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Overview Aspects of Anatomy and Histology of the Trachea, Pharynx, Larynx, and Esophagus: A Narrative Literature Review

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A B S T R A C T

This literature review aimed to describe the anatomical and histological aspects of the trachea, pharynx, larynx, and esophagus. The trachea is a tube-shaped respiratory tract consisting of cartilage and muscle and lined by a pseudostratified columnar ciliated epithelium. The pharynx is a funnel-shaped fibromuscular pouch that is large at the top and narrow at the bottom. This pouch starts at the base of the skull and continues through the esophagus to the level of the sixth cervical vertebra. The laryngopharynx is bordered superiorly by the upper edge of the epiglottis, anteriorly by the larynx, inferiorly by the esophagus, and posteriorly by the cervical vertebrae. The esophagus is a hollow cylindrical organ about 25 cm long and 2 cm in diameter, which extends from the hypopharynx to the cardia of the stomach. The esophagus lies posterior to the heart and trachea, anterior to the vertebrae, and pierces the diaphragmatic hiatus just anterior to the aorta. In conclusion, a thorough understanding of neck anatomy helps establish the diagnosis and management of patients in clinical situations.

1. Introduction

The upper digestive tract and upper respiratory tract are integrated pathways that separate the swallowing and respiratory functions.[1] The anatomical structures of these two systems have different functions but are coordinated in an integrated sensory and motorway. The trachea is a tube-shaped respiratory tract consisting of cartilage and muscle and lined by a pseudostratified columnar ciliated epithelium. One-third of the trachea lies in the neck, and the remainder lies in the mediastinum. The upper digestive tract and upper respiratory tract are integrated pathways that separate the swallowing and respiratory functions. The anatomical structures of these two systems have different functions but

The pharynx is a funnel-shaped fibromuscular pouch that is large at the top and narrow at the bottom. This pouch starts at the base of the skull and continues through the esophagus to the level of the sixth cervical vertebra. The laryngopharynx is bordered superiorly by the upper edge of the epiglottis, anteriorly by the larynx, inferiorly by the esophagus, and posteriorly by the cervical vertebrae. When the laryngopharynx is examined with a throat mirror on indirect laryngeal examination, the first structure that appears under the base of the tongue is the vallecula. The esophagus is a hollow cylindrical organ about 25 cm long and 2 cm in diameter, which extends from the hypopharynx to the cardia of the stomach.[4,5] This literature review aimed to describe the anatomical and histological aspects of the organs trachea, pharynx, larynx, and esophagus.

Trachea

The trachea is a tube-shaped respiratory tract consisting of cartilage and muscle and lined by a pseudostratified columnar ciliated epithelium. One-third of the trachea lies in the neck, and the remainder lies in the mediastinum. The trachea is located in the middle of the neck, and the more to the distal shift to the right, into the mediastinal cavity behind the manubrium sterni. The length of the trachea is approximately 10 cm in women and 12 cm in men. The average anterior-posterior diameter is 13 mm, while the transverse diameter is an average of 18 mm. The trachea extends from the lower border of the larynx, as high as the 6th cervical vertebra, to the 4th thoracic vertebra, where the trachea will divide into two bronchi, namely the right and left main bronchi. The lower tracheal rings extend inferiorly and posteriorly between the right and left main bronchi, forming an internally sharp septum, the carina.[1-3]

The trachea is very elastic. Its length and location vary depending on the position of the head and neck. The cartilaginous layer of the trachea is formed by 16-20 hyaline cartilage in the form of incomplete or open rings posteriorly (c-shaped cartilage). The two free posterior ends are connected by tracheal smooth muscle and elastic connective tissue fibers containing collagen (annular ligaments). The annular ligament connects the individual cartilage rings, allowing the trachea to lengthen and shorten during swallowing or other neck movements. Cartilage, annular ligaments, and tracheal muscles form the tracheal skeleton, which is sometimes referred to as the tunica fibromuscular cartilage. On endoscopic examination, the trachea appears to be a flat tube posteriorly, whereas a cartilaginous ring appears anteriorly. The cervical and thoracic trachea are oval in shape because they are compressed by the thyroid gland and the aortic arch.[4,5]

Histologically, the tracheobronchial tract consists of four layers, namely the mucosa, submucosa, cartilage, and adventitia. The mucous lining of the trachea consists of the epithelium and the lamina propria. This epithelial lining generally contains ciliated columnar cells, mucus-secreting goblet cells, and basal cells. Ciliated columnar cells are the most abundant cell type in the epithelial lining. On the upper surface of the cell, there are 200-300 cilia. Cilia are part of the mucociliary system that lines the trachea-bronchial tract. The mucociliary system plays a role in protecting the inner surface of the respiratory tract from unclean air.[4]

Goblet cells are columnar epithelial cells that are shaped like a goblet. Goblet cells are quite numerous and contain mucus granules. The mucus secreted by goblet cells is released into the lumen of the trachea, where it forms a mucous blanket on the surface of the epithelium. A mucous blanket serves to keep the epithelial layer moist and trap materials and pathogens that are inhaled by the respiratory air. One study showed that mucus from goblet cells plays an important role in ciliary action. Lack of mucus causes impaired ciliary movement. Basal cells are called short cells because they do not protrude to the surface. The shape is small, like a cube, and is thought to have the power to differentiate into ciliated columnar cells and goblet cells. Beneath the epithelium and membranes is the lamina propria. The lamina propria has a loose surface that contains lymphocytes. The inner lamina propria is denser in texture, rich in elastic fibers, and forms an elastic membrane. Membrane elastic is part of the mechanism recoil, which stretches on inspiration and returns to its original shape on expiration. The lamina propria separates the mucosa from the submucosa. The submucosa is a layer of loose connective tissue that lies on the outside of the muscle layer. The submucosa is rich in blood vessels, nerves, lymph nodes, and mucus-secreting glands (tracheal glands).

Tracheal glands are mixed glands that produce mucus together with goblet cells in the mucous layer. The ducts of the glands penetrate the lamina propria to the surface of the tracheal lumen, where mucus is secreted. The cartilage layer consists of C-shaped hyaline cartilage, which has many chondrocytes, and its surface is covered by perichondrium. On the inside of the mucosa, there are interrupted loops of smooth muscle fibers. During expiration, these muscle fibers contract to help expel air from the trachea (Figure 1). Muscle fibers will relax again during inspiration. So that air can enter the respiratory tract deeper. The adventitial layer is a layer of loose connective tissue that contains blood vessels, nerves, and fat cells.[4-6]

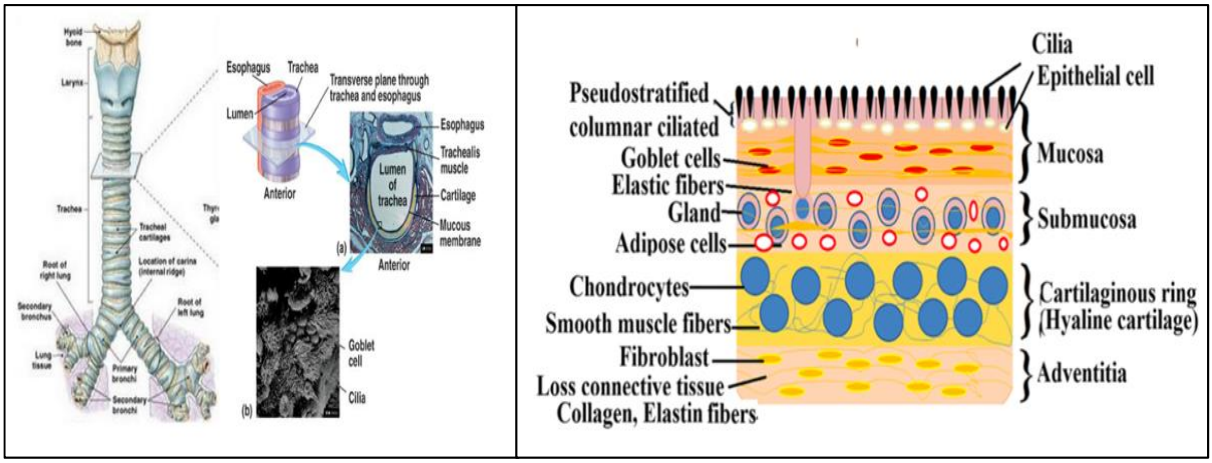

Figure 1. Anatomy and layers of the trachea.[2]

Integration of the digestive tract and respiratory tract

Upper digestive tract and upper respiratory tract are integrated pathways that separate the swallowing and respiratory functions. The anatomical structures of these two systems have different functions but are coordinated in an integrated sensory and motorway. The mouth is a muscular lip-shaped opening, which helps in obtaining, directing, and holding food in the mouth. The lips also have a non-digestive function, which is important for speech (the articulation of various sounds depends on the shape of lips) and as sensory receptors. The palate, which forms the arched roof of the oral cavity, separates the mouth from the nasal passages. Its presence allows breathing and chewing or sucking to take place simultaneously. Towards the front of the mouth, the palate is composed of bones that form the hard palate. Towards the back of the mouth, the palate is boneless and is called the soft palate. Behind, near the throat, there is a protrusion hanging from the soft palate, namely the uvula. The tongue forms the floor of the oral cavity and is composed of skeletal muscles, which are controlled voluntarily. Movement of the tongue is not only important for guiding food in the mouth when we chew and swallow but is also important for speaking.

Pharynx and larynx anatomy

The pharynx is a funnel-shaped fibromuscular pouch that is large at the top and narrow at the bottom. This pouch starts at the base of the skull and continues through the esophagus to the level of the sixth cervical vertebra. To the top, the pharynx is connected to the nasal cavity through the choanae, at the fore, it is connected to the oral cavity through the oropharyngeal isthmus, while the larynx below is related to the laryngeal aditus and downwardly, it is related to the esophagus. The length of the posterior pharyngeal wall in adults is approximately 14 cm. This is the longest part of the pharyngeal wall. The walls of the pharynx are formed by the mucous membrane, pharyngobacilliary fascia, muscle sheaths, and partly the buccopharyngeal fascia. The pharynx is divided into the nasopharynx, oropharynx, and laryngopharynx.[6,7]

The nasopharynx is bordered above by the base of the skull. Below is the soft palate, forward is the nasal cavity, and backward is the cervical vertebrae. The relatively small nasopharynx is closely connected with several important structures, such as the adenoids, lymphatic tissue on the lateral wall of the pharynx, and the pharyngeal recess, which is called the pharynx. fossa rosenmuler, Rathke's pouch, which is an invagination of the embryonic structures of the cerebral pituitary, torus tobarius, a reflection of the

pharyngeal mucosa over the cartilaginous projections of the eustachian tube, choana, foramen-jugular, through which n. glossopharynx, n. vagus, and n. spinal accessory cranial nerves and v. internal jugular, petrous part of the temporal bone and foramen lacerum, and the opening of the eustachian tube. The oropharynx is also called the mesopharynx, with the upper limit being the soft palate, the lower border being the upper edge of the epiglottis, the front being the oral cavity, and the back being the cervical vertebrae. Structures present in the oropharyngeal cavity are the posterior wall of the pharynx, palatine tonsils, tonsillar fossae, anterior and posterior pharyngeal arches, uvula, lingual tonsils, and foramen cecum.[7,8]

The laryngopharynx is bordered superiorly by the upper edge of the epiglottis, anteriorly by the larynx, inferiorly by the esophagus, and posteriorly by the cervical vertebrae. When the laryngopharynx is examined with a throat mirror on indirect laryngeal examination, the first structure that appears under the base of the tongue is the vallecula. It is composed of two concavities formed by the medial glossoepiglottic ligament and the lateral glossoepiglottic ligament on each side. Below the vallecula is the epiglottis. In its development, the epiglottis can become so wide and thin that on laryngoscope examination, it does not appear to cover the vocal cords directly. The function of the epiglottis is to protect the glottis when swallowing a drink or a bolus of food when the bolus travels to the piriform sinuses and to the esophagus.[9-11]

Esophagus

The esophagus is a hollow cylindrical organ about 25 cm long and 2 cm in diameter, which extends from the hypopharynx to the cardia of the stomach. The esophagus lies posterior to the heart and trachea, anterior to the vertebrae, and pierces the diaphragmatic hiatus just anterior to the aorta. The main function of the esophagus is to deliver food from the pharynx to the stomach. At both ends of the esophagus are sphincter muscles. The cricopharyngeal muscle forms the upper esophageal sphincter and is composed of skeletal muscle fibers. The upper esophageal sphincter is normally in a closed position and opens with the relaxation of the cricopharyngeal muscle and active movement of the laryngeal elevation of the suprahyoid muscle. The lower esophageal sphincter is the border between the esophagus and stomach. Normally in a closed state to prevent reflux of stomach acid through the smooth muscle of the esophagus and esophageal narrowing at the diaphragm. The sphincter opens to allow the bolus to be swallowed towards the stomach.[11,12]

The process of mastication or chewing is a process in preparation for swallowing to reduce the volume and change the structure of the bolus of food (Table 1). This process occurs as a result of a complex coordinated mechanism of the jaws, lips, cheeks, and tongue. The muscles that play a role are the muscle masseter, temporalis muscle, medial and lateral pterygoid muscles, digastric muscle, mylohyoid and geniohyoid muscles, and the temporomandibular joint. There are three innervation stages that regulate the swallowing process, including the afferent, swallowing center, and efferent stages. Impulses given from the pharyngeal arch, tonsils, soft palate, base of the tongue, and posterior wall of the pharynx are received by sensory receptors, then these impulses are passed on to the swallowing center via cranial nerves V, VII, IX, and X. The swallowing center will send motor impulses through the motor nerves V, VII, IX, X, XI, XII.[13]

Table 1. Functional components of the normal swallowing mechanism.

Oral cavity
Maintain bolus Lips, cheeks Closing Adequate tension Prepare the bolus Teeth: the process of chewing Tongue: moves the bolus Gums and gingivobuccal fissures: dispense the bolus Molar palate
Oropharynx
Oropharyngeal booster pump Molar palate Lateral wall of the pharynx Base of tongue Velopharyngeal function Palate mole: elevation according to tongue thrust Tongue elevation: required when pushing a bolus
Hypopharynx
Propulsion muscle Pharyngeal constrictor muscle Sinus piriformis Cricopharyngeal muscle Larynx Closure: glottis, ventricular folds, epiglottis pharyngeal pressure Hyoid elevation
Esophagus
Upper esophageal sphincter opening Primary peristaltic waves Secondary peristaltic waves

2. Conclusion

A thorough understanding of neck anatomy helps establish the diagnosis and management of patients in clinical situations.

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