

LUNG PATTERNS IN THE DOG – NORMAL AND PATHOLOGICAL

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ABSTRACT

The purpose of this article is to describe common principles of the radiological survey of the lungs, which is crucial for the making of correct and timely diagnosis in the clinical settings. The main lung patterns- alveolar, bronchial, interstitial and vascular are shown in details and their clinical value in different inflammatory, neoplastic and cardiac pathologies are reviewed. The different lung patterns are described using variety of radiologic imaging, which are supposed to demonstrate the principle difference between the common patterns and the descriptive differentiation of the pathology from the physiology.

Key words: radiology, lung, pattern, dog.

The radiological examination of the lung is of crucial importance for making an accurate diagnosis in clinical practice. The indications for lung radiography are listed in Table 1.

Table 1:

Cough	Dyspnoea
Rales/stridor	cyanosis /constriction
Trauma	Chest wounds
Cardiac noise	Suspected tumour
Confirmation/rejection of metastases	Vomiting/ regurgitation
Pre-anaesthesia examination	Other

The radiography of the chest makes use of a minimum three views for correct assessment – lateral (LL) – left and right and ventrodorsal / dorsoventral (VD/DV). All foreign bodies are removed in the radiographic examination – leash, neckpiece, bandages, dirt, water, blood. The patient must be immobilized to the limit. For fixation various accessories are used – bags with sand, a rope, adhesive materials, and straps – minimum radiological load of the assistants. Thoracic limbs must be stretched ahead. In DV/VD views the spine must be exactly on the sternum. For a LL view the sternum should be lifted for the sternum and the spine to be at an equal distance from the film.

In lateral view pathological changes in the upper lung (which is more distant from the film) are visualized. This is so because the lung in a lower position lapses into a state of short-term collapse and the pathological changes in it may remain hidden. An example of this is given in Image 1 and Image 2.

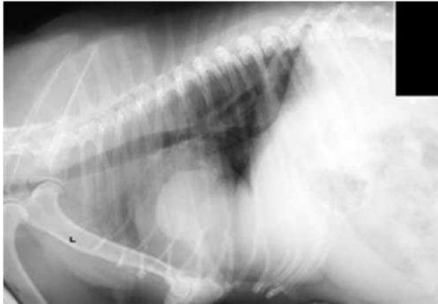


Image 1: Left lateral position in a 12-year old female sterilized Schnauzer. Presence of a large mass (point arrow) in the right medium lobe – primary lung carcinoma.



Image 2: The same patient in right lateral position. The tumour formation is not visible.

Other factors affecting the correct interpretation are:

1. Radiological imaging apparatus
2. Respiratory phase
3. Patient habitus

In 99.9% of diseases exposure is recommended during inspiration. Expiratory radiography is made in case of air-filled masses (bullae) and collapse of the thoracic section of the trachea and the main bronchi.

In the interpretation of an X-ray imaging of the lung we make an assessment of its parenchyma as rather dense or too lucid.

Lung patterns have been introduced for more objective judgment which help for a correct assessment of the lung field.

Types of lung patterns

1. Normal
2. Alveolar
3. Bronchial
4. Vascular
5. Interstitial (structural and non-structural)
 - a) Nodular interstitial (structural)
 - b) Diffuse interstitial (non-structural)
6. Mixed

Normal radiological anatomy of the lung in dogs.

Dog lungs have four lobes in the right section (cranial, median, caudal and additional lobe) and two lobes in the left segment (cranial and caudal lobe) – Image 3.

Image 4 is a schematic representation of the tracheal branches and the main bronchi.

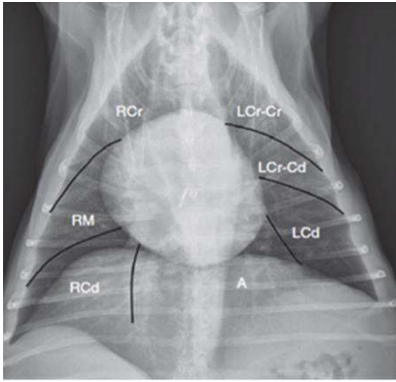


Image 3: A – Additional lobe; LCd – Left caudal lobe; LCr-Cd – Caudal segment of left cranial lobe; LCr-Cr – cranial segment of left cranial lobe; RCr –Right cranial lobe; RM –Right median lobe; RCd –Right caudal lobe.

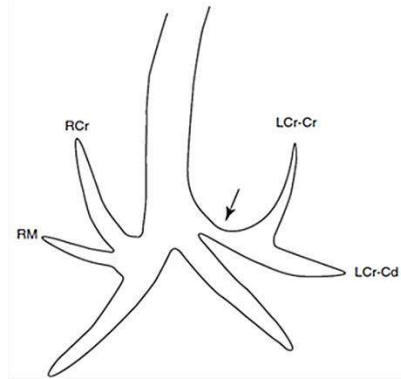


Image 4: Bronchi: right cranial (RCR) and right median (RM), cranial segment of the left cranial lobe (LCR-Cr) and caudal segment of the left cranial lobe (LCR-Cd).

Normal lung pattern.

It may be the most difficult to differentiate! It must be highlighted that normal is not synonymous to non-structural. Normal means without radiographic signs of pathology – Image 5.



Image 5: Normal view of the lung in a dog – right lateral projection (LL).

Alveolar lung pattern

It is obtained when the air in the alveoli is substituted by material with higher density. This could be exudate, haemorrhage or oedema fluid.

Alveolar pattern is characterized by:

1. Air bronchogram – due to the filling of the alveoli with fluid, a bronchus is clearly visualized in this area while the adjacent vessels become invisible. The principle of formation an air bronchogram is represented schematically in Image 6.

2. Lobe sign – this is the sharp edge formed when a higher density lobe touches a normal lobe („more transparent”).

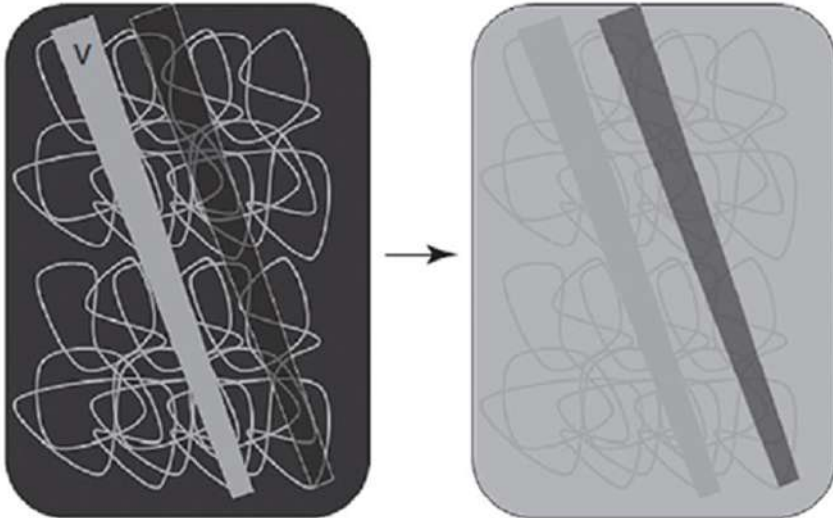


Image 6: On the right – a lung where the alveolar air has been replaced by exudate, haemorrhage or fluid. This increases the density of the lung. The bronchial lumen is an air bronchogram. On the left – normal transparency of the lung. Lung vessel (V) passes slantwise through the lung. It is clearly visible while the bronchi are less visible because their wall is thin and they are air-filled like the content of the alveoli.

Artery – Bronchus – Vein

It must be noted that the normal arrangement artery - bronchus- vein is not to be confused with the air bronchogram! In a lateral projection the artery is always located dorsally to the bronchus and in the VD/DV projection – laterally to the bronchus. Image 7.

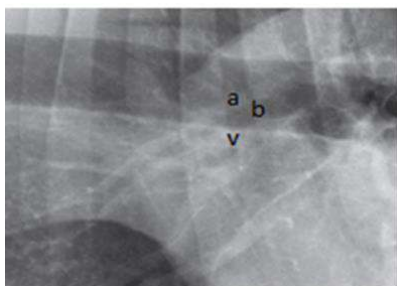


Image 7: Normal location of the artery (a) – bronchus (b) – vein (v).

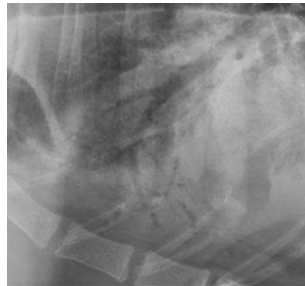


Image 8: Air bronchograms (arrow) in an alveolar pattern.



Image 9: Lobe sign – arrow.

The most common causes for formation of an alveolar pattern are shown in Table 2.

Table 2:

Cause	Frequency
Pneumonia	common
Cardiogenic oedema	common
Non-cardiogenic oedema	more rarely
Haemorrhage:	
• due to trauma	common
• due to coagulopathy	more rarely
Thromboembolism	more rarely
Atelectasis	common
Allergy	rare
Primary tumour	rare

Bronchial lung pattern

The bronchial pattern is obtained when the bronchial wall is infiltrated by cells or fluid or when the peribronchial space is replaced by cells or fluid. The thickening of those structures results in enhanced radiographic visualization of the bronchial tree.

The most common causes of a bronchial pattern are chronic inflammation, peribronchial oedema, atelectasis, lobe collapse (with subsequent bronchial obstruction in cats suffering from asthma), bronchiectasis, rib fracture, chronic bronchitis, bronchial mineralization, etc.

Radiological signs of the bronchial pattern are „ring-like shadows” and „tram lines”. Lung pattern formation is schematically represented in Image 10.

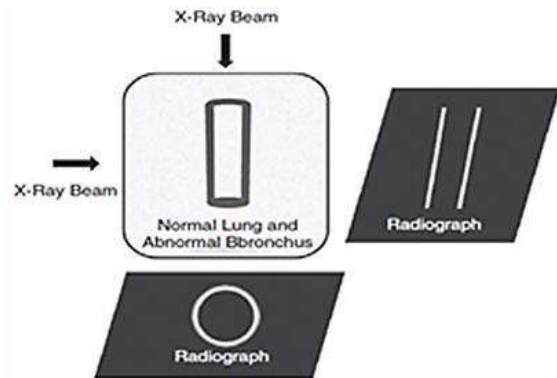


Image 10:

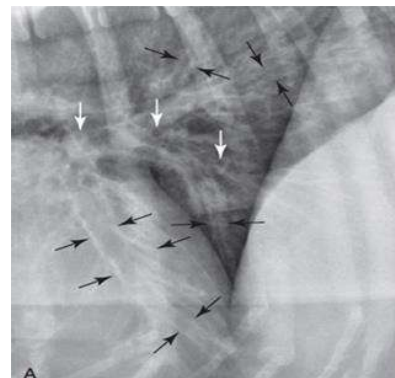


Image 11: A dog with expressed bronchial pattern. Ring-like shadows (white arrows) and „tram lines“ (black arrows).

The most common causes of formation of a bronchial pattern are shown in Table 3.

Table 3:

Cause	Frequency
Allergy	common
Infection	
• Bacterial	more rare
• Parasitic	rare
Chronic irritation	more rare
Cardiogenic oedema	more rare
Diffuse tumour	rare

Bronchiectasis – it is an abnormal permanent dilatation of the bronchi.

There are many risk factors- chronic infections, mucociliary disorders, obstruction, and aging.

A connection is mentioned between tracheal collapse and bronchiectasis (inherited structural changes in the cartilages).

Vascular lung pattern

A vascular pattern is described when there is a larger quantity of blood in the artery or its adjacent vein. This results in a change of the size, form and direction of the vessel which commonly becomes more visible.

Interstitial pattern – it may be:

1. Structural (nodular)
2. Non-structural (diffuse)

Nodular interstitial lung pattern

An aggregate of cells is observed in the interstitium which are growing and displacing the normal lung tissue. These become visible when they reach 4–5 mm.

A tumour or not? It should be taken in consideration that the inflammation could also form nodules (under 2 cm) or masses (over 2 cm)! A definitive diagnosis cannot be made only based on the radiographic examination!

Tumours, abscesses, granulomas, etc. should be considered as a differential diagnosis.

When reading the image, the following should be considered:

Overlapping

Location

Vessels (could often be confused for a nodule)

Always 3 projections! LL, RL, VD/DV

The formations must reach a certain size to be visible (again a problem for a definitive diagnosis).

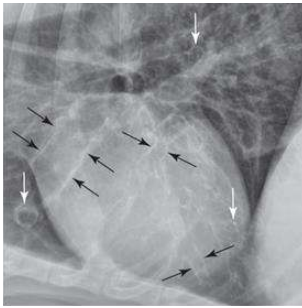


Image 12: A dog with advanced bronchiectasis. Multiple enlarged ring-like shades (white arrows) and wide tram lines (black arrows). Bronchiectasis in this case are caused by bronchomalacia.

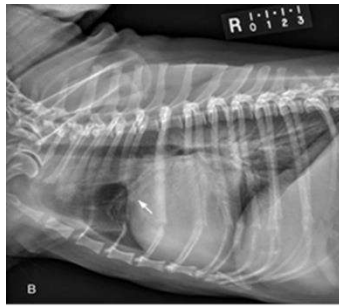


Image 13: Congestive cardiac failure in a dog.

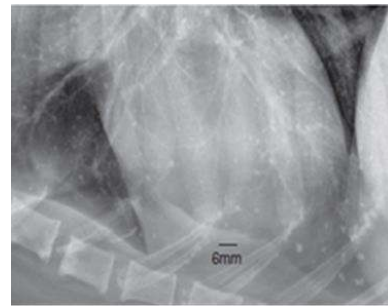


Image 14: A lateral view of the ventral part of the chest of a dog with lung metaplasia. There are multiple small mineralized opacities (arrow) in the lung. The ventral arrangement is characteristic for lung bone metaplasia.

The most common causes of nodular interstitial lung pattern are shown in Table 4.

Table 4

Finding	Cause	Prevalence
Multiple solid nodules	Metastases	common
	Mycoses	untypical
	Septic emboli	rare
Single solid mass	Primary tumour	common
	Abscess	rare
Cavity nodules	Metastases	rare
	Parasites	rare
	Bullae	untypical
Single cavity mass	Primary tumour	common
	Abscess	rare
	Bulla	untypical

Diffuse interstitial lung pattern

This pattern consists of small fibres, military nodules or a combination of both.

Normal interstitial structures include alveolar and bronchial walls, the septa between the different lobes, as well as the connective tissue supporting the vessels. Each of these structures is radiographically invisible on its own.

The presence of fluid, cells or fibrin in the interstitial space makes them denser in a radiographic aspect. The reduced lung volume also results in higher density!

Causes: diffuse lymphoma, interstitial oedema – before or after a cardiogenic lung oedema, vasculitis, atypical allergic/infectious pneumonitis.

What may confuse us?

Insufficiently exposed film

Insufficiently processed film

Habitus

Atelectasis due to reduced ventilation

Sedation

Overweight

All this could result in a heavier shade which could mislead the diagnosis.



Image 15: Lung metastases of hemangiosarcoma– diffuse interstitial pattern. May be confused with a bronchial pattern.

Conclusion

The knowledge of the normal radiological anatomy of the lung, as well as the types of lung patterns is of crucial importance for the making of a correct diagnosis of lung diseases in the clinical practice. It should be noted that occasionally there is more than one pathological process in the lung and the combination between two and more types of lung patterns is frequent. Final diagnosis is made after a complex examination of the patient – anamnesis, clinical examination, paraclinical parameters, x-ray examination and other imaging methods.

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