Ultrasonographic findings in adult cattle with chronic respiratory disease

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SUMMARY
Modern portable ultrasound machines provide the veterinary practitioner with an inexpensive, non-invasive tool with which to examine the pleural surfaces and superficial lung parenchyma and help differentiate painful lesions in adult cattle that involve the pleurae (pleurisy, suppurative pneumonia), heart (pericarditis, endocarditis) and peritoneum (traumatic reticulitis, focal peritonitis). Systematic ultrasonographic examination need take the busy farm animal practitioner no more than 5 minutes. Ultrasonographic examination of the chest is most helpful in the definitive diagnosis of chronic suppurative pulmonary disease (CSPD) where there are numerous hypoechoic columns extending 2 to 6 cm into the lung parenchyma which are bordered distally by bright white (hyperechoic) lines as the transmitted sound waves contact normal aerated lung. Pleural effusion, present in many cases of dilated cardiomyopathy, thymic lymphosarcoma and diffuse fibrosing alveolitis is readily identified as an anechoic area which increases in depth as the probe head is moved ventrally with consequent dorsal displacement of the ventral margins of the lung lobes which may be consolidated. Pleural abscess(es) appear echogenic as an anechoic area containing many hyperechoic dots (“snowstorm appearance”) allowing immediate differentiation from an effusion. In cattle with fibrinous pleurisy the visceral pleura appears thicker than normal and often displaced 2 to 3 cm from the parietal pleura by fibrin exudation of varying echogenicity. Metastases to the lungs are only imaged on the lung surface, appearing as discrete 2-3 cm diameter hypoechoic areas without a marked capsule, but are present throughout all lung lobes. Arcanobacterium pyogenes is the most common bacterial isolate from CSPD in adult cattle. Extended treatment with procaine penicillin is generally effective where lesions do not extend more than 5-10 cm above the level on the chest wall indicated by the point of the olearcanon.

KEY WORDS
Ultrasonography, respiratory disease, cattle, diagnosis.

INTRODUCTION
Auscultation is considered an important component of the veterinary clinical examination of farm animals but the accuracy with which it can detect, localise and differentiate prominent lung pathology has been questioned following analysis of sounds recorded over specific lung pathologies defined during ultrasonographic examination. Evidence for the role of auscultation of the lungs in the specific diagnosis of a variety of ruminant lung pathologies can be examined by downloading recorded sounds over specific lung pathologies in peer-reviewed articles accessed via the Internet. Accurate ultrasonographic diagnosis of the nature and extent of lung and pleural lesion(s) is essential before any treatment regimen is proposed and its efficacy assessed based upon evidence. This article describes the common ultrasonographic abnormalities affecting the lungs of adult cattle with chronic respiratory disease and recommends some possible treatment strategies based upon these findings.

MATERIALS AND METHODS
A 5.0 MHz sector transducer connected to a real-time, B-mode ultrasound machine provides diagnostic quality images in adult cattle. A 7 cm wide strip of hair is shaved from both sides of the thorax extending in a vertical plane from the point of the elbow to the caudal edge of the scapula. The skin is soaked with warm tap water then ultrasound gel liberally applied to the wet skin to ensure good contact. The transducer head is firmly held at right angles against the skin overlaying the intercostal muscles of the 6th or 7th intercostal spaces. The ipsilateral forelimb can be held forward to facilitate access to the ventral aspect of the thoracic wall and provide good images of the heart. The dorsal lung field is selected at the start of all ultrasound examinations to visualize normal lung tissue as this area is much less commonly affected by disease processes. The ultrasonographic examinations are made with an initial depth setting of 7 to 10 cm including 2.5 to 3.5 cm of chest wall. Good contact between the transducer head and skin overlaying an intercostal space is evident by the breadth and intensity of the ultrasound image. It is important to visualize normal lung dorsally (bright white line of visceral pleura) before scanning the more ventral areas. Artefacts can readily be created if the field includes the shoulder musculature. If in doubt, follow the visceral pleura down the chest wall and look for the junction between normal and lung pathology artefact. Normal lung extending into pathology is particularly evident in Fig. 10. This paper reports the findings of a study of chronic respiratory diseases in adult cattle encountered in general practice and thereby gives some indication of the relative occurrence of each disease. Ultrasonographic examination of the chest undertaken in 30 adult cattle found no lung abnormality; none was detect-
ed at necropsy. Adult cattle with suspected chronic respiratory disease included chronic suppurative pulmonary disease (20 cases; Fig. 1) dilated cardiomyopathy (2 cases), thymic lymphosarcoma (4 cases) and diffuse fibrosing alveolitis (three cases), fibrinous pleurisy (3 cases), pleural abscesses/pyothorax (5 cases), and metastases to the lungs (2 cases). Cattle with acute respiratory viral diseases such as infectious bovine rhinotracheitis and bovine respiratory syncytial virus, acute bacterial infections such as Mannheimia haemolytica, and lungworm (Dictyocaulus viviparus) infestation were excluded from the study.

RESULTS

Interpretation of ultrasonographic findings

Still images of specific lung lesions observed during the ultrasonographic examination do not convey as much information as continuous observation during scanning but there is presently no facility to display high quality video recordings because file sizes are too large for most Internet servers. Video recordings of the common lung diseases of cattle have been presented at the most recent World Buiatrics Conference. The sonograms are presented with the probe head/chest wall at the top of the image, dorsal is to the right and ventral to the left of the image. Centimetre dot markers are displayed on the margin of the images and should be consulted to ascertain the depth of field presented. An air interface, created by aerated lung parenchyma reflects sound waves and appears as a bright white (hyperechoic) linear echo (Fig. 2). The sonogram below the white linear echo may contain equidistant reverberation artefacts. The area visualized below the linear echo, including the reverberation artefacts, does not represent lung parenchyma thus the initial ultrasound machine setting should be 7 to 10 cms (approximately 3 cms of chest wall) then pleurae, and superficial lung parenchyma.

Normal cattle

The surface of normal aerated lung (visceral or pulmonary pleura) of 30 normal cattle was characterized by the uppermost white linear echo with equally-spaced reverberation artefacts below this line (Fig. 2). In normal adult cattle (around 600kg) the visceral pleura was observed moving approximately 5 mm in a vertical plane during respiration. No pleural fluid was visualized in these normal cattle. The chest wall was approximately 2.5 to 3.5 cm wide.

Normal adult cattle with thoracic ultrasound

Figure 2 - The surface of normal aerated lung (visceral or pulmonary pleura) of normal cattle is characterized by the uppermost continuous white linear echo. Equally-spaced reverberation artefacts may be evident below this line.

Figure 3 - Loss of the continuous white linear echo formed by the normal visceral (pulmonary) pleura (Fig. 2) replaced by hypoechoic areas giving a columnar appearance representing a lobular distribution of lung pathology (consolidation).

Figure 4 - Marked irregularity of the visceral (pulmonary) pleura caused by the presence of superficial lung pathology (lobular consolidation).

Figure 1 - It can prove difficult to differentiate painful lesions involving the pleurae, lungs, heart valves and peritoneum on clinical examination alone.
**Chronic suppurative pneumonia (CSPD)**
There was pronounced columnar irregularity of the white linear echo formed by the normal visceral (pulmonary) pleura in the antero-ventral apical and cardiac lung lobes of 20 cattle with CSPD (Figs. 3-6). There were numerous hypoechoic columns extending 2 to 6 cm into the lung which are bordered distally by bright white (hyperechoic) lines as the sound waves contacted normal aerated tissue deeper within the lung. These columns resulted from the increased sound wave transmission through consolidated lung parenchyma, typically in a lobular pattern, then striking normal lung tissue. Typically, as the probe head was moved ventrally there was an abrupt change from normal lung, represented by the bright hyperechoic visceral pleura, to be replaced by large hypoechoic areas measuring approximately 2 cm in the vertical plane and extending for 2-6 cm into the lung parenchyma. The dorsal margin of this abrupt change in sonographic appearance (Fig. 2 to Figs. 3-6) occurred at the level on the chest wall around 2 to 10 cm above the olecranon of the elbow joint.

Few discrete lung abscesses were observed at necropsy and the hypoechoic areas identified during ultrasonographic examination more commonly represented consolidated lung parenchyma, usually with a distinct lobular appearance, with purulent material within smaller airways (bronchiectasis). Arcanobacterium pyogenes was the most common bacterium isolated from CSPD cases (4 out of 6 cows sampled).

The prognosis was poor when the sonographic changes representative of CSPD extended more than 5 cm above the level of the olecranon of the elbow because this area represented a large amount of lung involved in the disease process. Too few animals have been treated thus far for statistical analysis and this clinical study is still progressing.

**Fibrinous pleurisy**
The visceral pleura (bright linear echo) appeared thicker than normal and displaced 2 to 3 cm from the parietal pleura by an area of varying hypoechogenicity representing fibrin exudation (pleurisy) between the parietal and visceral pleurae. Extensive fibrinous pleurisy in cattle with a hyperechoic fibrin matrix and anechoic background measuring 10 cm deep (Fig. 7) is much less common.

**Pleural effusion**
Extensive pleural effusion was caused by right-sided heart failure in cattle with diffuse fibrosing alveolitis, dilated cardiomyopathy, and thymic lymphosarcoma. In two of three cases of diffuse fibrosing alveolitis the pleural effusion was unilateral. An increasing depth of fluid (anechoic area) separated the pleurae as the probe head was moved down from about the mid point on the chest wall. At the ventral margin of the lung field the effusion extended up to 20 cm (including 3 cm of chest wall). The pleural effusion was readily identified as an anechoic area with dorsal displacement of the ventral margins of the lung lobes (Fig. 8). With extensive effusion, the ventral lung margins were consolidated and had the sonographic appearance of liver (Fig. 8).

**Pleural abscesses**
Unlike sheep, several discrete pleural abscesses are an uncommon finding in cattle. However, a single pleural abscess may extend over time to involve most of one side of the chest and contain 25 to 50 litres of purulent material. The pleurae are separated by a uniform hypoechoic to anechoic area containing many hyperechoic spots representing gas echoes within the abscess (Fig. 9). The presence of these hyperechoic dots within the hypoechoic matrix of an abscess allows immediate differentiation from an effusion which is an uniform anechoic area. Confirmation can be achieved by ultra-
sound-guided thoracocentesis. Ultrasound-guided thoracocentesis can be undertaken in cattle with pleural effusion and pleural abscesses using 4.5 cm (or greater) 19 gauge hypodermic needles. The overlying skin is surgically prepared and the intercostal muscles infiltrated with 2 per cent lignocaine solution five minutes before sampling.

**DISCUSSION**

In most veterinary practice situations provisional diagnoses will continue to be based upon history, clinical examination, response to antibiotic therapy, and in unsuccessful cases by post mortem examination. Evidence for the role of auscultation of the chest in formulating a specific diagnosis of ruminant lung pathologies can be examined by downloading sounds via the Internet recorded over specific lung pathologies.

Elevated fibrinogen and serum globulin concentrations reflect the cow’s response to chronic bacterial infection but such changes are not specific to one particular organ system and further ancillary testing is necessary. As the cost of ultrasonographic examination only involves the veterinarian’s time, enthusiastic clinicians are encouraged to try this technology as part of their clinical investigation in certain situations particularly the cow that present with “thoracic/anterior abdominal pain”. Ultrasonography provides an inexpensive, non-invasive tool with which to examine the pleural surfaces and superficial lung parenchyma. Systematic ultrasound examination of both sides of the chest and the anterior abdomen need only take 5 minutes.

Arcanobacterium pyogenes is the most common bacterial isolate from CSPD in adult cattle and was cultured from material collected from lung abscesses at necropsy in 4 of 6 adult cattle in the present study despite prior antibiotic therapy. A. pyogenes is also a common opportunistic pathogen and a cause of abscessation and pneumonia in sheep. Treatment with procaine penicillin is inexpensive but must be continued for 4-6 weeks because of the time-dependent pharmacokinetics of the drug. Penicillin is non-irritant, well-tolerated and can be given by intramuscular and subcutaneous injection.

**Bibliografía**