Echocardiography for the Assessment of Congenital Heart Defects in Calves

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KEYWORDS

• Cardiac • Malformation • Bovine • Imaging • Ultrasonography

KEY POINTS

- Congenital heart disease in calves commonly presents as chronic respiratory disease, failure to thrive, or poor growth.
- The most common congenital heart disease in calves is a ventricular septal defect, either alone or in combination with more complex abnormalities.
- The prognosis for survival varies from guarded to poor and depends on the severity and hemodynamic relevance of the defects, but there is no specific prospective study in calves.

Videos showing echocardiographic examples of congenital heart defects in calves accompany this article at http://www.vetfood.theclinics.com/

OVERVIEW

Congenital heart disease (CHD) in calves is uncommon, being observed in less than 0.2% of all bovine hearts inspected in 2 large necropsy studies.[1,2] A diagnosis of CHD is suspected following a history of ill thrift, poor growth, respiratory disease that fails to respond to appropriate therapy, and/or if a heart murmur is detected on physical examination.[3,4] Echocardiography is the most useful diagnostic test to confirm or rule out the presence of CHD. The detection of the common simple congenital abnormalities (eg, ventricular septal defects [VSDs]) is straightforward, but complex congenital abnormalities can prove more difficult to evaluate and interpretation of the images takes some experience and skill. Familiarity with the normal cardiac anatomy and a logical and standardized approach to the echocardiographic assessment are crucial to confirming a diagnosis of CHD. The authors recommend the

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systematic approach of sequential segmental analysis (SSA) when evaluating calves for CHD.[5]

EQUIPMENT AND SETTINGS

Echocardiography can be performed easily in calves in the field setting as well as the hospital. Despite the cranial location of the heart and the narrow intercostal spaces, echocardiography in calves is more rewarding than with adult cows.

Most calves can be evaluated using a medium-frequency probe (3.4–5 MHz) with a small footprint. A small, phased array probe is preferred, but microconvex, curvilinear, or linear probes can be used as well.

For two-dimensional echocardiography (2DE), the image should be optimized for a frame rate of at least 25 frames per second and typically 30 to 60 frames per second to fully appreciate cardiac motion. Higher frame rates can be achieved by reducing the sector width and imaging depth if necessary. An imaging depth of 10 to 15 cm is adequate for most young calves, whereas a depth of 15 to 20 cm may be necessary in older calves. Only 1 focal zone should be used, which is set to the far field. Tissue harmonics imaging results in a more favorable signal/noise ratio, increases depth of penetration, and improves endocardial border definition and visualization of cardiac structures, but echoes of fine structures such as valves and chordae appear thicker in harmonic imaging.

The 2DE-guided M mode uses a very high frame rate and therefore is capable of recording high-frequency motion (eg, a fluttering valve), which might be missed by the slower sampling rate of a 2DE study. Some echocardiography machines offer anatomic M mode, which can be used to derive M-mode tracings offline from 2DE cine-loop recordings and allows positioning of the M-mode cursor freely on the two-dimensional (2D) image, independent of the sector apex. However, this advantage can only be achieved at the expense of a lower temporal resolution, related to the low recording frame rate of 2DE recordings.[6]

In color Doppler imaging mode, a high frame rate (eg, achieved by narrowing the sector with and imaging depth), a slight reduction of tissue priority settings (favoring color priority), and selection of color maps with variance coding (eg, green coding of turbulent flow) facilitates recognition of intracardiac blood flow patterns. The velocity range is usually set near the maximum possible limits.

In spectral Doppler imaging mode (ie, pulsed-wave and continuous wave Doppler), the power can be reduced by 1 to 2 steps to increase clarity of the Doppler tracing, whereas specific filter settings allow the elimination of low-velocity noise. The velocity scale should be adjusted depending on the expected blood flow velocities to be recorded. More details on equipment and machine settings can be found elsewhere.[7]

A surface electrocardiogram (ECG) should be recorded simultaneously with all echocardiographic recordings for timing of cardiac events. If possible, cine loops containing at least 3 cardiac cycles should be recorded and stored. This method allows for offline measurements at several time points during the cardiac cycle and further evaluation of complex defects using slow motion playback. Still images are less optimal because subtle abnormalities may be difficult to detect.

PATIENT PREPARATION AND RESTRAINT

Young calves can be easily restrained in sternal or lateral recumbency, whereas older calves should be gently restrained standing. Most dairy breeds tolerate this procedure without sedation; however, light sedation may be necessary in older beef calves.