Thoracic Radiography: Sans Lung Pattern

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Thoracic imaging is challenging at the best of times. The purpose of this lecture is to provide attendees with a systematic framework that builds on the fundamentals of radiographic anatomy, the application of basic Roentgen concepts and signs and introduces an alternative interpretative paradigm.

Thoracic radiography is a diagnostic test like any other. Similar to a CBC or biochemical profile, as a clinician, you evaluate all the information the profile. Similarly a thoracic radiograph provides information about many structures in addition to the lungs and pleural space.

By consistently using a systematic approach you will be less likely to miss lesions or misinterpret the radiographic signs, ultimately becoming more confident in your abilities.

When looking at thoracic radiographs I use the "outside-in" approach to avoid a "satisfaction of search" pitfall. Below is a check-list of 6 catagories with specific mention of structures that are evaluated using this approach:

1. Extrathoracic structures
    a. Neck
        i. Cervical vertebrae
        ii. Hyoid apparatus
        iii. Larynx, pharynx, epiglottis, soft and hard palate
        iv. Sometimes caudal skull
        v. Soft tissues of the neck
        vi. Trachea
        vii. Region of retropharyngeal lymph nodes
    b. Cranial thorax
        i. Scapula
        ii. Humerus
        iii. Sometimes radius/ulna/elbow
        iv. Shoulder joint
        v. Dorsal thoracic soft tissues
        vi. Thoracic vertebrae
        vii. Sternum
        viii. Ribs
        ix. Thoracic inlet
    c. Cranial abdomen
        i. Lumbar vertebrae
        ii. Ventral thoracic and abdominal soft tissues
        iii. Liver, stomach, pylorus, peritoneal space
2. Pleural space – a very small space, between the visceral and parietal pleural. This is distinct from the mediastinum which is a reflection of the parietal pleural along mid-line. I evaluate the mediastinum separately from the pleural space. Signs of pleural space disease include wide pleural fissures – wide at the periphery. If the pleural fissure is wide towards the hilus and tapers towards the periphery this is most likely fat. At least 100ml of pleural fluid needs to be present before wide pleural fissures are detected. In some dogs and cats you will see normal pleural fissures, depending on the angle of the x-ray beam. Another cardinal sign of pleural space disease is rounding and retraction of lung lobe margins. Rounding or blunting of the costophrenic lung margins occurs most commonly with pleural fluid. Either fluid or gas (pleural effusion or pneumothorax). Do not be confused by retro-sternal or mediastinal fat. This will NOT silhouette or cause border effacement of the cardiac-silhouette or diaphragm. The pleural space is normally a negative pressure environment, designed to permit drainage of fluid and lymph and to allow smooth lubricated excursions between the lung margins and thoracic body wall. In the dog, the lymphatics that drain the pleural space drain into the thoracic duct. In the cat, lymphatics draining the pleural space drain into the pulmonary veins. This is the reason why cats in left sided congestive heart failure often get pleural fluid.

Lungs

The lungs response to disease or insult is limited. Therefore significant overlap exists between various disease processes and their radiographic appearance. Almost no radiographic sign is pathognomic for a particular pulmonary disease. A reasonable list of

differential diagnoses can be generated by defining the radiographic abnormality using the paradigm outlined in this lecture and combining it with history, signalment and physical examination findings.

As with any imaging, knowledge of basic anatomy is of paramount importance. It is worthwhile to have a basic anatomy book handy whenever evaluating radiographs or performing ultrasonography.

The ability to visualize and assess pulmonary blood vessel margins is key to detecting pulmonary disease. Most pulmonary diseases cause an increased opacity. The increased opacity is due to increased fluid, protein and/or cells (inflammatory, neoplastic, blood cells). Two basic mechanisms of disease affect the pulmonary vasculature – increased hydrostatic pressure (as seen in cardiac failure or fluid over-load) or inflammation. In either case, there is loss of tight endothelial junctions and fluid accumulates in the bronchovascular interstitium, causing border-effacement of pulmonary blood vessel margins. Depending on severity of the disease (i.e. the quantity of fluid leaking), the radiographic pattern can vary from interstitial (mild increased opacity) to alveolar (severe increased opacity).

In cases of bronchial disease, the bronchial wall becomes thick but the pulmonary blood vessel margins remain well-defined. The key is to look for THICK lines and rings. Admittedly you will often see thick rings and not as many lines. In very early cases of pulmonary edema when the bronchovascular interstitium has a minuscule volume of fluid (below human eye resolution), this may look like an airway or bronchial pattern.

The non-traditional approach to thoracic radiographic interpretation and Roentgenology of pulmonary disease is based on fundamental questions with less emphasis on the pattern:

1. Define the opacity in the lung
2. Define lung volume as this influences overall opacity
3. Define the distribution of the lesion(s) as this is more important in generating a reasonable list of differential diagnoses
4. Consider the pattern in general terms – Airway (bronchial) or Airspace (interstitial/alveolar)
5. All diseases are a continuum and radiographs do not have the spatial resolution to differentiate interstitial and alveolar spaces. Ascribing a histological entity to a radiographic appearance is inappropriate.
6. Radiographic signs do not correlate with the histopathological results of disease with respect to the microscopic anatomic location.

Pulmonary opacity is a summation of gas and soft tissue/fluid. The majority of lung volume is comprised of gas, hence they appear lucent. The soft-tissue/fluid component is a combination of blood vessels and interstitial tissue. There are 2 major compartments of interstitial tissue – the bronchovascular bundle interstitium and the alveolar septa/acinus. Any decrease in one or the other will alter the overall radiographic opacity of the lung. Reduced lung volume (less gas) will cause the lung to appear more opaque – this may or may not be disease. Conversely an oligemic lung (GDV with hypovolemia or shock) will appear more lucent, but this does not mean the dog has emphysema.

1. Cardiovascular structures: Cardiac silhouette, aorta, caudal vena cava, main pulmonary artery. On radiographs we do not see the heart, we see the “shadow” of the pericardial sac (surrounds the heart). If the cardiac silhouette is enlarged thick about either true cardiomegaly or pericardial disease (includes effusion, pericardial cysts or peritoneopericardial hernia). If based on shape and contours, it is considered to be cardiomegaly try to discern whether it is right or left sided – look for evidence of specific chamber enlargement by using the clock-face analogy. Often times the cardiac silhouette is “subjectively” big, but cannot be corroborated based on objective criteria. In this case you must find the patient “not guilty” of cardiomegaly! Another “objective” measure is the VHS – however, there are breed related variations and the original 10.5 is no longer valid across different breeds.
2. Mediastinum and thoracic lymph centers: The mediastinum contains the trachea, esophagus, cranial vena cava, aorta and its branches, sympathetic trunk and vagus nerves, thoracic duct and cranial mediastinal lymph nodes. There are 3 major lymph centers in the thorax
    a. Sternal (dorsal to the second sternebral segment)
    b. Cranial mediastinal
    c. Tracheobronchial
        i. Right
        ii. Middle (largest)
        iii. Left
3. Trachea and principal bronchi: evaluate the lumen, wall thickness, mucosal margins for irregularities, masses or foreign bodies. The bronchi should taper towards the periphery and if they are truncated, blunt, maintain an unchanging diameter or have terminal saccular enlargements, then a diagnosis of bronchiectasis should be considered.

References

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