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DESCRIPTIVE AND TOPOGRAPHICAL ANATOMY OF THE LUNGS OF DOMESTIC ANIMALS

DESCRIPTIVE AND TOPOGRAPHIC ANATOMY OF THE LUNGS OF DOMESTIC ANIMALS

Gabriele Barros Mothé – Faculty of Medical Sciences of Maricá
Aguinaldo Francisco Mendes Junior – Universidade Santa Úrsula
Camila Anselmé Dutra – Universidade Estadual Norte Fluminense

SUMMARY
The respiratory system is divided into airways (nose, nasal cavity, pharynx, larynx, trachea, bronchi and lungs) and gas exchange sites (respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli). The upper respiratory tract includes the nose and pharynx, while the lower respiratory tract includes the larynx, trachea and lungs. All of these organs contribute to the essential function of the system, which is the exchange of gases between the environment and the blood, transporting oxygen to cells and removing carbon dioxide. The inspired air is filtered, moistened and warmed before reaching the lungs, where oxygen is diffused into the blood and carbon dioxide is expelled. The lungs are, therefore, the organs that contain the most important structures responsible for gas exchange. Despite the similarity, the lungs present differences, both in the same animal and in different species. In this context, this work aims to present the descriptive and topographic anatomy of domestic animals, highlighting the differences between species. **Key words:**Anatomy. Veterinary Medicine. Lung. Respiratory system.

ABSTRACT
The respiratory system is divided into respiratory pathways (nose, nasal cavity, pharynx, larynx, trachea, bronchi, and lungs) and gas exchange sites (respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli). The upper respiratory tract includes the nose and pharynx, while the lower respiratory tract encompasses the larynx, trachea, and lungs. All these organs contribute to the essential function of the system, which is the exchange of gases between the environment and the blood, transporting oxygen to the cells and removing carbon dioxide. The inspired air is filtered, humidified, and warmed before reaching the lungs, where the diffusion of oxygen into the blood and the expulsion of carbon dioxide occur. Therefore, the lungs are the organs that contain the structures responsible for gas exchange and are of utmost importance. Despite their similarity, lungs exhibit differences both within the same animal and across different species. In this context, this work aims to present the descriptive and topographic anatomy of domestic animals, highlighting the differences between species.

Keywords: Anatomy. Veterinary medicine. Lung. Respiratory system.

1. INTRODUCTION

The respiratory system of domestic animals is essential for survival and well-being, performing several functions. The nose contains olfactory receptors that help with orientation and detection of dangerous substances. The nasal cavity and nasal turbinates warm, moisten and filter the inhaled air, removing foreign particles.

The larynx protects the trachea, regulating the entry and exit of air and assisting in vocalization, along with the tongue. The airways also help with water and heat exchange, crucial for thermoregulation in dogs.

The trachea is divided into main bronchi, which are subdivided into smaller bronchi up to the terminal bronchioles, carrying air to the alveoli. In the alveoli, gas exchange occurs: oxygen from the inspired air of passes into the blood, while carbon dioxide is removed from the blood to be exhaled.

Finally, the lungs are the organs where gas exchange takes place. Their anatomy in animals is complex and varies between species, but they have common characteristics that allow efficient gas exchange. They are divided into lobes, the number and shape of which may differ between species.

The inner surface of the lungs is lined with respiratory mucosa that helps filter, moisten and warm the air. At gas exchange sites, the alveolar wall is composed of a thin layer of squamous epithelial cells, facilitating the diffusion of gases.

Alveoli are small air sacs where gas exchange occurs: oxygen from inspired air diffuses - into the blood, while carbon dioxide is removed from the blood to be exhaled.

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In addition to respiratory functions, the lungs also play roles in thermoregulation and vocalization, especially in species such as dogs and cats. The structure and function of the lungs are adapted to the specific needs of each species, reflecting its ecology and behavior.

In summary, the anatomy of animal lungs is adapted to maximize the efficiency of gas exchange, essential for maintaining the life and well-being of animals. Based on this, the objective of this work is to describe the anatomy of the lungs of canines, felines, horses, ruminants and pigs.

2 THEORETICAL FRAMEWORK

2.1 Definition

The lungs are paired organs, known as the right lung and left lung, connected at the bifurcation of the trachea. They are elastic, full of air and have a soft, smooth and spongy texture.

2.2 Coloring

The color of the lungs can vary greatly depending on the amount of blood present and the quality of the air inhaled. In healthy, exsanguinated animals, the lungs tend to be light pink. In animals that have not undergone exsanguination, the lungs are darker, due to retained blood. Exposure to polluted environments can leave the lungs with a grayish hue, resulting from the deposition of polluting particles.

2.3 Size

The lungs occupy most of the thoracic cavity, and their size is influenced by the dimensions of this cavity and the phase of breathing. They remain expanded thanks to the air pressure in the respiratory tree, essential for gas exchange. However, they have an elastic recoil capacity that can lead to collapse if air enters the pleural cavities, a phenomenon known as pneumothorax. This compromises breathing capacity and may require medical intervention to restore pressure and re-expand the lungs.

2.4 Mediastinum

The lungs are practically independent, except at the roots, where they connect to the mediastinum. The mediastinum is a central region of the chest, located between the lungs, which in addition to connecting them, serves as a passage for structures such as the esophagus and trachea, provides structural support for nerves and lymphatic vessels, and houses several other vital structures. Problems in the mediastinum can result in several medical conditions, such as mediastinitis, which is inflammation of the mediastinum usually caused by infections; mediastinal tumors, which are abnormal cell growths that can be benign or malignant; mediastinal cysts, which are fluid-filled sacs that can compress adjacent structures; and mediastinal lymphadenopathy, which is enlargement of lymph nodes in the mediastinum, often associated with infections, as in cats with FeLV.

2.5 Pleural Sac / Pleurae

Each lung is enclosed in a pleural sac, composed of two layers of serous membranes: the visceral pleura and the parietal pleura. The visceral pleura adheres directly to the surface of the lung, while the parietal pleura lines the thoracic cavity, including the mediastinum, ribs, and diaphragm. The visceral pleura facilitates the expansion and retraction of the lungs during breathing, while the parietal pleura contributes to the creation of an airtight space. Between these two layers is the pleural space, which contains a small amount of pleural fluid. This liquid has two main functions: lubrication, which reduces friction between the layers of the pleura during breathing, and the maintenance of negative pressure, which helps maintain the expanded lungs. Clinical conditions related to the pleura include pleurisy, which is inflammation of the pleura usually caused by infection; pleural effusion, which is the excessive accumulation of fluid in the pleural space; and pneumothorax, which is the entry of air into the pleural space, which can cause lung collapse.

2.6 Faces and Margins

Each lung has three distinct faces: the costal face, which is convex and adjacent to the lateral chest wall; the mediastinal face, which faces the mediastinum and has several indentations, including the cardiac impression, larger in the left lung; and the diaphragmatic face, which is in opposition to the diaphragm. The lungs also have four margins: the dorsal margin, where the mediastinal and costal surfaces meet, being

rounded and thick, occupying the space between the ribs and vertebrae; the ventral margin, where the mediastinal and costal surfaces meet ventrally, being thin and recessed over the heart, forming the cardiac notch; the basal margin, where the diaphragmatic surface joins the dorsal surface; and the mediastinal margin, where the diaphragmatic surface joins the mediastinal surface. This summary highlights the importance of the anatomical structures of the lungs and their functions, as well as addressing relevant clinical conditions.

2.7 Format :

The right and left lungs are similar in appearance, each shaped like half a cone, divided into two parts: the apex and the base. The apex is the most superior end, facing the entrance to the thorax, while the base is the widest and most concave part, located most inferiorly, in opposition to the diaphragm.

2.8 Position:

The root of the lung, or pulmonary hilum, located dorsally to the cardiac impression, is the region that receives the main bronchus, in addition to the pulmonary vessels (pulmonary artery and vein, bronchial artery and vein, lymphatic vessels) and nerves. The lungs are maintained in their position due to their attachment to the trachea, blood vessels, mediastinum and pleura, which emits a pulmonary ligament dorsomedially, connecting them to the mediastinum and diaphragm, ensuring the stability and functionality of the respiratory system.

2.9 Structure of the lung :

The surfaces of the lungs are covered by the pulmonary pleura and, just below it, a fibrous capsule surrounds the organ, forming septa between the lobes, the distinction of which varies between species, being more pronounced in cattle and less so in horses. Structurally, the lungs are composed of parenchyma and stroma. The parenchyma is the part where gas exchange occurs, including bronchioles and terminal pulmonary alveoli, which are the main sites of gas exchange. The stroma is the supporting tissue, composed of connective tissue that provides structure and support for the functional cells of the parenchyma, including the interstitium, formed by elastic tissue and collagen, containing mixed glands, smooth muscle fibers, nerve fibers, blood and lymphatic vessels . The elasticity of interstitial tissue is critical to the lungs' ability to expand during inspiration and contract during expiration.

With aging and certain pathological conditions, this elasticity can be compromised, reducing respiratory efficiency. In horses, for example, chronic obstructive pulmonary disease (COPD) can lead to pulmonary emphysema, resulting in disruption of interstitial fibers. Animals severely affected by this condition have difficulty exhaling, requiring contraction of the abdominal muscles to aid breathing. In advanced stages of the disease, the formation of a visible groove can be observed between the aponeurosis and the muscular part of the external oblique muscle of the abdomen, indicating the additional effort required for breathing.

2.10 Bronchial tree :

The bronchial tree of the lungs is a complex structure that branches in a dichotomous or trichotomous manner, with each new generation of bronchi having a smaller diameter. This structure can be divided into two main parts: the respiratory passages and the gas exchange sites.

The bronchial tree begins with the bifurcation of the trachea, forming the right and left main bronchi, which enter each lung at the root. These main bronchi divide into lobar bronchi, which ventilate the different lobes of the lungs. Within each lobe, the lobar bronchi are subdivided into segmental bronchi, which ventilate specific segments of lung tissue, known as bronchopulmonary segments. These segments are specific areas of the lung, supplied by distinct bronchi and partially delimited by connective tissue septa, giving a marbled appearance to the surface of the lung under the visceral pleura. True bronchioles, the last generation of bronchioles without alveolar cells in their walls, branch to form terminal bronchioles, which divide into respiratory bronchioles, containing some alveolar cells in their walls. The respiratory bronchioles are subdivided into alveolar ducts, surrounded by alveoli and ending in alveolar sacs. The respiratory bronchioles, alveolar ducts and alveolar sacs are the main sites of gas exchange, where oxygen from inspired air is transferred to the blood and carbon dioxide is removed from the blood to be exhaled.

2.11 Lung lobes :

In many species, fissures extend through the parenchyma towards the root, dividing the lung into parts known as lobes, defined by the branching of the bronchial tree.

In the left lung, there is a division into two main lobes: the cranial lobe and the caudal lobe. The right lung is more complex, having, in most species, in addition to the cranial and caudal lobes, a middle lobe and an accessory lobe. In some animals, the cranial lobes are subdivided into cranial and caudal parts, while in others, the right lung lacks four lobes. Identification of the lungs of different species is often based on this degree of lobation and lobulation.

2.12 Differences in the lungs in different species :

Dogs and cats:

Dog lungs are characterized by deep fissures that form lobes connected mainly by branches of the bronchial tree and pulmonary vessels, which can result in torsion of a lobe after trauma. The right lung is larger and has cranial, middle, caudal and accessory lobes, while the left has only the cranial and caudal lobes. The cardiac impression in the left lung is shallower, covering almost the entire lateral surface of the pericardium. The area for auscultation and percussion is triangular, delimited by the fifth rib, dorsal muscles and a line joining the sixth costochondral junction, the middle of the 8th rib and the dorsal end of the 11th intercostal space. On x-rays, the vessels and bronchi are the main visible features, with the bronchi appearing as dark streaks due to air. Contrast techniques, such as bronchography and angiocardiography, make the bronchial tree and vasculature more evident, helping to identify illnesses. Bronchoscopy is also useful for visualizing the bronchial tree. Progressive branching of the bronchi increases cross-sectional area and reduces air resistance in the deep parts of the lung. In dogs, the greatest resistance to airflow occurs in the nasal part, especially in brachycephalic breeds, causing dyspnea even at rest. Cat lungs are similar to those of dogs, except they are shallower.

Equines:

Horse lungs are long and flat, molding to the pleural cavities, with the right and left lungs almost the same size, the right being slightly thicker. Externally, there is no clear division into lobes, except for the accessory lobe at the base of the right lung and a slight separation at the front of each lung. Both lungs are connected by connective tissue behind the bifurcation of the trachea. The left lung has a deep cardiac notch, allowing extensive contact of the pericardium with the chest wall between the third and sixth ribs. On the right side, the cardiac notch is smaller due to the asymmetry of the heart, extending from the third rib to the fourth intercostal space. When inflated, the base of the lungs extends to the sixteenth rib, with the lung margin separated from the pleural reflection line by about 5 cm dorsally and up to 15 cm ventrally. The useful clinical area for percussion and auscultation is triangular, defined by the caudal angle of the scapula, the tip of the elbow, and the dorsal tip of the sixteenth rib. The puncture to collect pleural fluid is safest in the distal part of the seventh intercostal space, avoiding the superficial thoracic vein. Lobulation of the lungs is noticeable on detailed examination, with possible collateral ventilation between neighboring lobes due to the incomplete septum. The main bronchus, pulmonary artery, and pulmonary vein form the root of the lung before entering the hilum. In standing horses, ventilation and perfusion of the lungs are proportional, although favored in the ventral regions by gravity. In supine or lateral decubitus, ventilation and perfusion are impaired, leading to collapse of the alveoli in the lower part of the lung.

Ruminants:

Cattle lungs are quite unequal and asymmetrical, with the right lung being larger than the left in a 3:2 ratio. This difference affects the arrangement of the pleural sacs and displaces the medial sacs. cranial and caudal directions to the left, exposing both to similar risks when foreign objects penetrate the thorax from the reticulum. The apex of the right pleural sac projects in front of the first rib, making it susceptible to injury from penetrating wounds at the base of the neck. The caudal reflection of the costal pleura follows a concave line that allows access to the abdomen without risk of injury to the pleural sac. The costodiaphragmatic recess, a space cranial to this line, is never completely occupied by the lung and may appear exaggerated after death when the lung is collapsed. In addition to the asymmetry, bovine lungs have a pronounced lobation. The left lung has cranial and caudal lobes, with the cranial lobe divided into two parts. The basal margin of the lung varies with breathing, and the main area for percussion and

Auscultation is a small triangle limited by the triceps, margin of the back muscles and a line that joins the apex of the elbow to the 11th rib. The right lung has four lobes: cranial, middle, caudal and accessory, with the cranial lobe also divided into cranial and caudal parts, and is independently ventilated by a bronchus that originates from the trachea. The cardiac notch on the right side is smaller than that on the left side and is covered by the arm. The main area for clinical examination is larger on this side as it is free from the pressure of the rumen on the diaphragm. Percussion toward the basal margin is more accurate due to the abrupt transition from the hollow lung sound to the dull liver sound. Respiratory diseases, such as bronchial pneumonia, cause significant economic losses in livestock farming, often during periods of physiological stress, caused by adverse climates and nutritional deficiencies, which compromise immunological defenses. Common pathogens include bovine herpesvirus and Mycoplasma spp. Connective tissue septa divide the lung parenchyma and demarcate the surface where they connect to the pleura, helping to localize infections and isolating compromised parts of the lung. Compared to other species, in cattle, respiratory exchange capacity is limited by the small alveolar surface area and lower capillary density. Therefore, a large part of the lung capacity is necessary for basal needs, with little reserve available. The lungs of small ruminants are similar, but with less lobulation.

Pigs:

In pigs, the left lung is divided into two lobes: cranial and caudal. The right lung is more complex, containing cranial, middle, caudal and accessory lobes. The cardiac notch separates the left cranial lobe and also divides the right and middle cranial lobes. A unique characteristic of pigs is that the cranial lobe of the right lung is ventilated by a tracheal bronchus, something different compared to other species. The lobulation of pig lungs is quite pronounced, making it easier to identify the different lobes. The projection of the lungs on the chest wall of pigs is relatively small. The basal margin of the left lung extends from the sixth costochondral junction to the dorsal end of the second-to-last rib. In contrast, the basal margin of the right lung is less steep, reaching the penultimate rib. Auscultation and percussion of the lungs are practices generally reserved for young pigs that have a cooperative disposition, due to the difficulty of performing these procedures on adult animals.

2.13 Vascularization :

The pulmonary vasculature is crucial for gas exchange and nutrition of lung tissue. The pulmonary arteries carry deoxygenated blood from the right ventricle of the heart to the lungs, where oxygenation occurs. After this exchange, the pulmonary veins return oxygenated blood to the left atrium of the heart. Additionally, the bronchoesophageal artery and vein provide additional nutrition to the lung. The pulmonary trunk and its branches, the pulmonary arteries, are unique in that they carry venous blood. These branches follow the bronchial tree to the alveoli, forming a dense capillary network around each alveolus, with about ten capillary loops surrounding each one. Some of these capillaries are constantly perfused, while others are activated as the demand for oxygen increases. Pulmonary veins, on the other hand, do not necessarily follow the bronchial tree and may have independent trajectories. This pattern can vary between species and even within a single lung, although this variation is not of great clinical importance. The absence of arteriovenous anastomoses makes the lung an effective filter, preventing the spread of emboli and tumor cells, but also contributes to the formation of abscesses and tumor metastases in the lung tissue, secondary to diseases of other organs.

2.14 Lymphatics :

The lymphatic system of the lungs directs lymph to the tracheobronchial lymph nodes, located around the bifurcation of the trachea. These lymph nodes are called left, right and tracheobronchial. medium, depending on your location. In species with a tracheal bronchus, there are also lymph nodes cranial tracheobronchial tubes. In cattle, there are additional pulmonary lymph nodes along the main bronchi. Lymph from these lymph nodes drains into the mediastinal lymph nodes and ultimately into the thoracic duct.

2.15 Innervation :

Lung innervation is provided by a plexus located in the mediastinum, which receives sympathetic and parasympathetic (vagal) fibers. Sympathetic fibers originate from the caudal and medial cervical ganglia, radiating through the mediastinum and joining the parasympathetic fibers of the vagus nerve to form the cardiac plexus

at the base of the heart. This plexus distributes nerve fibers to the pulmonary plexus. Efferent fibers innervate bronchial glands, muscles and blood vessels, while afferent fibers come from the mucosa and stretch receptors, ensuring efficient communication between the lungs and the central nervous system. In humans, sectioning the vagus nerve can relieve pain in cases of inoperable bronchial carcinomas.

2. MATERIAL AND METHOD

This work consists of a narrative review of the literature on the lungs of domestic animals. The literature search was carried out in the PubMed, ScienceDirect and Google Scholar databases, using the following keywords: “Anatomy”, “Lung”, “Respiratory system”, “Animal”, “Veterinary medicine”, “Bovine”, “ Equine”, “Swine”, “Canine”, “Feline”.

After selecting the studies, a critical reading and analysis of the contents was carried out, seeking to identify the main details related to the lungs of domestic animals, as well as the differences between species.

3. FINAL CONSIDERATIONS

The detailed study of the anatomy and physiology of the lungs of domestic animals reveals the complexity and efficiency of this vital system. The lungs, with their spongy and highly vascularized structure, are essential for gas exchange, allowing oxygen to be absorbed and carbon dioxide to be eliminated. The division into lobes and the branching of the airways to the alveoli guarantee a large surface for the diffusion of gases, essential for the survival and well-being of animals.

In addition to their primary function in breathing, the lungs play important roles in thermoregulation and vocalization, adapting to the specific needs of each species. The respiratory mucosa and the alveolar structure are examples of adaptations that maximize the efficiency of the respiratory system, protecting the organism against foreign particles and facilitating gas exchange.

Understanding the anatomy and physiology of the lungs is crucial to the practice of veterinary medicine, as it allows for more accurate diagnoses and more effective treatments for respiratory diseases. This knowledge is also fundamental for the development of management strategies that promote the respiratory health of domestic animals.

REFERENCES

ALMEIDA, ID Methodology of scientific work. Recife: Ed. UFPE, 2021.

ASHDOWN, R.R.; DONE, SH Color atlas of equine veterinary anatomy. 2ed. Rio de Janeiro: GEN Guanabara Koogan, 2012, 360p.

ASHDOWN, R. R; DONE, SH Color atlas of veterinary anatomy of ruminants. 2ed. Rio de Janeiro: Elsevier, 2011, 272p.

BOYD, JS Color atlas of clinical anatomy of the dog and cat. 2ed. São Paulo: Manole, 2002, 218p.

CONSTANTINESCU, GM Clinical Anatomy of Small Animals. Rio de Janeiro, Guanabara Koogan, 2005, 400p.

DONE, SH; GOODYPC; EVANS SA; STICKLAND NC Color Atlas of Veterinary Anatomy of the Dog and cat. 2ed. Rio de Janeiro: GEN Guanabara Koogan, 2010, 544p.

EVANS, HE; DELAHUNTA, A. Guide to dog dissection. 5ed. Rio de Janeiro: Guanabara Koogan, 2001, 266.

EVANS, HE; DELAHUNTA, A. Miller's Anatomy of the dog 4ed. Philadelphia: Elsevier, 2012, 872p.

GETTY, R. Anatomy of Domestic Animals. 5ed. Rio de Janeiro: Guanabara Koogan, 2vol., 1986, 2052p.

INTERNATIONAL COMMITTEE ON VETERINARY GROSS ANATOMICAL NOMENCLATURE. Nomina Anatomica Veterinaria. 6ed. Rio de Janeiro: World Association of Veterinary Anatomists. 2017, 160p.

KÖNIG, HE; LIEBICH, HG Anatomy of domestic animals: [Text and Color Atlas]. 7ed. Porto Alegre: Artmed, 2021, 856p.

MATTOS, PC Types of literature review. Unesp, 1-9, 2015. Available at: https://www.fca.unesp.br/ Home/ Biblioteca/tipos-de-evisao-de-literatura.pdf

PEREIRA AS et al. Scientific research methodology. [free e-book]. Santa Maria/RS, 2018. Ed. UAB/ NTE/ UFSM.

PRODANOV, CC; FREITAS, EC Methodology of scientific work: Methods and Techniques of Research and Academic Work. 2ed. Ed. Feevale, 2013.

ROTHER, ET Systematic review x narrative review. Acta paulista de nursing, 20 (2), 2007. https:// doi.org/ 10.1590/S0103-21002007000200001.

SINGH, B. Textbook of Veterinary Anatomy. 5ed. Rio de Janeiro: GEN Guanabara Koogan, 2019, 872p.