

Radiographic Anatomy of the Thorax

Robert T. O'Brien, DVM, MS, ACVR
University of Illinois
Urbana, IL

Knowledge of “what is normal” is essential for detection of lesions. “Normal” includes all the variations by age, breed, sex and body condition. Radiographic variations are as clinically important as, and more difficult to learn than, normal radiographic anatomy.

Remember that cats are not little dogs.

Radiological variations

Expiration causes increased lung opacity. Decreased amount of air in the lung results in proportional increased interstitial pattern.

Overlap of the diaphragm and caudal cardiac silhouette should alert you to this variation. (see comments below on obese patients)

Underexposure causes increased lung opacity. Poor penetration of the spine, especially superimposed on the scapula, should alert you to this variation. Especially a problem with obese patients if the technique is not adjusted accordingly.

Flexion of the neck causes bending of the trachea in the lateral projection. Undulation of the trachea should not be mistaken for “dorsal deviation” secondary to a cranial mediastinal mass. Repeating the radiograph with the neck hyperextended tests the validity of the tracheal positioning due to head position.

- Rotation of the chest in the lateral projection makes the heart base appear larger.
- Without foam support beneath the ventrum, an increased opacity in the heart base mimics left atrium enlargement and hilar lymphadenopathy.
- Oblique positioning on VD/DV projections distorts the cardiac silhouette mimicking chamber enlargements.

Geriatric patients

With increased age we see a large number of changes to the appearance of the thorax. The most common change in cats and dogs is increased lung opacity. This is mostly due to combined increased bronchial and interstitial patterns. The bronchial pattern is due to dystrophic mineralization in the walls. The interstitial component is thought to be due to pulmonary fibrosis. mineralized costal cartilages and costochondral junctions are seen in the ventral thorax. Spondylosis deformans is a radiographic change (more common in dogs than cats) associated with smooth bone formation extending (= originating) from the vertebral end plates towards the adjacent vertebral end plate. This change thought to be a degenerative of the annulus fibrosis part of the intervertebral disk and, as an isolated finding, is an incidental finding. Heart orientation often changes in older patients. The heart in older animals (more common in cats) tends to be less upright (= “falls forward”, “leans over”) than in young animals. This exaggerates the appearance of the aortic arch on both the lateral and VD/DV views.

Obesity

With increased obesity, increased lung opacity. This is mostly due to a increased interstitial pattern. This is due to relative expiration. The weight of the thoracic wall fat limits chest wall excursions and intrabdominal fat decreases caudal movement of the diaphragm. Increase the KvP 10 to 15% compared to a normal conformation patient of the same measurements.

- The heart size is apparent increased in obese patients. The smaller lung volume makes the heart appear larger (= out of proportion).
- This is a challenge with both the subjective interpretation and when using cardiac measuring schemes that utilize intercostal spaces or percent of chest width.

In obese patients increased width of the mediastinum is seen. Fat infiltration in the cranial mediastinum can mimic a mass (cats and dogs). This increased width usually has parallel sides, as seen on the VD/DV view, unlike an enlarged lymph node or thymoma. In the middle mediastinum the fat adjacent to the heart may silhouette with the cardiac outline mimicking heart enlargement. Caudal mediastinal widening, between the accessory and caudal left lung lobes can be mistaken for pleural effusion.

Finally, increased distance between lung lobes or between lung and inner body wall is often noted. Fat can accumulate in pleural fissures or on the inner aspect of the chest wall mimicking pleural effusion.

Breed variations

Brachycephalic dogs often have smaller diameter to trachea (normal > other brachycephalic breeds > bulldogs). Additionally, they have apparently larger heart size (result of wide, shallow conformation). A bulldog is not a bulldog without a caudal thoracic hemivertebra. Dachshund and greyhound hearts measures big using the vertebral heart scale. Collies commonly have heterotopic bone formation in the lungs (mimic nodules).

Some old techniques reinvented

How many views

Whilst the norm may seem to be 2-views we have discovered that the 3rd view is requested so frequently that it was more efficient to always take 3 views. The reason to take both laterals was because middle lung field disease is hidden when that disease is in the dependent lung. For example, right middle lung pneumonia is NOT seen in a right lateral projection.

Similarly, in dogs with suspected dynamic large airway disease, the ability to detect collapse of the intra-thoracic portions is greatly reduced on inspiratory-phase images. So, an expiratory-phase radiograph is indicated to demonstrate collapse, or at least the propensity to collapse, of the intra-thoracic trachea and larger bronchi. This is so common that it has become our traditional 4-view thorax.

In our most dyspneic patients we either add an additional view (“5-view”) or replace the expiratory view with a lateral projection of the neck, including the nasopharynx to the level of the thoracic inlet. This view provides information on the extra-thoracic trachea, larynx, pharynx and soft palate. Seeing air-filled lateral laryngeal ventricles supports normal or laryngeal paralysis. Opaque lateral ventricles supports laryngeal collapse (everted saccules) and mass-lesion diagnoses. Laryngeal inflammation and mass lesions are common in cats. In these cases the thoracic portion of the series may be normal or indicate a global thoracic wall conformation change associated with upper airway obstruction. This conformation will be discussed in the lecture.

Other views?

The reason take other views depends on the clinical history, clinical exam findings and concurrent radiographic findings.

- Placing barium on suspected cutaneous lesion is very helpful to evaluate possible nodules seen on routine images. Ticks, nipples, skin tags and other skin lesions can show up when located in the nondependent portion of the patient, making interpretation of nodules difficult.
- Horizontal beam radiographs are indicated to more accurately determine the presence or absence, more accurately characterize the volume, and to diagnose the concurrent fluid component of a patient with pneumothorax. The VD view is the worst at detecting pneumothorax. Horizontal beam view more accurate than other projections at providing volume of the pneumothorax in the nondependent hemithorax and detecting the fluid component in the dependent hemithorax. This technique requires the use of thick open cell foam pads (8-12 inches thick) to elevate the patient off of the radiology table and ability to 1) lower, and 2) rotate the x-ray tube to a horizontal position. Both horizontal VD views are taken with the dog in right and left lateral recumbency.
- “Humanoid” views are quite valuable to more accurately image the cranial lung regions bilaterally. On standard VD views the scapulae are superimposed upon the left and right cranial lobes obscuring the lungs. By pulling the arms caudally, alongside the chest wall (similar to a person standing with their arms at their sides) on the VD projection, the scapulae are rotated and are no longer superimposed on the lungs. This positioning will be discussed in greater detail during the lecture.

Summary

Thoracic radiographs are powerful tools for the detection and characterization of lung, heart, mediastinal, pleural and bodywall lesions. Through knowledge of normal variants (according to age, breed, species, and body conformation) differentiation of disease from a normal variant is possible. Through utilization of additional creative radiographic views, lesions are seen better or better differentiated from normal anatomy.