COMPUTED TOMOGRAPHY EVALUATION OF LUNG PARENCHYMA IN DOGS

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Abstract
The imaging examination of the respiratory apparatus is a difficult exam, assuming detailed knowledge of the anatomy of the chest cavity. The respiratory system is in constant contact with the environment, being responsible for the facility of gas exchange between the body and the environment, which also implies an increased interaction between the lung and the pathogens in the environment. The radiological examination is the main exam in assessing the pathology of the thoracic cavity and pulmonary parenchyma. With the evolution of technology, the CT test has begun to be used more and more frequently in veterinary medicine. The limitation of the radiological examination in the pulmonary cavity examination is the biplanar image and overlapping of the lung structures. In human medicine CT examination of the lung cavity is the gold standard in the diagnosis of pathology located at this level.
Keywords: *lungs pattern, dog, Computed Tomography*

Introduction

Computed tomography is considered to be the best imaging modality for pulmonary parenchyma assessment. High resolution computed tomography (HRCT) is capable of providing morphological details of normal and abnormal pulmonary parenchyma and has been widely accepted in human medicine as an imaging gold standard in lung parenchyma assessment. Many reports have confirmed the high diagnostic value of this technique, particularly in the study of diffuse or generalized pulmonary disease where the HRCT protocol allows imaging at intervals of 10 or 20 mm. Spiral CT, and in particular CT spiral multi-detector rows, has made enormous changes in imaging and also has significant potential for the study of lung parenchyma.

This procedure is indeed capable of generating volumetric high resolution images that provide a continuous and detailed view of lung parenchyma. This view is no longer limited to the axial plane, as multi-plane reconstructions and three-dimensional volumetric reconstructions can easily be accomplished. In addition, very detailed imaging of pulmonary parenchyma is no longer reserved for diffuse and interstitial lung diseases being available for the study of all lung pathology.

Materials and Methods

The CT examination was performed on 30 dogs aged between 1 and 11 years, with different breeds, age and sex. The cases were selected from patients examined in the radiology laboratory of the Faculty of Veterinary Medicine during 2016-2018.

Before the CT examination the patients were clinically examined, the weight was measured, and an individual anesthetic protocol was determined for each patient.

The CT examination was performed using a 16-slices Siemens Somatom Scope. To obtain images, a matrix of 512X512, 130 Kv, 110-120 mAs, total collimation of 9.6, a peach of 0.5-0.8 was used.

Chest scanning was performed with the patient in the dorsal decubitus, this position helps to reduce breathing artifacts.

For scanning, the default chest and abdomen protocol were used, giving a cross-scan at a thickness of 3-5 mm. Scanning at this slice thickness allows to reduce the amount of time needed to get images and reduce breathing artifacts. After the scan, the images were processed to achieve transversal, dorsal and sagittal multi-planar reconstruction (MPR) at 1 or 2 mm, using soft tissue and pulmonary reconstruction windows.

Images obtained through MPR reconstruction were post-processed using DICOM viewer software (HOROS Dicom), this program allows the contrast to be changed, making it possible to highlight the aspects of lung parenchyma.

Results and discussions

The principle of interpreting a CT scan of the chest cavity is based on three principles: 1)Proper identification of lung patterns; 2)Modality of distribution of changes in pulmonary parenchyma; 3) Correlation of information obtained from CT imaging and patient history.

Depending on the appearance of the lesions, the changes in the pulmonary parenchyma can be categorized into four categories (Verschakelen and Wever, 2007):

•Changes associated with increased pulmonary opacity (increased pulmonary attenuation).

• Changes associated with decreasing pulmonary opacity (low pulmonary attenuation).

• Changes that cause nodular opacities.

• Changes that cause linear opacity.

The increase in attenuation of pulmonary parenchyma is determined by the increase in density. The density of pulmonary parenchyma on the CT image is slightly higher than that of air, being determined by three components: pulmonary tissue, blood from capillaries and tissue and air.

Pulmonary opacity is determined by:

• The thickness of the parenchyma,

• Increased pulmonary blood volume or pulmonary vessel distention,

• When the relative amount of air from the lungs decreases, which may be the result of loss of lung volume or of the replacement of air in the alveoli with fluid and / or cells.

Increasing pulmonary attenuation is often the result of two or more of these processes. Depending on the degree of involvement of lung parenchyma, two types of increased opacity can be described:

• Appearance of ground glass or ground glass attenuation when lung parenchyma is mildly affected (fig. 1),

• Consolidation when parenchymal damage is more advanced (fig. 2).

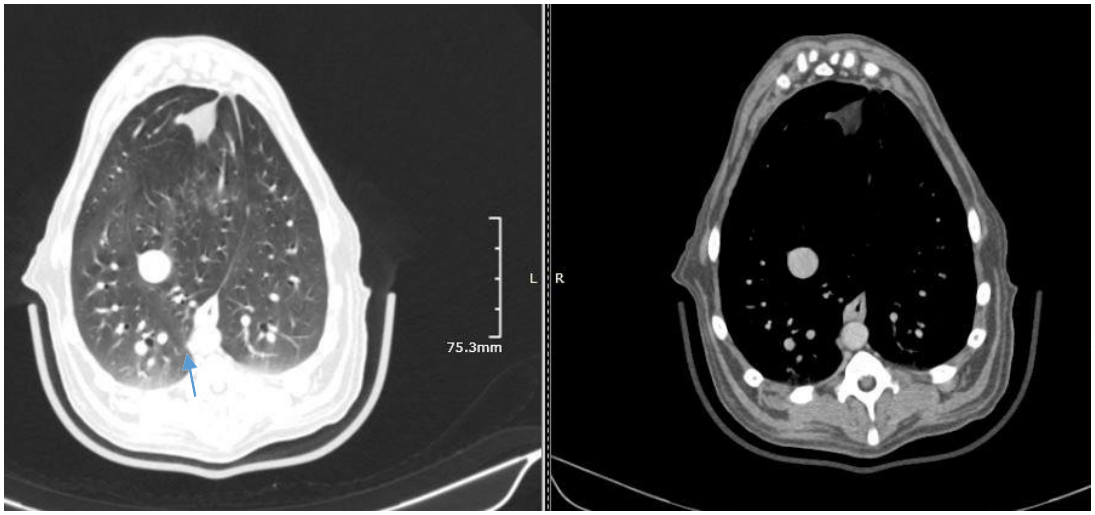

Figure 1 Ground Glass attenuation (arrow), lung window and soft tissue window

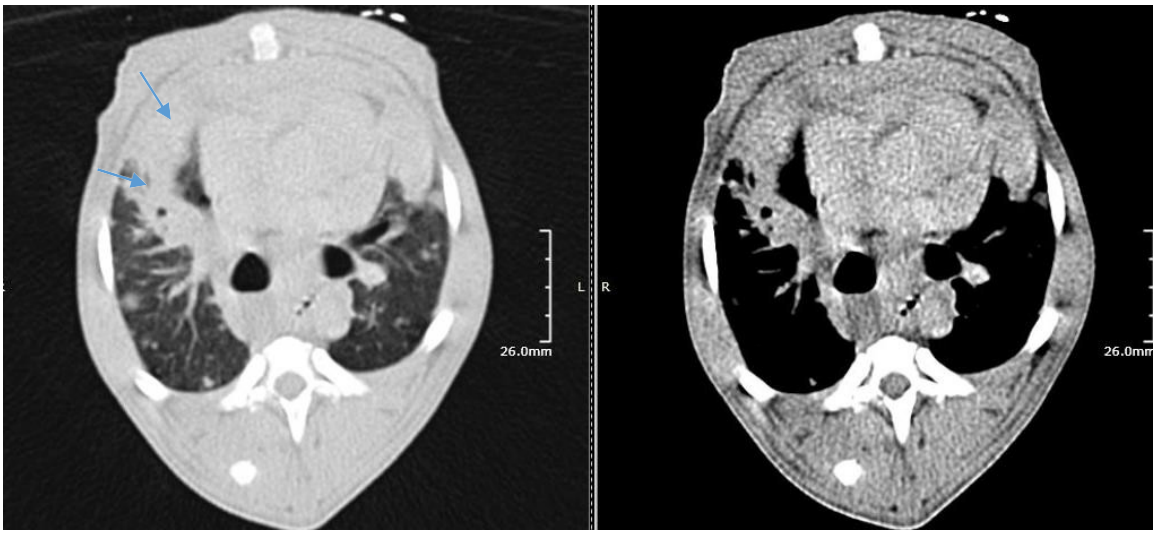

Figure 2 Consolidation of the lung parenchyma

The term ground-glass attenuation is used to describe a diffuse modification of the opacity of the pulmonary parenchyma while preserving the bronchial-vascular demarcation (Austin et al., 1996, Verschakelen and Wever, 2007).

Pulmonary consolidation, on the other hand, always has a pathological implication and this term is used to describe an increase in attenuation of lung parenchyma that masks delineation of vessels and airways (Austin et al., 1996, Tuddenham 1984, Webb et al. 1993).

Compared to increased pulmonary attenuation, decreasing pulmonary attenuation is partly caused by opposite phenomena. An abnormal increase in air volume, an abnormal decrease in intravascular blood volume and, as a result, an abnormal size of vessels that are beyond CT

resolution, but also tissue destruction and loss of density are responsible for a decrease in pulmonary attenuation (fig. 3).

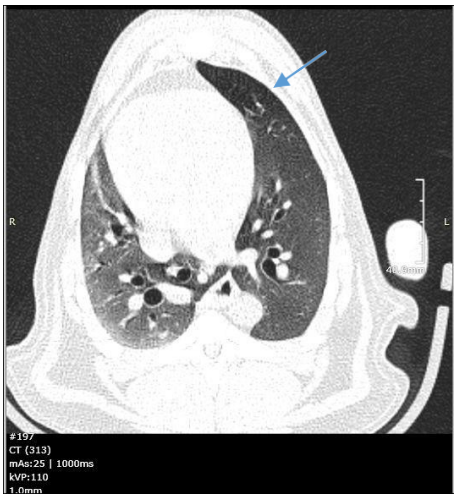

Figure 3 Decrease opacity on left cardiac lung lobe (arrow)

The nodular model (fig. 4) is characterized by the presence of multiple nodular opacities with a maximum diameter of 3 cm. A nodule with a diameter of less than 1 cm can be defined as a small noduke, while a nodule greater than 1 cm is often called a large node (Grenier et al., 1991). The term "micronodule" usually refers to nodules no larger than 7 mm in diameter (Austin et al., 1996). CT evaluation of the nodular model is based on:

- Their dimensions (small or large)
- Their appearance (well defined or undefined)
- Their attenuation (soft tissue density or matte glass)
- Distribution of these (lymphatic (peri) lymphatic, centrilobular, at random).

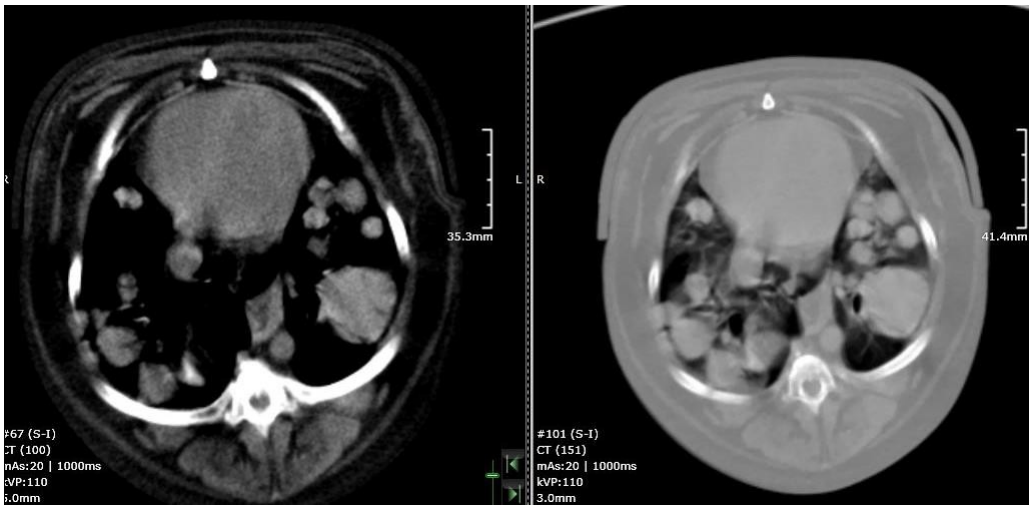

Figure 4 Nodular lung pattern (soft tissue window and bone window)

The evaluation of the nodule characteristics is based predominantly on the study of the edges (clear or unclear) and density (solid or matte glass). Using these features, pulmonary nodules can often be divided into interstitial nodules and alveolar nodules. Other characteristics such as the size, cavity and presence of calcium may be considered (Muller et al., 2003a-d; Tsuchiya 2005).

The linear model is characterized by the presence of several lines. Because these lines often intersect with each other, the term "reticular pattern" is also used. However, the appearance of a network aspect does not have to be present, while the number of lines can also be limited. In this situation, the term "linear opacity" is preferred (fig. 5). The differential diagnosis of pulmonary linear opacity is mainly based on the identification of their location and appearance (smooth, irregular) (Verschakelen and Wever, 2007).

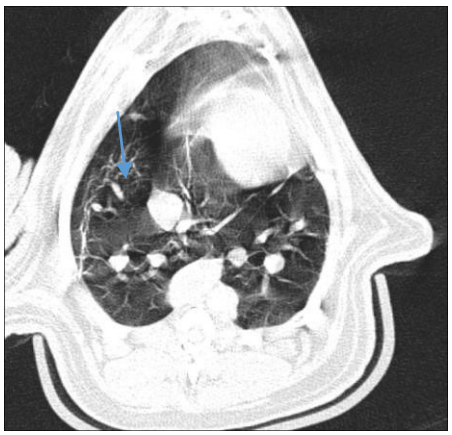

Figure 5 Linear opacity of the lungs

Sometime a mixt pulmonary pattern is present, which often complicates the interpretation of anomalies. A combination of patterns may be caused by a new disease overlapped with an already existing lung disease (fig. 6).

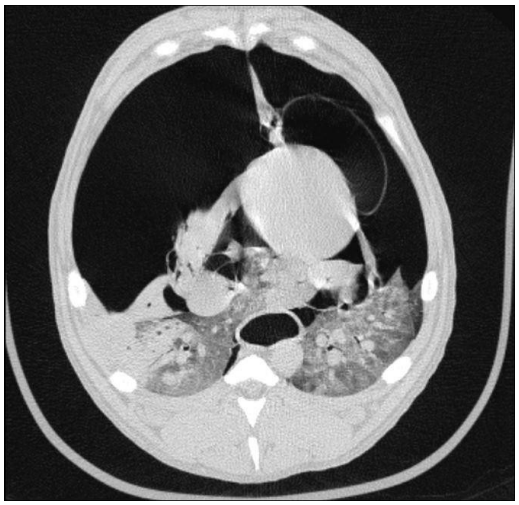

Figure 6 Mixt pulmonary pattern – lung emphysema

Conclusions

The correct diagnosis of lung disease involves the correlation of CT data with anamnesis, inspection, palpation, percussion, ausculation and laboratory examinations. The CT examination in lung disease in the dog has a major diagnostic relevance on the basis of which the lung model can be established in relation to the type of condition.

In the pulmonary CT examination, the interpretation of lung patterns is the key to establishing a correct diagnosis in lung disease. Depending on the affected lung area, several pulmonary models may be found: nodular pulmonary model, linear pulmonary model or mixed pulmonary model.

Acknowledgement

This study was performed in the Radiology department of FMV Cluj Napoca being part of internal department research grant.

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