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INTRODUCTION

Coughing is a common presenting complaint in dogs. The list of possible etiologies is long and can roughly be divided into the following entities: infectious, allergic, cardiogenic, traumatic/toxic and last but not least neoplastic. It has to be taken into consideration that the differentiation between cough and retching can be difficult for the owner. Furthermore the cause for the cough can be located in the upper as well as in the lower respiratory tract. A thorough workup of the patient history and a good clinical examination are essential to plan the optimal diagnostic imaging procedure.

Another problem is seen in geriatric patients. How much „alteration“ is still normal? Mineralization of the bronchial skeleton and the lung parenchyma is often seen in the aging dog. Also the trachea and larynx may mineralize in older dogs without any clinical significance. In cases of obesity, a generalized increase of thoracic opacity can be seen.

In the clinical workup of coughing, radiography is still the modality of first choice. Radiography is efficient, sensitive, widely available, relatively easy to perform and well tolerated, as most often sedation or anesthesia is not necessary. It has to be mentioned that in several countries restraining personnel are not allowed to stay in the radiology suite during exposure. This implies the use of sedatives. Depending the drug used, alterations in the appearance of the cardiovascular structures can be induced and have to be considered reading the films.

Additional modalities such as Ultrasound, Computed Tomography (CT) and/or Magnetic Resonance Tomography (MRT) are usually of second choice for further evaluation of the pathology if needed.

TECHNIQUES IN RADIOGRAPHY

Especially for thoracic radiographs with the aim of pulmonary and cardiovascular examination, optimal technique is crucial. You find this aspect thoroughly covered in the “BSAVS Manual of Canine and Feline Thoracic Imaging”.

An optimal evaluation of the lung parenchyma necessitates at least two, if not three projections of the thorax: two lateral (right and left lateral) views and either a ventrodorsal or dorsoventral projection. Using right lateral and dorsoventral radiographs for cardiologic evaluation is a custom in many institutions. The choice of views depends also a great deal of the habit of the examiner.

If diseases of the upper airways are suspected, a lateral projection of the larynx/pharynx area and proximal trachea is mandatory. Thoracic studies should always be obtained during inspiration. However, in case of suspected minimal pneumothorax, an end-inspiratory study might provide more valuable information. An additional exception to the rule is the comparison of diameters of the trachea and main stem bronchi in patients with tracheal collapse, which requires both respiratory phases or even fluoroscopy.

Also in the case of the coughing patient, a complete and systematic examination of the thorax is indispensable. As mentioned above, the list of differentials in those cases is comprehensive. Therefore it is essential, that the clinician obtains a thorough picture of the patient.

UPPER AIRWAYS AND MEDIASTINAL STRUCTURES

The cardinal sign of laryngeal and pharyngeal diseases is retching. In many cases of inflammatory causes, a definitive radiographic diagnosis is not possible, but space occupying lesions and secondary signs of trauma and foreign bodies will be appreciated or can be excluded respectively.

The evaluation of the trachea should include its position, evenness, width and possible space occupying lesions or foreign bodies. Generally, infection of the lower respiratory tract does not lead to a visible thickening of the tracheal wall. A granulomatous tracheitis, which produces a marked narrowing of the tracheal lumen, usually causes dyspnea rather than cough.

The dynamic luminal decrease seen in tracheal collapse is seen predominantly during the inspiration at the level of the thoracic inlet and during expiration at the level of the carina. Findings can be intensified by the elicitation of cough. The significance of a soft tissue opaque shadowing of the dorsal tracheal border is subject to discussions.

One possible explanation for the appearance is a redundant tracheal membrane, meaning the protrusion into the tracheal lumen.
The esophagus has only secondary influence on the cough symptomatic. Oropharyngeal dysphagia and esophageal motility disorders, which are associated with megaesophagus, present relevant risk factors for the development of aspiration pneumonia.

A soft tissue opaque shadow seen between descending aorta and caudal vena cava represents a fluid filled esophagus. In large breeds it is incidentally seen in the left-lateral projections, but it could as well indicate a motor dysfunction. Patients with esophageal foreign bodies show rather retching than coughing, provided that the original problem is not further complicated by aspiration pneumonia.

THE CARDIOVASCULAR SYSTEM

As coughing in the dog could potentially be caused by cardiac disease, the cardiac silhouette demands attention in the thoracic radiograph. In the coughing dog the size of the left atrium has to be evaluated. An enlargement of the left atrium leads to a dorsal and eventual compression of the left stem bronchus. This can lead to a “cardiogenic” cough and can be difficult to control medically. This cough is not triggered by congestive heart failure but the irritation initiated by the mechanical compression. In the lateral radiograph the splitting of the stem bronchi is visible. The dilated left atrium leads to a space occupying effect in the caudodorsal region of the cardiac silhouette and depending on the severity also to a convex shape of the caudal margin. In the DV-projection the enlargement leads to an increased soft tissue opacity caudal to the carina and can lead to a decreased visibility of the left stem bronchus and the “cowboy-sign”. An enlargement of the right heart in the coughing dog is usually a secondary sign of pulmonary hypertension in cases of chronic lung disease, such as fibrosis.

The pulmonary vessels of the caudal lobes are better visualized in the DV-projection. The pulmonary arteries are located lateral to the veins. The vessels of the cranial lung lobes are better visualized in lateral projections where the arteries are located dorsally and veins ventrally.

THE LUNGS

Mineralization of the bronchial walls leads to an increase of radiopacity of them without signs of thickening. Real thickening of the bronchial walls leading to “doughnuts” and “tramlines” is a sign of chronic bronchial inflammation. Primary differential diagnosis are chronic bronchitis, eosinophilic infiltrates or parasitic infections. Thickening of the peribronchial tissues (bronchial cuffing) due to edema or inflammation can mimic bronchial wall thickening but belong to another list of differentials (bronchopneumonia, cardiogenic edema in large breed dogs, or allergic reactions).

Chronic bronchitis is an exclusion diagnosis. Thickened bronchial walls and their increased visibility are a reliable sign of chronic bronchitis in dogs. In severe cases the bronchi can be completely opacified by mucus and can be confounded with vessels or even small nodules. In cases of acute bronchitis the thoracic study may be inconspicuous or resemble chronic cases. Bronchiectasia may be seen and is then sign of very chronic disease.

A relatively common cause of cough is inhalated foreign bodies such as grass awns, wooden pieces and the like. The radiographic appearance depends on the degree of bronchial obstruction and if the foreign body has irritating properties.

The most common form of pneumonia is unspecific bacterial infection and often follows primary lung disease such as hemorrhage, viral infection or chronic bronchitis. Patients suffering immunodeficiency or having reduced ciliary apparatus motility are prone to pneumonia. In cases of pneumonia, three different projections are recommended to visualize all parts of the lung field. The most common radiographic sign is an alveolar pattern affecting an entire lobe or just its tips ventrally. The most often affected areas are the cranioventral parts of the lung and the right middle lobe. An asymmetric distribution is also possible. A very specific form of pneumonia is aspiration pneumonia. It is initiated by the inhalation of larger particles or fluids. Stomach content may lead to chemical irritation and then can lead to edema and bronchial obstructions. A subsequent bacterial infection then leads to lobar pneumonia. Aspiration pneumonia most often affects the cranioventral regions, whereas inhalated foreign bodies tend to lodge in the caudodorsal region (see above). A resulting acute respiratory distress syndrome (ARDS) is also controversial in human medicine. ARDS is not a radiographic diagnosis but a combination of imaging, clinical and laboratory findings.

Neoplasmia of the bronchial walls is relatively rare. The most common tumor type is bronchial wall carcinoma. Also in neoplasmia the radiographic appearance may be manifold (solitary nodules, military to alveolar consolidation). The accumulation with cells and fluids in the interstitium may lead to an increased opacity without complete obliteration of the air containing spaces. Therefore the vessels, caudal vena cava and the cardiac silhouette may still be visible but ill defined.
Cardiogenic edema in dogs in cases of congestive heart failure tends to start as unstructured, perihilar interstitial pattern. With increasing degree the changes extend into the periphery and can turn into alveolar patterns. In most cases the pulmonary veins are enlarged.

Recently more emphasis has been given to the distribution and appearance of lesions than to pattern. Lobar disease with increased or decreased volume has been addressed. Multifocal has been opposed to focal distribution. In cases of alveolar opacification ventral distribution has been opposed to caudodorsal and has been shown to stratify pneumonia from non-cardiogenic lung edema in dogs.

ADDITIONAL DIAGNOSTIC IMAGING

As radiographs provide a summation image of overlying structures they are very sensitive in detecting changes, but they lack specificity. The distinction between consolidated areas or just confluent and superimposing processes very often cannot be done. Also bronchial foreign bodies often remain undetected on radiographs. In such instances cross-sectional techniques such as CT prove to be beneficial. MRI studies of the lungs are yet not useful as they are prone to motion artifacts. MRI finds its use in space occupying lesions especially located in the mediastinum.

CT is excellent for the depiction of lung pathologies. It shows high resolution images of the parenchyma, free of superimposition leading to an optimized and more precise diagnosis. Lung pathologies can be detected earlier in stage and secondary changes such as lymphadenomegaly can be depicted very early. With the use of contrast enhanced imaging techniques a further qualification of the lesions is possible. Angiographic techniques are able to demonstrate vascular pathologies such as thromboembolism.

As mentioned above ultrasound is an excellent tool and is very often forgotten as a useful modality for thoracic imaging. Superficial lesions, pleural changes and especially in cases with pleural effusion, mediastinal pathologies can be imaged. And of course, echocardiography being the gold standard for cardiac examinations.

Scintigraphy is also discussed in the literature and used in specialized centers for the demonstration of cardiovascular and respiratory functionality. It provides an excellent possibility to examine ventilation and perfusion of the lungs.

LITERATURE