

ISSUES IN ANATOMY AND PHYSIOLOGY OF SWALLOWING:

IMPACT ON ASSESSMENT AND TREATMENT
OF CHILDREN WITH DYSPHAGIA

KEY ISSUES

Complex Anatomy can be Viewed as a Series of Tubes and Cavities with a Division by Function

The swallowing system is comprised of a single tube which widens in the upper region to form cavities. The tube divides at the lower end into a tube for feeding (i.e. the esophagus) and a tube for breathing (i.e. the trachea). Each cavity, formed by the enlargement of a portion of the tube serves initially either the function of feeding (i.e. oral cavity, vallecula, pyriform sinus) or breathing (i.e. nasal cavity).

The Function of Both the Feeding and Respiratory Systems Can be Modified by the Use of Valves

Each system contains a series of valves which change the shape or configuration of the system or protect it. Valves created by the lips and tongue keep food in the mouth and in place prior to swallowing. The valve created by the cricopharyngeous muscle at the top of the esophagus keeps air out of the digestive system during breathing. The valve created by the soft palate keeps food out of the nasal airway during swallowing. The valves created by the false and true vocal folds and the epiglottis prevent food from entering the airway during swallowing.

Shared Pathways Exist between the Feeding and Respiratory Systems

The feeding and respiratory systems share a portion of the pharynx between the area behind the tongue and the area at the entrance to the larynx and the entrance to the esophagus.

Since a Shared System Exists, Valves are Used to Support the Desired Activity and Protect the Alter- nate System

During breathing the valves open to allow air to enter the nose, larynx, and trachea and close to prevent air from entering the esophagus and lower digestive tract. During swallowing the valves open to allow food to enter the digestive tract and prevent food from penetrating the nose and larynx and entering the airway.

During swallowing the goal of the system is to move food into the digestive system and keep it out of the respiratory system. The following events occur rapidly and often simultaneously to support this goal.

- Food is propelled from the front to the back of the mouth during the oral stage of the swallow. The lips and sides of the tongue serve as valves to

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direct the food efficiently toward the pharynx. The back of the tongue elevates and moves food into the pharynx as the pharyngeal swallow is triggered.

- The pharyngeal constrictors contract in a peristaltic wave, moving the bolus downward.
- The soft palate elevates to prevent the bolus from refluxing into the nasal cavity.
- The hyoid and larynx elevate and the epiglottis moves downward to protect the entrance to the airway. This movement of the hyoid also initiates relaxation of the cricopharyngeus muscle and opening of the esophagus.
- The aryepiglottic folds and the true and false vocal folds contract, providing additional airway protection.
- The bolus moves through the cricopharyngeal sphincter into the esophagus. This sphincter closes, preventing upward movement of the bolus.
- Peristaltic movement of the esophagus carries the bolus to the stomach. The lower esophageal sphincter closes to prevent gastroesophageal reflux.

During breathing the goal of the system is to move air efficiently into the respiratory system and keep it out of the digestive system. The following events support this goal.

- The soft palate relaxes allowing air to enter the nose and pass downward toward the lungs.
- The false and true vocal folds remain relaxed and open for the entry of air.
- The cricopharyngeus muscle sustains contraction to close off the top of the esophagus and prevent air from entering the digestive system.

The Infant is not an Anatomical Miniature of the Adult

Proportional differences exist between the young infant and the older infant, child, and adult. These include:

- The oral cavity is small in the newborn and is totally filled by the tongue due to a small and slightly retracted lower jaw.

- The newborn has a set of sucking pads in the cheeks which provide stability during sucking.
- The soft palate and epiglottis are in contact at rest, providing an additional valve at the back of the oral cavity.
- The larynx and hyoid cartilage are higher in the neck and closer to the base of the epiglottis, providing added protection of the airway.
- The infant's eustachian tube runs horizontally from the middle ear into the nasopharynx, rather than its later vertical angle in the older child and adult.

IMPLICATIONS FOR THE CHILD WITH SWALLOWING DYSFUNCTION

The Absence of a Swallowing Reflex Leaves the Airway Unprotected

If the swallowing reflex is not triggered by backward movement of the bolus and/or intention, the airway remains open and unprotected. The upper esophageal sphincter remains closed, preventing food entrance into the esophagus and indirectly biasing its movement into the open airway.

Delay in Elicitation of the Swallowing Reflex Places the Airway in a Risk Position

Difficulties with sensory awareness, inefficient organization of the oral bolus, and problems with timing and coordination of movement may cause portions of the bolus to enter or remain in the pharynx during periods of airway opening. This creates a risk of aspiration before, during, or after the swallow has been triggered.

Small Cavities Formed by the Valleculae and Pyriform Sinuses can Serve as Catching Pools for Portions of the Bolus

Pooling of the bolus in the sulci or cavities formed by the valleculae and pyriform sinuses can delay penetration of the airway by the bolus. Because of this delay, it can appear clinically as if the bolus were swallowed. Entrance into the laryngeal vestibule or penetration of the airway may be signalled by coughing or choking that occurs during the 3rd or 4th small bolus.

The Shared Use of the Pharynx by Respiratory and Feeding Systems Increases the Risk of Aspiration in Children whose Respiratory Systems are Compromised.

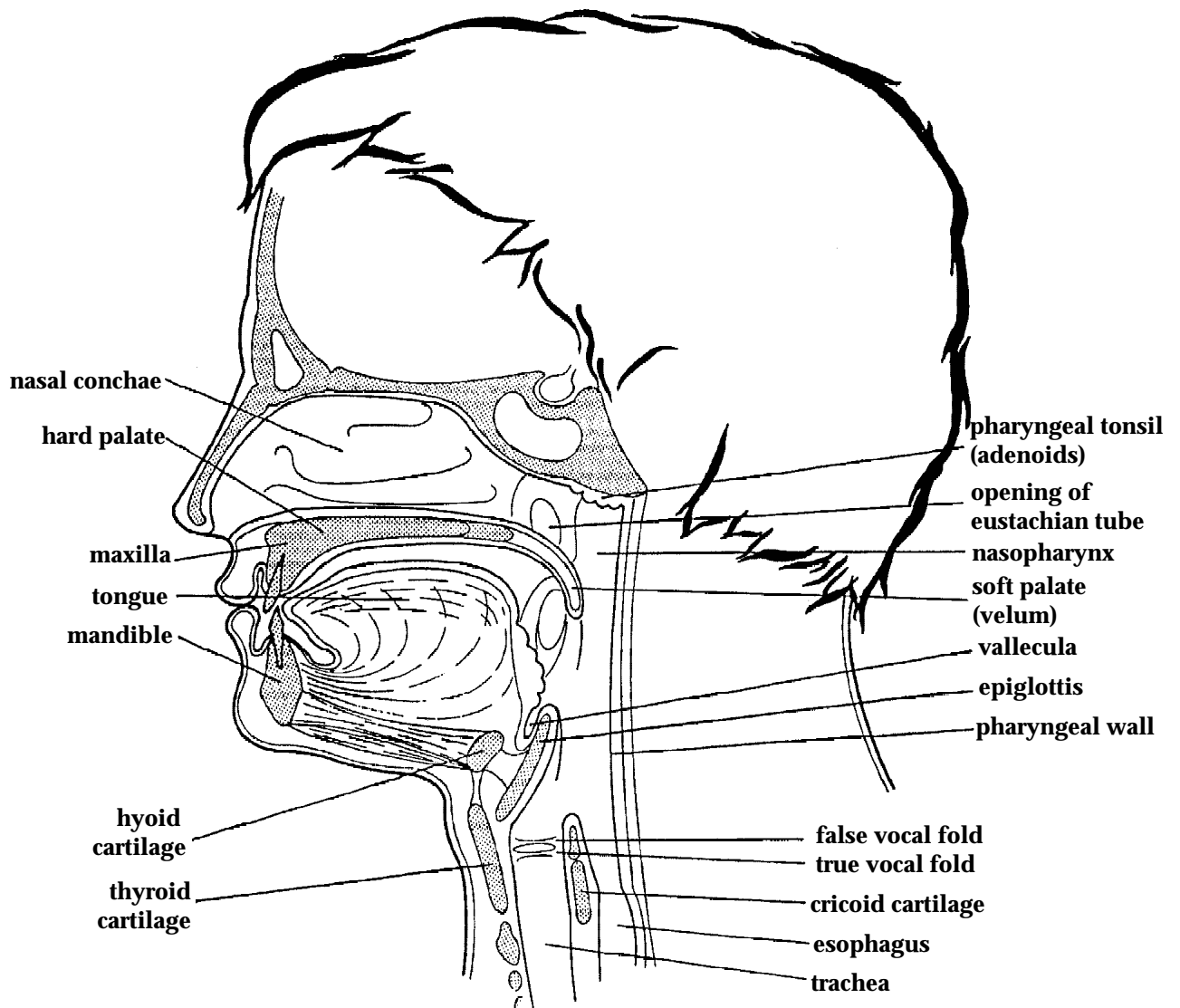
Infants and children with primary respiratory difficulties (i.e. respiratory distress syndrome, bronchopulmonary dysplasia) often protect their vulnerable respiratory systems through a central inhibition of the swallowing reflex, or a voluntary refusal to swallow. This may be observed even when the child is receiving respiratory assistance through a ventilator or additional oxygen.

The Infant Anatomical Differences Create Additional Protective and Learning Systems which may not be Present in the Older Infant or Child with Severe Swallowing Dysfunction

- The small infant oral cavity creates abundant sensory input to the tongue, giving information on spatial and movement relationships within the mouth. This supports the lesser neurological coordination of the young infant. When an infant or child has developed anatomically without a comparable development neurologically, the evolving feeding coordination lacks the early infant anatomical back-up system.
- The sucking pads provide additional stability of the jaw and support a more efficient sucking pattern as the infant gradually develops the coordination of the jaw, lips, cheeks, and tongue to support oral feeding. When an older child is initially developing the sucking coordination of the newborn, the sucking pads may be reduced or absent. Thus, the early coordination lacks the anatomical support available to the newborn with this degree of oral control.

- When the soft palate and epiglottis grow away from each other and are no longer in contact, the baby loses a valve which helps keep food in the mouth until the pharyngeal swallow is initiated. The older infant or child with poor oral control of the bolus may then have food fall over the back of the tongue into the valleculae or airway before the swallow is triggered.
- The airway has less anatomical protection as the larynx assumes its lower position in the neck and is not as directly protected by the epiglottis. Since infants younger than 4-6 months have additional airway protection, poor closure of the airway or even a partial paralysis of the vocal folds may not be as evident. When the anatomy no longer gives additional protection for a marginally coordinated swallowing mechanism, coughing, choking or aspiration may occur.
- The horizontal positioning of the eustachian tube places the infant at greater risk for ear infections from food or liquid that refluxes upward into the nasopharynx.

THE MOUTH AND PHARYNX OF THE ADULT (saggital section)



THE MOUTH AND PHARYNX OF THE NEWBORN

(sagittal section)

