

The use of thoracic ultrasonography to aid diagnosis of pneumonia in calves

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Part 1

Bovine respiratory disease (BRD) is highly prevalent amongst dairy and beef heifers. It is the main cause of death in both Holstein dairy calves over 30 days of age and in milk-fed calves. Early diagnosis of BRD must be a priority for the farm and veterinarian. When identified quickly, the risks of irreversible lung damage and long-term effects are reduced, therapeutic success of antimicrobials is maximised, antimicrobial resistance is minimised and recurrence rates are lowered.

Thoracic ultrasound (TUS) technique

Many studies have focused on the use of the thoracic ultrasound technique (TUS) to diagnose BRD. Compared to other diagnostic techniques, TUS has been found to have high sensitivity and specificity.

The key to accurate TUS is a systematic approach. Firstly, it is important to screen both sides of the thorax so pathology is not missed. Secondly, basic knowledge of the external thoracic anatomy of the calf and the internal anatomy of the lung is required to identify the correct ultrasonography landmarks.

The external anatomy of the calf refers to the specific intercostal space (ICS) where the probe is placed (figures 1 and 2).

Figure 1 and 2 demonstrating correct areas for positioning of the ultrasound transducer.

The internal anatomy refers to the specific lung lobes that are being evaluated (figure 3).

The ventral landmarks of the ultrasound image provide a unique identifier for each lung to ensure that the high-risk areas for pneumonia are examined (figure 4 and 5).



Figure 1



Figure 2

Figure 3
Schematic diagram illustrating the bovine lung.

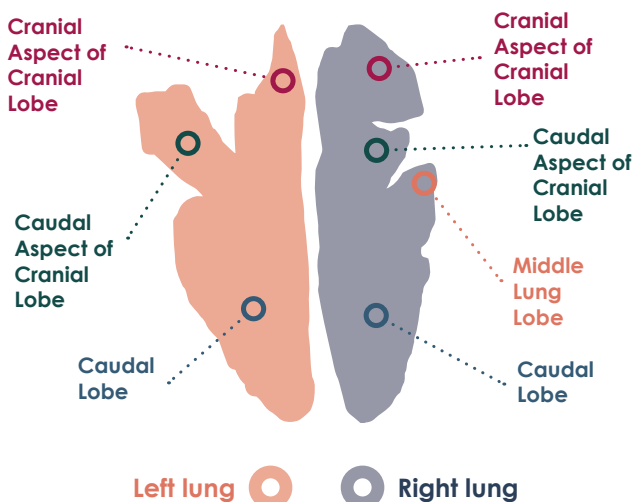


Figure 4
Landmarks for the right lung during ultrasonographic examination.

Lung Lobe

	Caudal	Middle	Caudal Aspect of Cranial Lobe	Cranial Aspect of Cranial Lobe
R-ICS	10 to 6	5	4 to 3	2 to 1
Ventral Landmarks	Diaphragm	CCJ and pleural deviation	Heart	Internal thoracic artery and vein

Abbreviation: R-ICS Right intercostal space, CCJ Costochondral junction
Adapted from Ollivet et al., 2015

Figure 5
Landmarks for the left lung during ultrasonographic examination

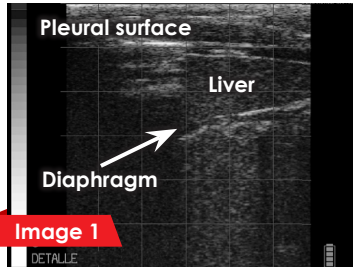
Lung Lobe

	Caudal	Caudal Aspect of Cranial Lobe	Cranial Aspect of Cranial Lobe
L-ICS	10 to 6	5 to 4	3 to 2
Ventral Landmarks	Diaphragm	CCJ and pleural deviation	Heart

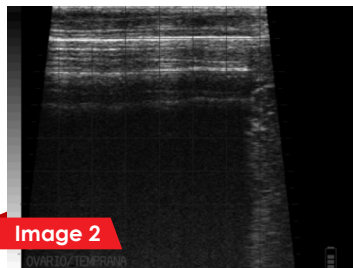
Abbreviation: L-ICS Left intercostal space, CCJ Costochondral junction
Adapted from Ollivet et al., 2015

Landmarks for the right lung US examination

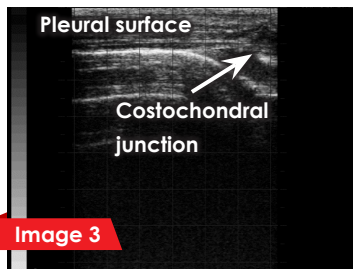
Images are displayed with orientation with respect to patient as described in **Figure 6**



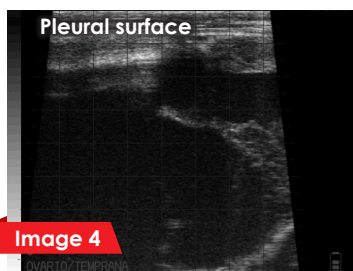
When scanning the right caudal lung lobe from the 10th to the 6th ICS, the diaphragm marks the ventral border of the lung. In this location, the liver can be seen deep to the diaphragm.



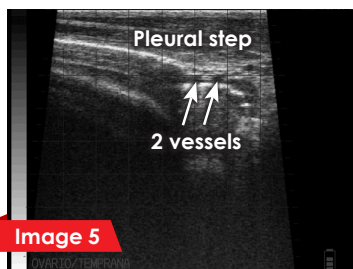
The pleural surface is identifiable as a strong, hyperechoic white line and reverberation artefact beneath the skin. The "pleural glide sign" can be seen as the lung moves in and out of the ultrasonographic window, intermittently obscuring visualisation of liver during respiration. The lateral diaphragm is always hidden by the reverberation artefact and not seen in normal TUS.



The right middle lobe is scanned from the 5th ICS. The costochondral junction appears ventrally in the image (arrow). The pleural surface is slightly deviated due to its depth under the costochondral junction.



The caudal aspect of the right cranial lung lobe is scanned from the 3rd and 4th ICS. The heart is identified in the ventral image.



The cranial aspect of the right cranial lung lobe is scanned from the 2nd and 1st ICS. These two areas image similarly having an obvious step in the pleural surface as the lung moves around the internal thoracic artery and vein (arrows).

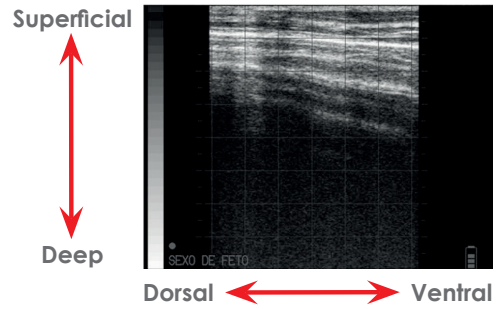
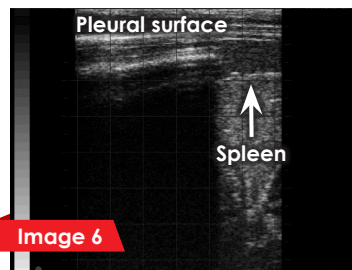


Figure 6

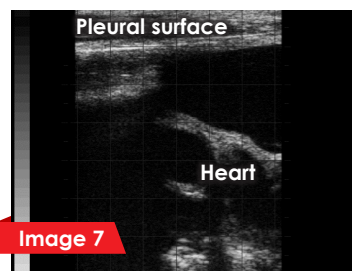
With the probe marker positioned dorsally, the left of the ultrasound screen corresponds to the dorsal aspect of the patient and the right of the screen to the ventral aspect. As with traditional ultrasound images, the near field depicts the superficial tissues while the far field corresponds to the deeper tissues.

Landmarks for the left lung US examination

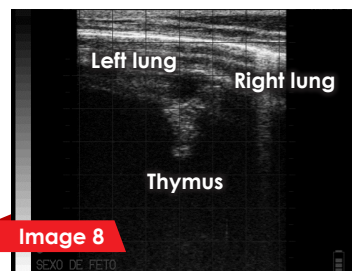
Images are displayed with orientation with respect to patient as described in **Figure 6**



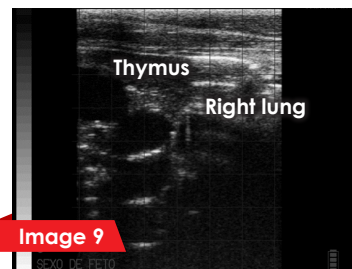
When scanning the left caudal lung lobe from the 10th to the 6th ICS, the diaphragm marks the ventral border of the lung. The spleen is imaged deep to the diaphragm on the left (arrow). As the rumen develops, the caudodorsal lung field becomes smaller and by 4 – 5 months of age, the lung can be seen via TUS in just the 2nd–9th ICS.



The cranial aspect of the left cranial lung is scanned from the 2nd to the 3rd ICS, where the heart is the ventral image landmark.



Occasionally, a small amount of lung can be imaged from the 1st ICS. This area is usually difficult to image and rarely adds useful information. Notice the cranial aspect of the right cranial lung can be imaged as it crosses the thorax in front of the heart from the 2nd ICS. The right cranial lobe extends into the left hemithorax and can be seen in the left 2nd ICS.



In young calves the thoracic portion of the thymus occupies much of the 1st – 2nd left ICS and relatively little lung is seen. Occasionally, the thymus is visible ventrally in the first ICS on the right. Care must be taken not to confuse the thymus with hypoechoic lung consolidation.

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