

Chapter 2

Evolution and Development of Human Swallowing

Kannit Pongpipatpaiboon, Yoko Inamoto, Koichiro Matsuo,
Yoichiro Aoyagi, Seiko Shibata, and Hitoshi Kagaya

Abstract This chapter will describe the human swallowing in comparison with other mammals.

Besides, the context will focus on swallowing and feeding development in infants. The basic knowledge of how evolutionary and developmental changes of human swallowing allows an insight into which swallowing-related problems may directly relate.

An understanding of the evolution of human swallowing begins from a comparative mammalian context. The larynx is a focal point in this comparison. Many other mammals, such as the rat, horse, pig, cat, and others, have remarkably similar anatomical templates of the structures involved in swallowing (Fig. 2.1).

The position of the larynx is relatively high in the neck relative to the base of the cranium. The larynx is located in the opening of the intranarial array, providing a continuous airway from the nose to the lungs. Other than the anatomically high position of the larynx in many other mammals, the part of the epiglottis that touches or overlaps above the soft palate (so-called intranarial larynx) permits the margins of the soft palate to seal the airway from food passage. This structure enables the larynx to open directly into the nasopharynx and generates a physical separation of the two pathways (breathing and swallowing) to ensure survival. Furthermore, the

K. Pongpipatpaiboon • Y. Aoyagi • S. Shibata • H. Kagaya
Department of Rehabilitation Medicine I, School of Medicine, Fujita Health University,
Toyoake, Aichi, Japan
e-mail: ning665@gmail.com; yyy@rc5.so-net.ne.jp; sshibata@fujita-hu.ac.jp;
hkagaya2@fujita-hu.ac.jp

Y. Inamoto (✉)
Faculty of Rehabilitation, School of Health Sciences, Fujita Health University,
Toyoake, Aichi, Japan
e-mail: inamoto@fujita-hu.ac.jp

K. Matsuo
Department of Dentistry, School of Medicine, Fujita Health University, Toyoake, Aichi, Japan
e-mail: kmatsuo@fujita-hu.ac.jp

Fig. 2.1 Illustration of the midsagittal section of the head and neck regions of the horse

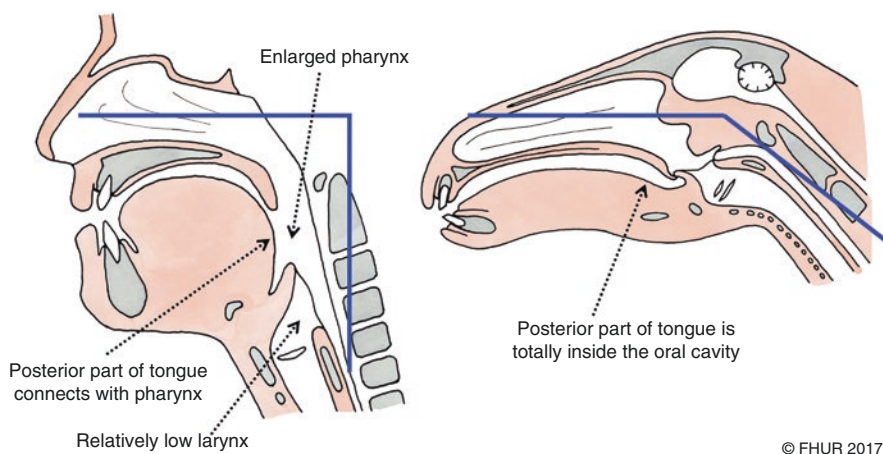
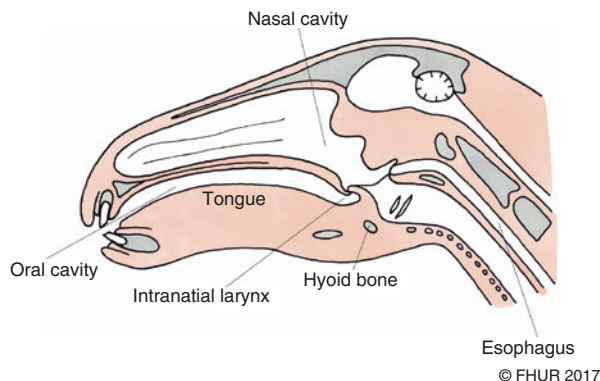


Fig. 2.2 Comparative oropharyngolaryngeal structures between humans and other mammals

tongue in other mammals lies almost entirely within the oral cavity; no portion is present in the pharyngeal part [1, 2].

Comparison of the oropharyngolaryngeal anatomy in humans and other mammals (Fig. 2.2) illustrates three main principles of swallowing:

1. In the standing position, the oral and pharyngeal regions in humans are at a right angle to each other, bending sharply at 90° , as shown in Fig. 2.2. In contrast, the angle between the oral and pharyngeal regions is relatively flat in other mammals. This means that in humans, liquid easily enters the larynx before flowing into the esophagus.
2. The pharynx of other mammals is comparatively small, with the laryngeal opening to the nasal cavity (intranarial larynx). This structure therefore serves as a protective mechanism to prevent aspiration during swallowing.
3. The entire posterior part of other mammals' tongues is located inside the mouth. In contrast, the posterior part of the human's tongue is connected to the pharynx, forming part of the anterior pharyngeal wall (Fig. 2.3).

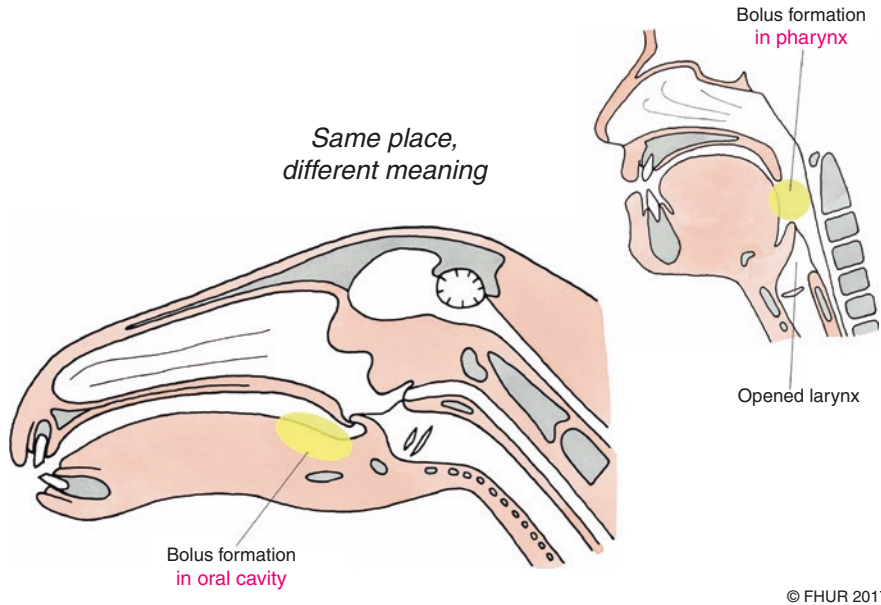


Fig. 2.3 Comparison of the location of bolus formation in humans and other mammals. Although the bolus is located at the same place (posterior part of the tongue), the significance in terms of swallowing differs. Bolus formation occurs in the oral cavity in other mammals and in part of the pharynx in humans. This is because in humans, the posterior part of the tongue is opened in larynx. Thus, the bolus cannot stay here during chewing

These structural differences arose from the evolutionary demand for rich phonation in the human being. Thus, the pathways of breathing and swallowing converged in the pharynx, and the functions of this common pathway have no clear separation in humans. This results in a higher risk of aspirating food from the shared oropharynx into the larynx. Although this anatomical arrangement enables safe swallowing in other mammals, it significantly limits the array of sounds (phonation). This limitation in the range of sounds that can be produced is similar to that in a human infant.

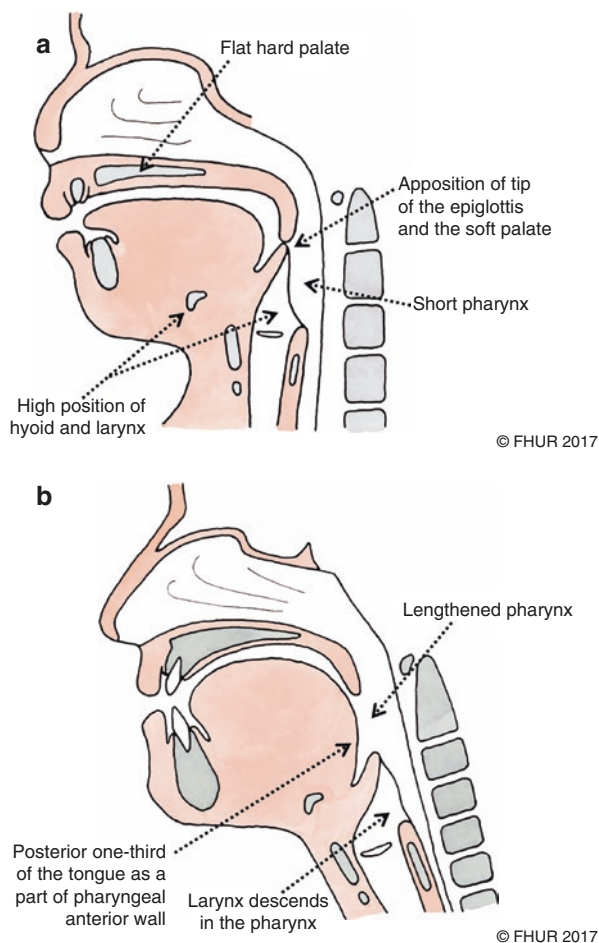
2.1 Development of Swallowing in Humans

Proper development of the anatomical structures involved in swallowing is crucial to subsequent normal swallowing function. For this reason, an understanding of the evolution of the normal anatomy involved in the human swallowing mechanism is required. There is clear evidence of differences in the anatomy of the head and neck between infants and adults, and these anatomical differences influence feeding and swallowing [3–5].

The oral cavity in the newborn is totally occupied by the tongue because of the small and slightly retracted lower jaw. The hard palate is flat and no teeth have emerged. Additionally, thicker fat pads are present in the cheeks and provide stability during suckling. Because of these structures, the space in the oral cavity is smaller in newborns than in adults, and infants are more efficient at suckling than chewing. The pharynx is relatively short, and the hyoid bone and larynx lie at a much higher level and closer to the base of the epiglottis than in the adult, providing added airway protection. In addition, the tip of the epiglottis contacts the soft palate at the second cervical level; thus, the larynx opens directly to the nasal cavity, similar to nonhuman mammals as described previously (Fig. 2.4).

These anatomical differences create a separation between the respiratory and digestive routes, affording natural protection of the airway and providing an optimal arrangement for safe feeding.

Fig. 2.4 Mouth and pharynx, (a) newborn, (b) adult in sagittal section



The anatomy involved in swallowing gradually changes as follows throughout development:

- The dentition develops.
- The oral cavity enlarges.
- The larynx descends in the pharynx.
- The pharynx lengthens vertically.
- The posterior one-third of the tongue descends into the pharynx and bends at a right angle relative to the oral portion, lying in a vertical plane and forming the upper anterior wall of the pharynx. The oral cavity and oropharynx are thus open to the nasopharynx and hypopharynx.

The upper aerodigestive tract begins to closely resemble that of an adult by approximately 5 months of age.

This change in the human requires elaboration of airway protection, functionally separating the two pathways. The respiratory and digestive tracts now cross each other in the pharyngeal area, minimizing aspiration protection. This is one reason why older individuals are at higher risk of swallowing problems. Although humans have acquired the disadvantage of pharyngeal swallowing because of anatomical changes, the descent of the larynx provides an advantage. The longer pharyngeal portion enables rich sound production at the vocal folds (phonation) and the ability to fully articulate speech.

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