OBJECTIVE:

The objective of this lecture is to review the radiographic principles of lung disease in dogs and cats. Traditional and non-traditional lung patterns will be briefly described with the intention of underemphasizing their importance to the final diagnosis. Instead, lung disease distribution is the single-most important radiographic determinant of the correct diagnosis.

KEY POINTS:

- Lung patterns (interstitial, alveolar, bronchial, or vascular) are simply defined as an increase in opacity (“whiteness”) of normally gas-filled, lucent lungs.
- NONE of these patterns are specific to a particular disease process but may be used to describe the severity (mild, moderate, severe) of lung disease.
- The distribution of the lung pattern (cranio-ventral, caudo-dorsal, multi-focal, and concurrent pleural disease) has far greater relevance to the true etiology of the disease.
- Progression or improvement of a lung pattern after a short-term treatment (diuresis, antibiotics, pleurocentesis) is sometimes the most important radiographic sign supporting or refuting a diagnosis.

OVERVIEW:

1. Lung Patterns:
A lung pattern describes an abnormal increase in opacity (“whiteness”) of what are normally black, gas-filled lungs.

- An interstitial lung pattern PARTIALLY obscures the margins of the pulmonary blood vessels that are normally surrounded by air.
- An alveolar lung pattern COMPETELY obscures the margins of the pulmonary blood vessels that are normally surrounded by air.
- A clinically relevant bronchial pattern will partially obscure margins of the pulmonary blood vessels, hence the term broncho-interstitial lung pattern.
- A vascular pattern gives the impression of increased opacity of the lungs because the pulmonary blood vessels are too large.
Interstitial and Alveolar Lung Patterns: Any disease that produces an interstitial lung pattern can progress to a more severe alveolar lung pattern or can be the result of recovery from a previous alveolar lung pattern. A mild interstitial lung pattern may actually be normal, especially if the lungs are in an expiratory phase of respiration, the patient is over-weight, or if a film was underexposed. A severe interstitial lung pattern blurs into the descriptions of an alveolar lung pattern.

- Some textbooks will separate interstitial lung patterns into structured (nodular) and unstructured. In the context of partially obscuring pulmonary blood vessel margins, we are describing the unstructured interstitial lung pattern. When we describe nodules, like those seen with pulmonary metastasis, we are referring to the term structured interstitial lung pattern.

- A severe whitening of the lungs that completely obscures the pulmonary blood vessel margins (=alveolar lung pattern) may have two supporting radiographic signs:
  - Air Bronchogram Sign: Black linear airways surrounded by opaque lungs.
  - Lobar Sign: A well-margined line separating completely opaque lung lobe from a more normal, darker lung lobe.

Bronchial (Bronchointerstitial) Lung Patterns: Linear and round (“tram lines” and “donuts”) opacities outlining the larger and lower airways are called bronchial patterns. Mild bronchial patterns can represent normal-age related changes in dogs and can represent a variant of normal in cats, independent of age. As the bronchial pattern progresses, the lines and donuts are blurred (partially obscured) because of peribronchial interstitial opacity. Rather than seeing lines and rings, I begin to liken the pattern to the nooks and crannies of an English muffin!

Vascular Patterns: A vascular pattern alone will not blur the margins of the pulmonary blood vessels. Instead, the pulmonary blood vessels are considered larger than normal. Various measurements have been published to define the radiographic determinants of pulmonary blood vessel distension. However, “beware of the radiologist with a ruler in hand!”

- My recommendation is to compare the vein and the artery.
- Both should be approximately the same size at the level of the 4th rib on the lateral view. Both should be approximately the same size at the level of the 9th rib on the DV/VD view.
Classic examples where the vein is larger than the artery include cases of left-sided heart disease leading to pulmonary venous congestion and cardiogenic pulmonary edema. Classic examples where the artery is larger than the vein include cases of pulmonary hypertension (including heartworm disease). Finally, classic examples where the artery and vein are both larger than expected can include pulmonary overcirculation in the case of a left-to-right shunting cardiac anomaly like patent ductus arteriosus.

2. Lung Pattern Distribution
The distribution (location) of a lung pattern is generally more important for arriving at the correct diagnosis, more so than the lung pattern itself. Some important distinctions between dogs and cats should be made:

- In dogs, a CRANIOVENTRAL distribution of lung disease should alert the veterinarian to pneumonia.
- In dogs, a CAUDODORSAL distribution of lung disease should alert the veterinarian to pulmonary edema (cardiogenic vs. non-cardiogenic).
- In dogs and cats, the presence of pleural effusion decreases the likelihood of pneumonia.
- The presence of pleural effusion will always keep heart failure on the differential for cats.
- The presence of pleural effusion will generally decrease the likelihood of heart failure in dogs.

3. The Struggle to be Normal:
Breed variations (like the hellish bulldog!) and changes occurring as dogs and cats age will be illustrated. Some comparisons between film-screen radiography and digital radiography will also be discussed, primarily with regards to the superior contrast resolution of digital radiography.

Breed:

- Bulldogs: Always a difficult thoracic radiograph to interpret, even for those with experience.
  - The cranial mediastinum of a bulldog is often wider than other breeds. The right cranial lung lobe does not extend cranially and medially to outline the cranial aspect of the cardiac silhouette.
  - Bulldogs tend to have a ‘normal’ (or at least clinically insignificant) diffuse bronchial pattern.
  - Mid- to caudal thoracic vertebral column anomalies are very common, especially in French Bulldogs. Be prepared to accept this breed’s odd conformation!
• Basset Hounds: The VD projection of a Bassett Hound (and some Dachshunds) outlines prominent costochondral junctions at the lateral pleural surface of the lungs. This prominence makes the pleural surface undulate, giving the impression of pleural effusion. This is normal and NOT pleural effusion! The lateral view will confirm this.

• Collies, shelties, and other deep-chested dogs: Shelties and collies (in particular) will have prominent small (1-2 mm) mineral foci in the cranial lungs that represent incidental pulmonary osseous metaplasia (osteoma, osteomata, or heterotopic bone are synonyms). Other dogs will have this as well and this should not misinterpret this as pulmonary metastasis. Soft tissue pulmonary metastasis (nodules) must be greater than 4-5 mm to be visible radiographically. When a 1-3 mm nodule is visible in the lung it is either mineralized (as in the case of osseous metaplasia) or it represents an end-on blood vessel.

• Deep-chested dogs in general tend to have an upright cardiac silhouette. This gives the heart a perfectly ovoid shape on the VD projection. This is normal.

• Skin folds can increase the opacity of the lungs, particularly on the VD projection. The fold tends to lie along the lateral peripheral margin of the lung, and should not be confused with pneumothorax. And then there’s the Sharpei dog…Deal with it! Skin folds.

• A classic example of an age-related change in cats is the “lazy heart” appearance. The geriatric cat’s heart will have increased sternal contact on the lateral view. This also causes the arch of the aorta to abruptly arc in a ventral to dorsal direction. On the VD projection, this end-on blood vessel (the aorta) will look like a rather large nodule to the left of midline, just cranial to the heart. This is not a lung nodule or mediastinal mass. Also, the descending aorta tends to undulate on the lateral view. Speculation as to whether this appearance of the heart and aorta is related to systemic hypertension in cats is remains a question. In dogs, a bronchial pattern, or more commonly a mineralization of the larger airways is identified progressively, as the dog ages. Mineralization/bronchial patterns can be a variant of normal in cats also, but this is not necessarily age-related.

• Miscellaneous variations: Some examples regarding the differences in right versus left lateral, VD/DV, and oblique projections will be illustrated. Inspiratory and expiratory phases of respiration will be compared.

SUMMARY:
The classification of lung patterns has perhaps made the interpretation of thoracic radiographs more difficult than it truly is. Added classifications describing non-traditional lung patterns add terminology, without getting to the heart of the issue... why is the patient sick? This lecture uses everyday examples of lung disease to drive home the point that DISTRIBUTION of an abnormal lung pattern is more important than the lung pattern itself. Although there are species differences between dogs and cats, some general guidelines exist. At the end of the day, response to treatment may be the most important sign to support or refute your clinical suspicion of disease.

REFERENCES:


