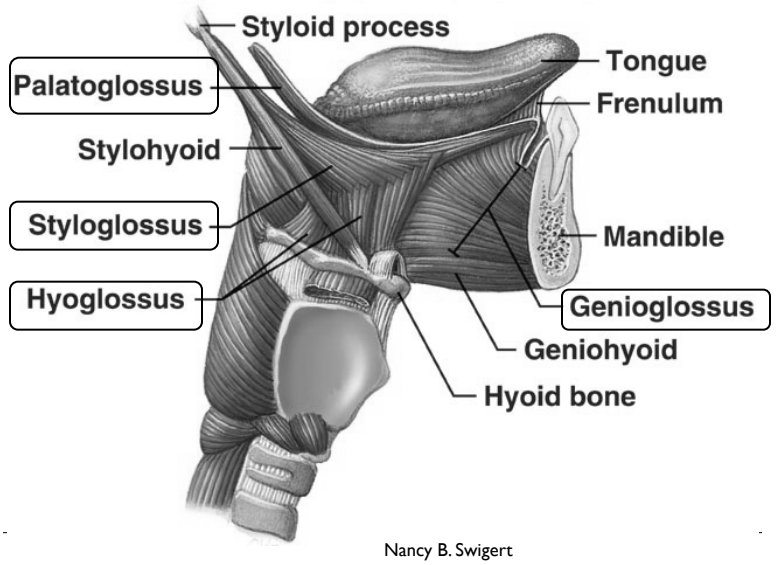
Extrinsic muscles of tongue



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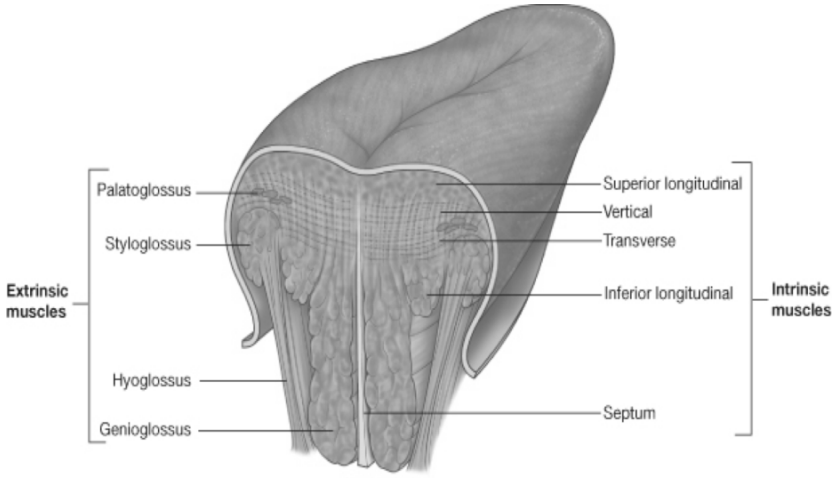
Intrinsic muscles of tongue



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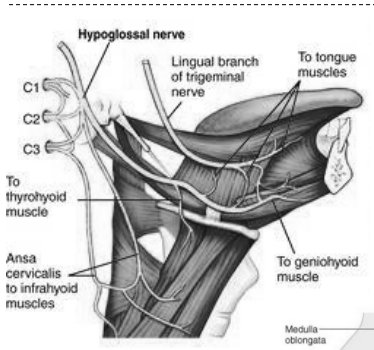
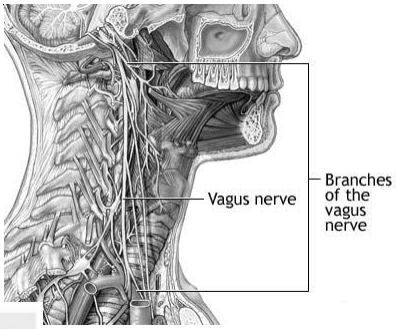
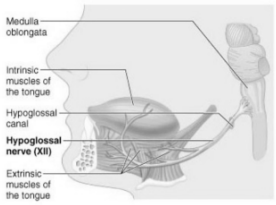
Innervation to tongue: Hypoglossal and Vagus







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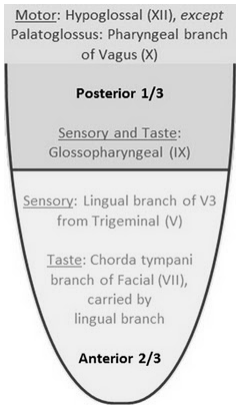
Sensory to the tongue



IMPAIRED PHYSIOLOGY OF TONGUE – IMPACT ON SWALLOW

What physiologic problem might you observe if impairments in tongue muscles	What symptoms might it cause
Back of tongue to soft palate does not seal to keep bolus in mouth	Premature loss of bolus over back of tongue. Can result in penetration or aspiration
Base of tongue fails to pull back towards pharyngeal wall adequately	Residue in valleculae
Increased stage transition duration (is this perhaps a sensory deficit in the back of the tongue? OR sensory deficit in the pharynx?)	Penetration Aspiration before the swallow
Inability to protrude and retract tongue	Can't move bolus back in oral cavity
Inability to cup, flatten, lateralize the tongue	Reduced ability to form and manipulate bolus Can't clear residue

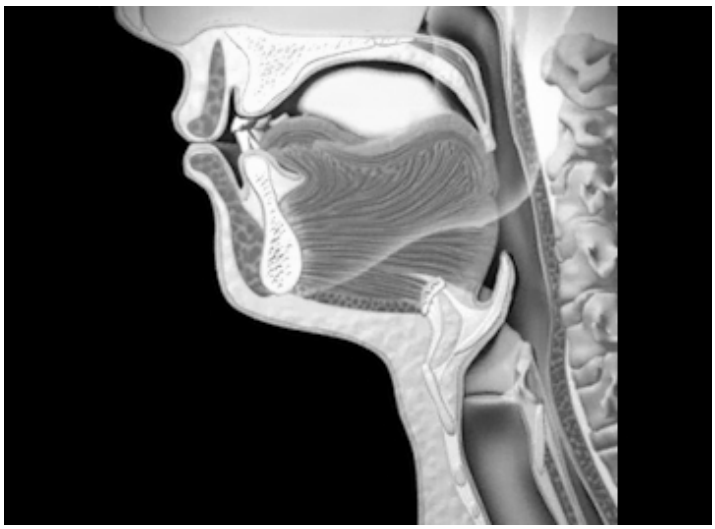
Soft Palate

- Pulls tight against base of tongue
- Lifts to seal off nasal cavity

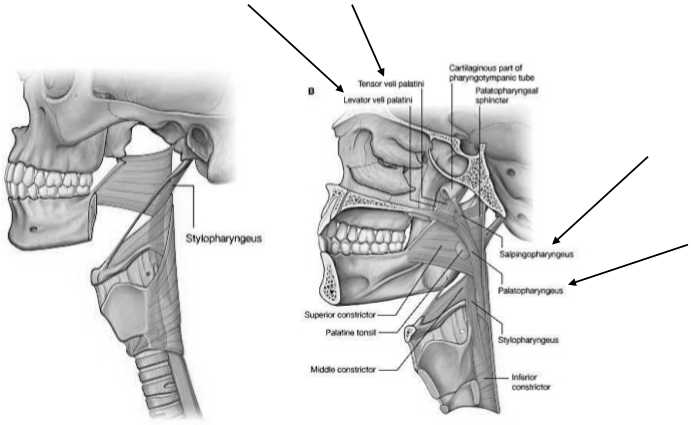
Soft Palate/Faucial Arches

Muscle	Function for swallowing	Function for breathing	Innervation Motor	Innervation Sensory
Tensor veli palatini	Tenses soft palate; may help close nasopharynx	Velopharyngeal port open for respiration	V Trigeminal	CN VII Facial CN IX Glossopharyngeal CN X Vagus
Palatoglossus	narrows the faucial opening (this muscle is in the anterior faucial arch); pulls soft palate down and forward		X Vagus	
Levator veli palatine	Lifts soft palate		X Vagus XI Accessory	
Salpingopharyngeus	Lifts soft palate		X Vagus	

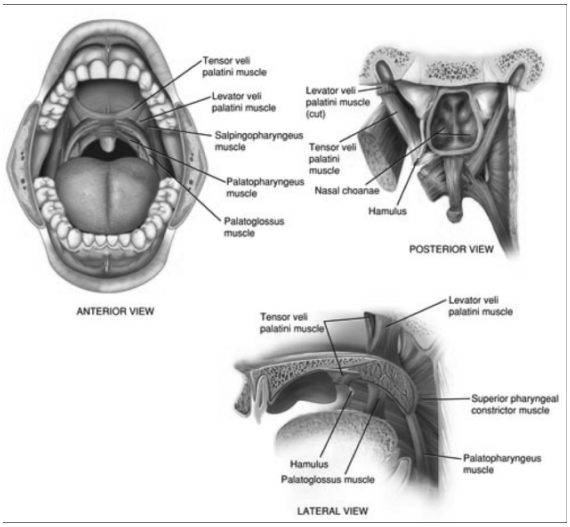
Animation soft palate



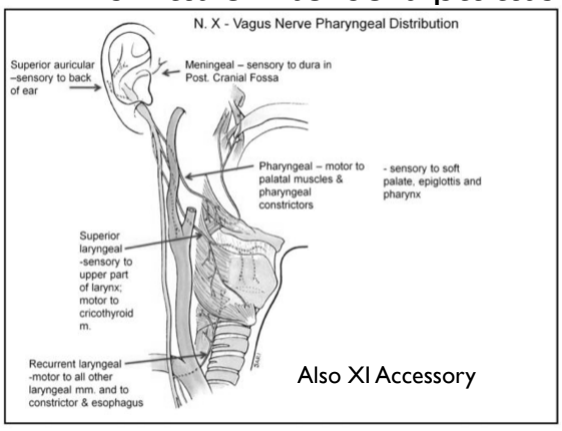
Muscles of soft palate/faucial arches

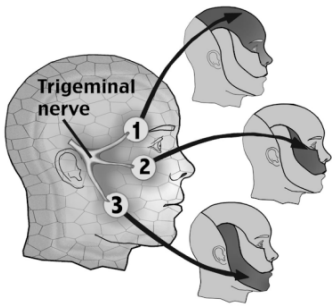


Another look at the muscles

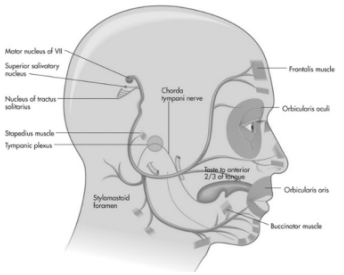


Innervation to soft palate

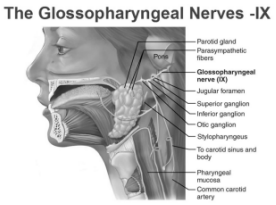




Innervation to soft palate sensory



VII



IX

And also X

IMPAIRED PHYSIOLOGY OF SOFT PALATE: IMPACT ON SWALLOW

What physiologic problem might you observe if impairments in muscles of soft palate	What symptoms might it cause
Can't elevate soft palate	Backflow of bolus to nasal cavity
Asymmetrical elevation of soft palate	Partial backflow to nasopharynx
Can't pull palate tight against back of tongue	Loses bolus prematurely over the back of the tongue

Pharynx

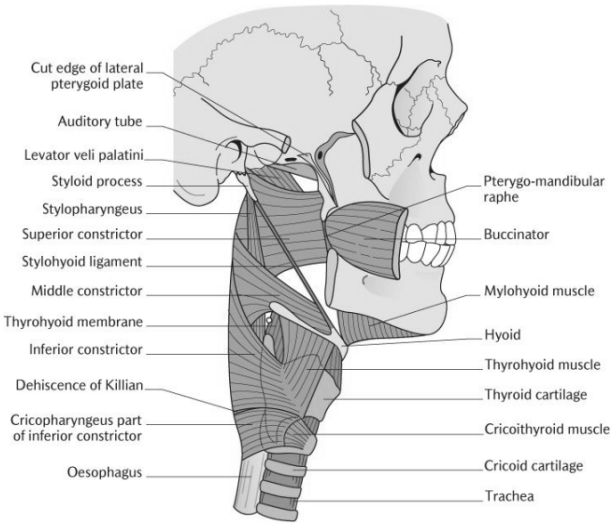
- Muscles of pharynx surround the:
  - Nasopharynx
  - Oropharynx
  - Laryngopharynx
- They squeeze the bolus into the esophagus

Movie posterior view

Pharynx

Muscle	Function for Swallowing	Function for breathing	Innervation-Motor	Innervation – Sensory
Superior and middle constrictors	Contract on bolus to squeeze it down		CN X Vagus (pharyngeal branch)	CN IX and CN X (pharyngeal plexus) – general sensory
Inferior constrictor	Includes thryopharyngeus (superior) and cricopharyngeus(CP) (Inferior). CP is tonic until it relaxes during swallowing to open so bolus can pass	CP tonic (active) during quiet breathing to keep air from entering esophagus	CN X (pharyngeal branch)	CN IX and CN X (pharyngeal plexus) – general sensory
Palatopharyngeus	Elevates; contracts on bolus; some laryngeal elevation		CN X (pharyngeal branch)	CN IX and CN X (pharyngeal plexus) – general sensory
Salpingopharyngeus	Elevates and laterally draws walls up		CN X (pharyngeal branch)	CN IX and CN X (pharyngeal plexus) – general sensory
Stylopharyngeus	Elevates pharynx; some laryngeal elevation	Counterbalance airflow through upper respiratory tract by stiffening and enlarging upper	CN IX (Glossopharyngeal)	CN IX and CN X (pharyngeal plexus) – general sensory

Muscles of pharynx



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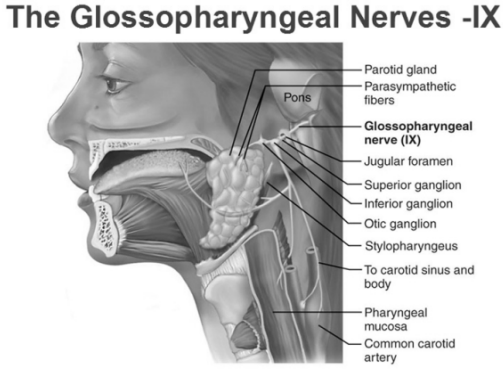
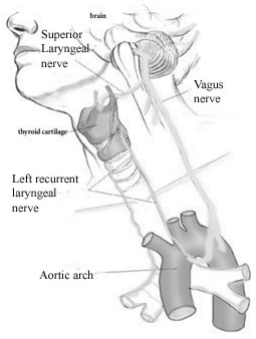
Motor and sensory to pharynx: IX and X





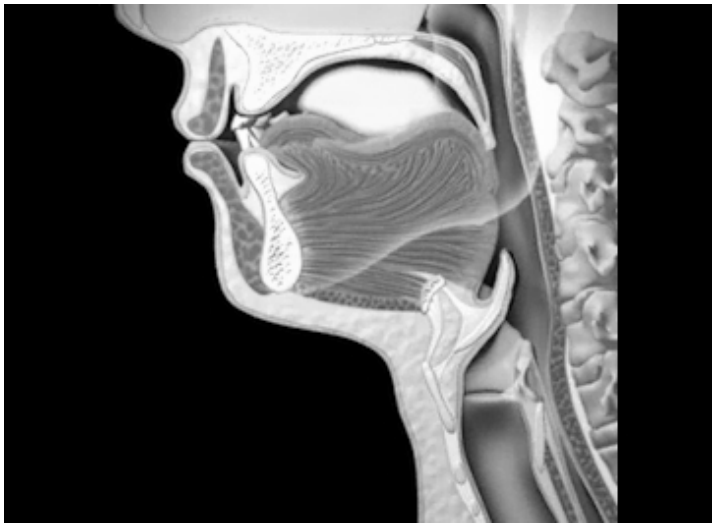
Impaired physiology of pharynx – Impact on Swallow

What physiologic problem might you observe if impairments in tongue muscles	What symptoms might it cause
Increased stage transition duration (is this perhaps a sensory deficit in the back of the tongue? OR sensory deficit in the pharynx?)	Penetration Aspiration before the swallow
Reduced laryngeal elevation/pharyngeal shortening	Can contribute to penetration during swallow Can result in residue in pyriforms
Reduced constriction of pharyngeal walls	Residue in pharynx, pyriforms

Hyolaryngeal complex

- Hyoid bone is attached to thyroid cartilage below and tongue above
- Can be pulled in many different directions
  - Supra-hyoid muscles
  - Infra-hyoid muscles
- Moves up and forward as larynx elevates
  - Protects the airway
  - Pulls open the PES

Animation lateral focus on hyoid



Hyolaryngeal complex (Hyoid and Larynx)

Muscle	Function for swallowing	Function for breathing	CN innervations-motor	Sensory
Mylohyoid	Upward movement of hyoid		CN V Trigeminal (mylohyoid branch)	Cervical spinal, cervical plexus
Geniohyoid	Upward and forward of hyoid		Cervical plexus C1	Cervical spinal, cervical plexus
Anterior belly digastrics	Jaw opener Moves hyoid upward		CN V	Cervical spinal, cervical plexus
Posterior belly digastrics	Posterior, upward movement hyoid		CN VII (Facial)	Cervical spinal, cervical plexus
Stylohyoid	Posterior, upward movement hyoid		CN VII	Cervical spinal, cervical plexus
Hyoglossus	Upward hyoid		CN XII Hypoglossal	Cervical spinal, cervical plexus
Thyrohyoid	Moves hyoid and larynx together		Cervical plexus C1	Cervical spinal, cervical plexus
Sternothyroid	Pulls larynx down	Stabilize larynx during quiet inspiration	Ansa cervicalis	Cervical spinal, cervical plexus
Sternohyoid	Pulls hyoid down		Ansa cervicalis	Cervical spinal, cervical plexus
Omohyoid	Pulls hyoid down	Stabilize larynx during quiet inspiration; prevents collapse of lung apices during deep inspiration	Ansa cervicalis	Cervical spinal, cervical plexus

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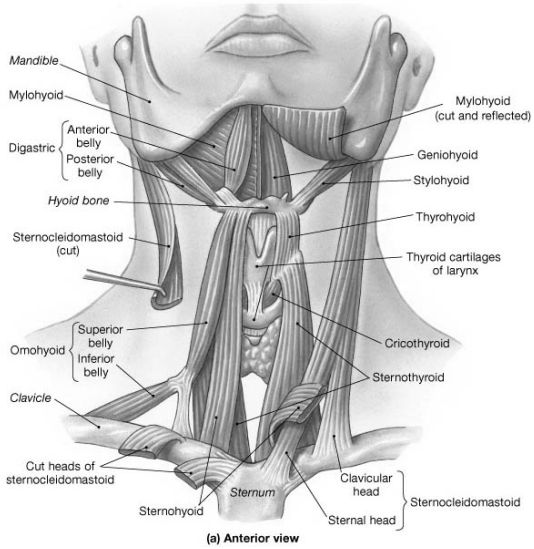

(a) Anterior view

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Impaired physiology of hyolaryngeal complex – Impact on Swallow

What physiologic problem might you observe if impairments in tongue muscles	What symptoms might it cause
Reduced anterior and superior movement of hyolaryngeal complex	Decreased PES opening Residue in pyriforms Epiglottis does not fully invert, allowing penetration
Reduced closure at entrance to airway	Allows penetration into vestibule May allow aspiration during the swallow

Larynx

- Protects airway by closing and moving up and forward
  - *See previous slides on hyolaryngeal complex*
- As larynx lifts, epiglottis flips down to send bolus on either side of larynx
- True and false folds adduct to close the glottis

Posterior view animation

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Larynx

Muscle	Function for swallowing	Function for breathing	CN innervations-motor	Sensory
Thyroarytenoid Includes vocalis	Adductor, tensor or relaxer		CN X (left recurrent laryngeal)	CN X(internal laryngeal) mucous membrane at valleculae, epiglottis, aryepiglottic folds and most of larynx CN X (recurrent laryngeal) – mucous membrance below VF CN X special sensory to epiglottis
Cricothyroid (pars oblique and recta)	Lengthen and tense vf, alters distance b/t thyroid and arytenoids	Increases A-P dimension of opening during inspiration	C N X(external laryngeal)	
Posterior cricoarytenoids	Abduct and internally rotate arytenoids	Increases horizontal diameter of glottic opening during inspiration	CN X (left recurrent laryngeal)	
Lateral cricoarytenoids	Adduct and internally rotate arytenoids		CN X (left recurrent laryngeal)	
Transverse arytenoids	Adduct arytenoids		CN X (left recurrent laryngeal)	
Oblique arytenoids	Adducts arytenoids		CN X (left recurrent laryngeal)	

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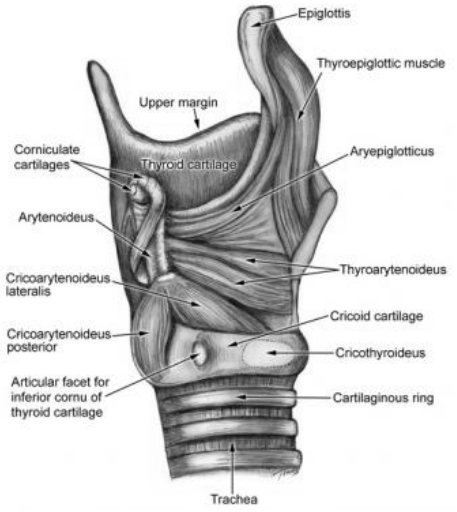

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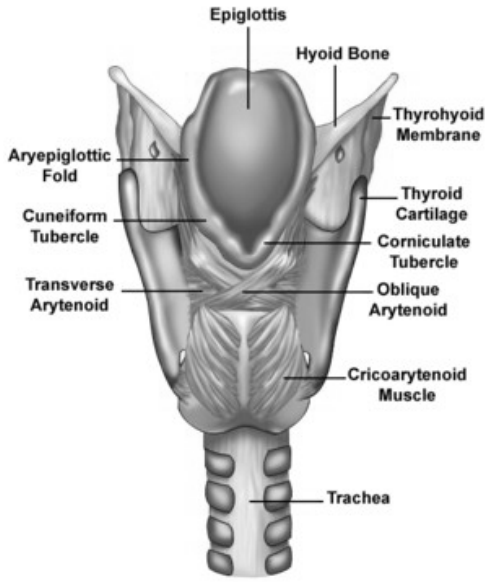

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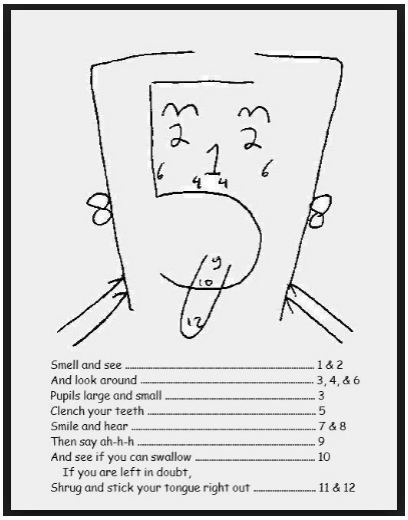
Impaired physiology of larynx – Impact on Swallow

What physiologic problem might you observe if impairments in tongue muscles	What symptoms might it cause
Reduced closure at entrance to airway	Allows penetration into vestibule May allow aspiration during the swallow
Reduced closure of airway at glottis	Allows aspiration of material

Closure at level of larynx

- Rarely is it just failure of true and/or false vocal folds to close
- The coordinated movements of closure of the larynx are intricately related to the elevation and forward movement of the larynx

Cranial nerves and muscles



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Incorporating cranial nerve testing into clinical swallow exam

_____	Closes & opens mandible	V Trigeminal
_____	Rotary jaw movement	V Trigeminal
_____	Cheeks hold food out of sulci	VII Facial
_____	Opens, closes, protrudes, inverts lips	VII Facial
_____	Raises back of tongue	X Vagus (Pharyngeal)
_____	Lifts soft palate	X Vagus (pharyngeal)
_____	Lifts soft palate	XI Accessory
_____	Retracts tongue	XII Hypoglossal
_____	Elevates tongue up and back	XII Hypoglossal
_____	Pulls tongue tip downward	XII Hypoglossal
_____	Narrows and elongates tongue	XII Hypoglossal
_____	Lateralizes tongue	XII Hypoglossal

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Assessing CN on instrumental exam

____	Closes & opens mandible	V Trigeminal
____	Rotary jaw movement	V Trigeminal
____	**Raises hyoid**	V Trigeminal
____	Cheeks hold food out of sulci	VII Facial
____	Opens, closes, protrudes, inverts lips	VII Facial
____	**Pulls soft palate down and forward**	X Vagus
____	Raises back of tongue	X Vagus (Pharyngeal)
____	Lifts soft palate	X Vagus (pharyngeal)
____	**Squeezes pharynx**	X Vagus (pharyngeal)
____	**Adducts vocal folds**	X Vagus (Recurrent laryngeal)
____	**Draws hyoid up and forward**	X Vagus (Recurrent laryngeal)
____	Lifts soft palate	XI Accessory
____	**Shuts off nasopharynx**	XI Accessory
____	Retracts tongue	XII Hypoglossal
____	Elevates tongue up and back	XII Hypoglossal
____	Pulls tongue tip downward	XII Hypoglossal
____	Narrows and elongates tongue	XII Hypoglossal
____	Lateralizes tongue	XII Hypoglossal
____	**Draws hyoid up and forward**	XII Hypoglossal
____	**Pulls thyroid up to hyoid**	XII Hypoglossal

- Bold items can be seen only on instrumental

Practice case A

- Bedside evaluation reveals:
  - Pocketing in L cheek
  - Diffuse residue in oral cavity
  - Can't clear residue in L cheek with tongue sweep

What cranial nerves might be impaired?

- V Trigeminal (could be sensory deficit?)
- VII Facial (could be motor with decreased tone in cheek)
- XII Hypoglossal (motor- poor tongue movement)

Can we determine etiology?

- Could be:
  - Stroke
  - TBI
  - MS
  - ALS (bulbar)

Practice Case B

- Bedside evaluation reveals:
  - Jaw movement WNL
  - Tongue movement WNL
    - Protrusion/retraction
    - Lateralization
    - Back of tongue elevation
  - Palatal movement WNL
  - Can't elevate eyebrow on R
  - Pucker is asymmetrical
  - Can't maintain closure with cheek puff

What cranial nerves might be impaired?

- Jaw = Trigeminal OK
- Palate = IX, X and XI OK
- Tongue = Hypoglossal OK

- Unilateral decreased movement of R face indicates isolated damage to Facial CN VII

Facial nerve palsy

- Facial nerve palsy occurs when there is damage to the seventh cranial (facial) nerve. It is a type of **mononeuropathy**.
- This type of nerve damage may occur with local growths, such as a tumor, that put pressure on the facial nerve.
- Facial nerve palsy may also be caused by:
  - **HIV infection**
  - **Lyme disease**
  - **Sarcoidosis**
  - It also may have no obvious cause.

Symptoms of facial nerve palsy

- Change in the appearance of the face
  - Difficulty closing one eye
  - Difficulty making expressions, grimacing
  - Difficulty with fine movements of the face
  - **Facial droop**
  - **Paralysis** of one side of the face
- Difficulty eating (items fall out of the weak corner of the mouth)
- Face feels pulled to one side
- Face feels stiff
- Headache
- **Impairment of taste**
- Increased loudness of sound in one ear
- Pain behind the ear (for Bell's palsy)
- Sensitivity to sound (hyperacusis)

Practice Case C

- Bedside results indicate:
  - Jaw movement WNL
  - Movement of soft palate WNL
  - Lip movement WNL
  - No pharyngeal signs
  - Tongue
    - Fasciculations on L
    - Can't lateralize to R
    - Residue on L

References

- Martin-Harris, B. (2006). Coordination of respiration and swallowing. GI Motility online.
- Swigert, N. B. (2007). *The source for dysphagia*. LinguiSystems (ProEd).
- Humbert, I. A. (2011). *Swallowing Pocket Guide*. Northern Speech Services.

What cranial nerves might be involved?

- V, VII, I, X, XI all appear to be functioning
- XII Hypoglossal nerve damage
  - Muscle for protrusion (genioglossus) is contralateral only
  - Other muscles bilateral innervation
  - So the lesion must be……
    - Lower motor neuron

What might damage the XII nerve?

- Causes include a tumor or bone abnormality at the base of the skull, a stroke, infection of the brain stem, or an injury to the neck, such as that due to surgical removal of a blockage from an artery in the neck (endarterectomy).
- Amyotrophic lateral sclerosis (Lou Gehrig's disease) can also damage the hypoglossal nerve.
  - Which of these might be LMN?