Research Article

The Role of Ultrasonography in 20 Calf with Pneumonia: Diagnostic and Prognostic Value

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Abstract

Bovine respiratory diseases in calves are one of the enormous burdens on the cattle industry worldwide. Early detection and treatment are crucial for successful disease management. Thoracic ultrasonography has emerged as a valuable diagnostic tool for diagnosing calf pneumonia. Apart from diagnosis, determining the severity of pneumonia and subjectively assessing lung lesions are essential for prognosis. This study aimed to assess the role of thoracic ultrasonography in diagnosing and determining the severity of calf pneumonia.

84 calves under six months old were examined at Ondokuz Mayıs University Veterinary Hospital for respiratory complaints. Lung lesions were evaluated in two parts as right and left sides of the thorax of twenty calves, categorized as comet-tail artifacts, pleural irregularities, consolidation, thoracic effusions, and hepatized lung lobes.

Thoracic ultrasonography was performed on specific intercostal spaces, without clipping the hair, using 70% isopropyl alcohol. The most common abnormalities among 84 animals were comet artifacts, lung lobe consolidation, and pleural irregularities. Pleural irregularities were more common on the right side.

In the evaluation of lung lesions in the twenty calves, the most common lesions were comet artifacts (23.3%) and pleural irregularities (25.23%). Pleural irregularities were found to be more common in the right thorax than the left side ($P < 0.05$). There was no significant difference between the right and left thoracic regions in terms of other lesions. During the study period, nine animals with lung hepatization or thoracic effusion in either the right or left thoracic region, as determined by thoracic ultrasonography, died. It was concluded that animals with these lesions had a poor prognosis. In conclusion, it was found that thoracic ultrasonography is an advantageous diagnostic method for diagnosing lung diseases, as well as revealing lesions and determining prognosis.

Keywords: bovine respiratory system disease, calf, pneumonia, thorax, ultrasonography

Introduction

In nations where the livestock industry plays a significant role in the agricultural sector, respiratory issues have an economic impact. Producers of cattle may suffer large financial losses as a result of these issues. In the US, respiratory illnesses are thought to result in yearly economic losses of between $800 million and $900 million due to treatment expenses, decreased feed efficiency, and mortality (Chirase and Greene, 2001; Gorden et al., 2010).

The diagnosis of BRD may be difficult, especially in subclinical or chronic stages, and also because typical signs, including both increased rectal temperature and alteration of the respiratory function (tachypnea, dyspnea, or nasal discharge, etc..), lack both specificity and sensitivity (Buczinski 2013 short communication). However, auscultation of the lungs shows a low sensitivity in detecting lung pathologies (Buczinski, 2014). TU is very useful in the antemortem determination of lung lesions and has a positive correlation with postmortem lesions (Flöck, 2004). And besides that, it is very useful in revealing the lesions in bronchopneumonia in calves (Adams, 2016; Buczinski, 2016). Also, TU can reveal pleural disorders, comet-tail artifacts, lung consolidation, hepatization, and thoracic effusions. The frequency of these lesions has been investigated in previous studies (Braun, 2018; 2020; Tharwat 2011), but the relationship between the right and left sides of the thorax has not been evaluated. This study aimed to determine whether TU findings in calves with clinical pneumonia and also investigate the difference between right and left thoracic region lesions.

Materials and methods

The study's animal material consisted of calves that were brought to Ondokuz Mayıs University Faculty of Veterinary Medicine Training-Application and Research Hospital with respiratory problems. Calves less than six months old were included in the study. The animals underwent clinical respiratory scoring (CA BRD3 scoring system) and clinical examinations to confirm the complaint. Calves with a score of five or above were diagnosed with pneumonia. Between August 2017 and August 2021, a total of 84 calves were brought to the hospital and included in the study.

Thoracic Ultrasonography Application

Ultrasonography was performed by the same physician to minimize application differences and errors. The Esaote MyLab Five Vet ultrasonography device with a 2.5-6.6 MHz micro convex probe was used, and the depth was adjusted between 5-15 cm based on the lesions. The area was not shaved or clipped, and 70% isopropyl alcohol and ultrasound gel were applied before performing thoracic ultrasonography (TU).

The ultrasonography procedure was standardized for all animals. The systematic scanning of the thorax began at the processus transversus in the right/left 10th intercostal spaces. The probe was positioned parallel to the ribs within each intercostal space and moved ventrally toward the costal arch. The scanning continued sequentially through the caudal intercostal spaces towards the cranial region. The examination extended up to the 1st intercostal space on the right side and the 2nd intercostal space on the left side.

Pneumonic ultrasonographic lesions were defined by Detrich et al. (2015) in humans and by Rabeling et al. (1998) and Flöck (2004) in cattle. These lesions were classified as comet-tail artifact, diffuse comet-tail artifact, thoracic effusions, pleural irregularities, consolidation, and hepatization of the lung tissue. The identified pathologies were recorded separately for the right and left lung lobes. All animals included in the study were hospitalized, and treatment was initiated. For treatment purposes, all calves received subcutaneous florfenicol at a dose of 40 mg per kg and flunixin meglumine at a dose of 2.2 mg/kg. If necessary, fluid therapy was administered to dehydrated calves. Each calf was housed in an allocated calf box with heating lamps and provided with 24-hour access to water and feed. Necropsy was performed on deceased animals.

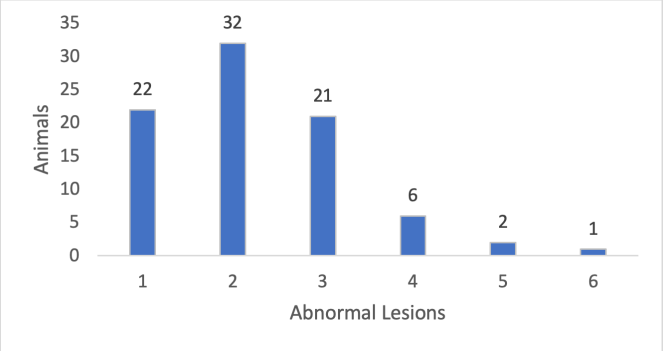
Statistical analysis

The data obtained in the study were subjected to statistical analysis using SPSS 21v. software. For this purpose, the t-test was employed to determine whether there was a difference in the number of lesions between the right and left lung lobes. Additionally, the chi-square test was used to assess the presence of the lesions.

Results

An average of 2.25 pathological thoracic ultrasonographic lesions were determined per animal. The most common abnormal ultrasonographic images were comet-tail artifacts (48), diffuse comet-tail artifacts (31), and consolidation (71). Pleural disorders (55), hepatization (16), and effusion (11) were observed less frequently. The number of abnormal ultrasound lesions in each animal resulting from ultrasonography is summarized in Figure 1.

Figure 1. The number of abnormal ultrasound lesions in each animal



Considering the lesions detected in the lungs, the most common lesions encountered were comet-tail artifacts and pleural irregularities in 20 animals. No difference was found between the right or left lung lobes in terms of comet-tail artifacts. Pleural irregularities were more common in the right thoracic region than the left ($p<0.05$). Among the animals with pleural irregularities (27 regions), the most common accompanying lesion was lung consolidation (19 regions). The ultrasound findings obtained in the right and left thorax are presented in Table 1.

Table 1. Differences in abnormal ultrasonographic findins at right and left lungs.

Lesions	Right Thorax	Left Thorax	Total	P
KOMT	13 (12.14%)	12 (11.21%)	25	P<0.05
Diffuse KOMT	7 (6,54%)	9 (8.41%)	16	
Pleural Irregulaties	17 (15.88%)	10 (9.34%)	27	
Consolida-tion	12 (11.21%)	9 (8.41%)	21	
Thoracal efusions	4 (3.73%)	3 (2.80%)	7	
Hepatisa-tion	6 (5.60%)	5 (4.67%)	11	
Total	56	51	107	

KOMT: Comet-tail artifact, Diffuse KOMT: Diffuse Comet-tail artifact.

All calves in which thoracic effusion and hepatized lung lesions were detected died despite the treatments applied. Necropsy was performed on these animals, and the thoracic ultrasonography (TUS) findings were compared to the necropsy findings.

Discussion

The ultrasonographic appearance of a healthy respiratory system in calves and the ultrasonographic findings of lesions have been revealed in various studies (Babkine, 2009; Jung and Bosted, 2003). Additionally, the effectiveness of thoracic radiography in diagnosing calf pneumonia has been investigated (Shimbo, 2019). Comparisons have been made between thoracic ultrasonography and thoracic radiography (Jung and Bosted, 2003), as well as between thoracic ultrasonography and bronchoalveolar lavage (Olivett et al., 2015), and it has been determined that thoracic ultrasonography is effective in detecting both clinical and subclinical pneumonia in calves.

Studies have been conducted to assess the specificity and sensitivity of thoracic ultrasonography in diagnosing pneumonia, and a strong positive correlation between necropsy findings and thoracic ultrasonography has been observed (Reinhold, 2002). Subclinical lung lesions detected by thoracic ultrasonography have been evaluated in terms of their impact on disease susceptibility and daily weight gain in calves. It has been found that average daily weight gain decreases as the number of lesions increases (Francoz, 2015). Furthermore, studies have indicated that a higher number of lesions increases the likelihood of mortality (Buczinski et al., 2014).

It has been determined that all animals diagnosed with pneumonia through clinical scoring systems and clinical examination exhibited pneumonia lesions on thoracic ultrasonography. While auscultation can help in identifying thoracic and/or lung diseases, it requires significant expertise, and the characteristics of lung lesions cannot be determined through auscultation alone. Buczinski et al. (2014) reported that only 5.9% of lung consolidations could be identified through auscultation, and this rate increased to 71.4% when clinical scoring and auscultation were combined, but the success of thoracic ultrasonography could

not be achieved.

Although radiography allows for the evaluation of lung tissue, it is not practical for use in field conditions in large animal medicine. On the other hand, thoracic ultrasonography has gained importance as a valuable adjunctive clinical diagnostic tool in pneumonia cases due to its applicability under field conditions, providing insights into the nature and size of lung lesions, and offering objective findings.

Comet-tail artifacts, which appear as bright, closely spaced echo bands starting at the lung surface and running perpendicular to the pleura in the lung tissue, have been observed in ultrasonography. Comet artifacts are not specific to a particular pathology but indicate interstitial or alveolar diseases in the lungs. These findings are commonly seen in pulmonary emphysema affecting the surface alveoli (Tharwat and Oikawa, 2011). Even small changes in the lung can reveal comet artifacts. In human medicine and calves, these findings are always considered indicative of lung parenchymal diseases (Lichtenstein and Meziere, 1998). The most common lesions detected in calves diagnosed with pneumonia were comet artifacts, which were found in 38% of the right and left lungs of calves, regardless of their extent or size. It has been mentioned in a study that sporadic comet artifacts may also be observed in healthy calves (Buczinski et al., 2014).

It has been reported that bovine respiratory disease (BRD) often starts in the cranial part of the right cranial lobe (Reinhold, 2002). Studies have reported the presence of consolidation areas in calves with clinical or subclinical pneumonia in this region, and ultrasonography was not sufficient for detecting consolidations smaller than 1 cm. However, severe and widespread comet tail artifacts were observed in these regions (Ollivett, 2015).

Furthermore, it has been found that lesions can occur in both the cranial and caudal aspects of the right cranial lobe, as well as in the right medial lobe and left cranial lobe. In this study, Pravettoni et al. (2021) concluded that scanning the entire lung tissue is superior to diagnosing BRD compared to ultrasonography of specific lung areas. Consistent with these studies, the higher occurrence of pleural irregularities in the right thoracic region compared to the left thoracic region suggests that scanning the right lung contributes to earlier diagnosis of pneumonia compared to the left side. Another study revealed that calves treated for pneumonia while still young experienced slower growth, delayed age at first calving, and shorter survival compared to animals without pneumonia (Stanton, 2012).

Pleural irregularities and thickening were noted when the pleural line appeared serrated with an irregular shape and a thickness greater than 1 mm, as opposed to the normal thin, smooth hyperechoic line (Fig. 2). Reef (1998) mentioned that the sonographic diagnosis of pulmonary parenchymal consolidation is based on detecting hypoechoic pulmonary parenchyma with visible bronchograms or vessels. Extensive consolidation appears as wedge-shaped hypoechoic and often heterogeneous zones, with anechoic areas representing fluid-filled or necrotic regions. Studies have linked the diagnosis of active inflammation or BRD in the lungs to areas of consolidation (Flöck, 2004; Jung, 2004). The presence of lung consolidation in 71 calves with pleural irregularities observed in 55 calves indicates a progressive disease associated with active pneumonia. The number and depth of consolidation areas, as well as the presence of pleural disorders, provide insights into the survival rate of calves (Braun, 2020). Braun suggests that these lung lesions in livestock have prognostic value. Ultrasonographic consolidation corresponded to firm, red lung lesions observed during gross examination at necropsy (Fig. 3, 4, and 5).

Figure 2. Calf No 10, calf pleural irregularities

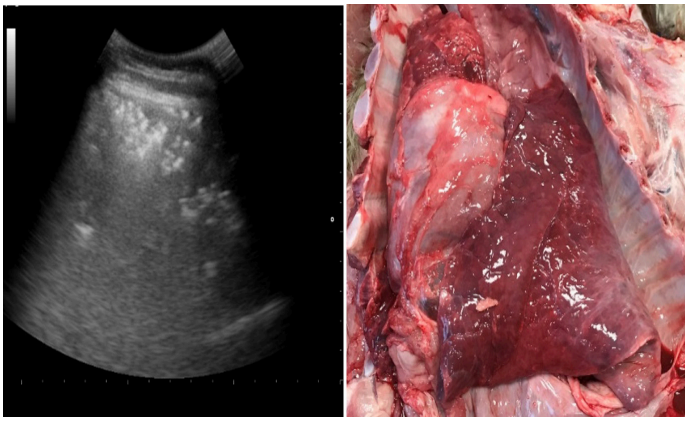


Fig 3. Calf No 6, consolidation

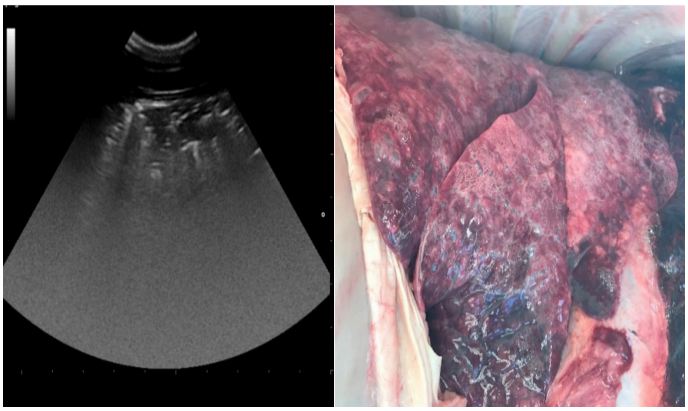


Fig 4. Calf No 7, superficial alveolar emphysema and consolidation

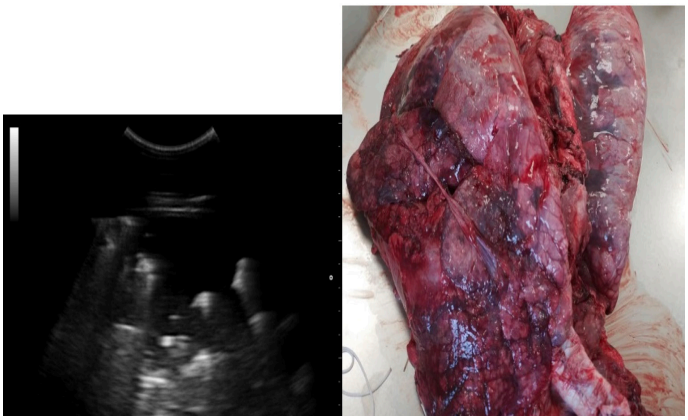


Fig 5. Calf No 18, consalidation

Hepatization of lung parenchyma occurs with severe and widespread consolidation, while effusion is a sign of severe pneumonia, giving rise to an ultrasonographic appearance similar to that of a liver (Rabeling et al., 1998; Reef, 1998). Pleural effusions appear as anechoic spaces between the lung and thoracic wall. The fibrin image formed as a result of pneumonia can be detected within the anechoic fluid in this area, indicating very severe pneumonia (Fig. 6). All calves with hepatization of lung tissue and/or thoracic effusion died despite treatment. Considering that all animals with these two lesions died despite treatment, it can be concluded that the prognosis for calves with these lesions is quite poor. Assessing the severity of pneumonia by identifying lung lesions with ultrasonography can contribute to decision-making regarding the continuation or completion of treatment, prevention of excessive medication usage or costs, and prognostic evaluations. When used as described in this study, thoracic ultrasonography can provide a rapid and objective assessment of lung health, improve the classification of BRD status, and should be considered as a primary method for detecting lung lesions in both clinical and research settings (Ollivett, 2015).

In cases of severe respiratory symptoms, extensive lung consolidation, and lack of response to treatment, it is crucial to be able to inform the animal owner about the prognosis in terms of breeding costs, treatment costs, and the future of the herd. Ultrasonography has been found to be a suitable complementary tool to clinical examination, with each method providing complementary information for recognizing and quantifying respiratory diseases in pneumonic calves.

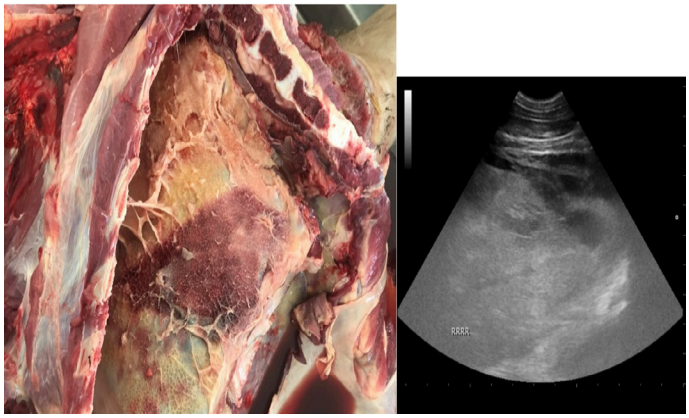


Fig 6. Calf No 19, diffuse KOMT, fibrin ve effusion.

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