



## **Physiology of Swallowing and Airway Protection**

Swallowing is a complex sequence of events that must occur with precise timing in order to function properly. Airway protection is intimately involved and coordinated with swallowing overall and helps to protect the lower bronchotracheal tree when dysfunction occurs.

### **Anatomy of the Aerodigestive Tract**

- The aerodigestive tract anatomy is generally divided in three regions by phase of swallowing
  - Oral cavity/pharynx
    - Dentition, Tongue, Soft palate, Pharyngeal Constrictors
  - Larynx/Hypopharynx
    - Hyoid Bone, Epiglottis, Vocal Folds, Upper Trachea, Pharyngeal Constrictors, Cricopharyngeus
    - Although extrinsic to the larynx, the strap muscles are integral to larynx movement and function
  - Esophagus
- Innervation
  - Brain Stem, Cranial Nerves 5, 7, 9, 10, and 12, Pharyngeal Plexus, Ansa Cervicalis

### **Normal Swallowing Physiology**

- Swallowing function generally separated into 3 stages:
  - Oral Phase
    - This is generally broken in an oral preparatory and oral propulsive stage which include the preparation of the bolus through mastication, and then subsequent propulsion of the bolus to the posterior oropharynx and vallecula by movement of the tongue and closure of the nasopharynx by the soft palate.
  - Pharyngeal Phase
    - There are two key aspects to the pharyngeal phase: movement of bolus to the esophagus and airway protection



- The pharyngeal constrictors squeeze the bolus in a superior to inferior manner, while the strap muscles constrict to move the hyoid and larynx together in an anterior and superior direction. This motion causes epiglottic inversion while moving the larynx off the spine posteriorly. Simultaneously the cricopharyngeus relaxes to allow passage of the food bolus into the upper esophagus.
- During this phase the vocal folds adduct to create a glottic seal, while the larynx moves up and under the base of tongue which moves posteriorly. This in conjunction with epiglottic retroflexion and apposition to the arytenoids helps to prevent penetration of the larynx by the bolus and subsequent aspiration.
- Esophageal Phase
  - Once the bolus reaches the upper esophagus, the autonomic system coordinates bolus movement in a coordinated fashion towards the lower esophageal sphincter (LES). The LES relaxes thus allowing passage of the bolus into the stomach.

#### References

- Matsuo K, Palmer JB. Anatomy and physiology of feeding and swallowing: normal and abnormal. *Phys Med Rehabil Clin N Am*. 2008 Nov;19(4):691-707.
- Flint Paul W. Cummings Otolaryngology-Head & Neck Surgery, 6th Edition. Philadelphia: Elsevier/Saunders, 2015.

#### Airway Protection Physiology

- As detailed above in the pharyngeal phase, the larynx performs coordinated movements to decrease the risk of penetration and aspiration.
- Physiologic cough is the protective mechanism by which penetrated or aspirated materials can be ejected from the upper airway.

#### References

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