Diagnosis of heart failure in dogs with mitral valve disease

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PHILLIP SPEER reports on a webinar sponsored by Ceva Animal Health discussing canine mitral valve disease by specialists João Loureiro and Simon Dennis.

MITRAL valve disease is the most common form of heart disease in the dog and is known to affect 14 per cent to 15 per cent of adult small breed dogs.

Function and pathophysiology

The cardiovascular system maintains blood pressure and ensures adequate perfusion to the vital organs.

If the blood pressure becomes reduced, this is detected by baroreceptors in the brain, which promote an increase in sympathetic tone and hence an increased heart rate and contractility. If this is still not sufficient to maintain blood pressure, the kidney then produces angiotensin II (which causes vasoconstriction) and aldosterone (which increases fluid reabsorption). While this may help to maintain blood pressure in the short term, in the long term, catecholamines, angiotensin II and aldosterone cause harmful effects such as volume overload (and subsequent pulmonary oedema), fibrosis and cell death.

Heart failure stages

Heart failure has been defined in humans as a “complex clinical syndrome of symptoms and signs caused by impairment of the heart”¹. If an asymptomatic dog, for example, has a heart murmur and
an enlarged heart, it will have heart disease but may not yet have developed heart failure, which is the point when clinical signs develop and treatment is indicated.

In 2009, the American College of Veterinary Internal Medicine (ACVIM) developed a staging system for canine mitral valve disease (Table 1). However, it is important to note heart failure is a continuum (Figure 1) and it can, for example, be difficult to distinguish late stage B2 and early stage C.

**Clinical signs**

The clinical signs of heart failure usually include respiratory difficulty/distress and/or tachypnoea (increased respiratory rate). This can be challenging to assess in a veterinary consultation if the dog is stressed.

However, most normal dogs will have a sleeping or resting respiratory rate at home of 3. By contrast, most dogs with congestive heart failure will have a resting respiratory rate of >35-40 breaths/minute at home and >40-45 breaths/minute in the hospital.

In a trial looking at dogs suspected of having heart failure caused by mitral valve disease, having a respiratory rate of >41 breaths/minute had a sensitivity (ability to correctly identify patients with heart failure) of 92 per cent. Conversely, if the respiratory rate was

Coughing is often described as a symptom of heart failure, although in dogs with mitral valve disease, it is more commonly associated with a large left atrium pushing up on the mainstem bronchus and/or concurrent airway disease. Dogs with pulmonary oedema may also cough. However, since these dogs typically have left atrial enlargement, it is not known whether the cough is the result of the oedema, the left atrial dilatation, concurrent airway disease (if present), or a combination of more than one factor. A recent study has shown that coughing alone is an unreliable sign of heart failure.

Once clinical signs develop, the chronic treatment of heart failure commonly involves angiotensin-converting-enzyme (ACE) inhibitors (which reduce the production of angiotensin II), spironolactone (which blocks the harmful effects of aldosterone), pimobendan (a positive inotrope and vasodilator) and furosemide (a diuretic). However, the clinical signs of heart failure are non-specific and diagnosing whether the clinical signs are caused by heart failure can be difficult.

**Diagnosis**

There is no single test for diagnosing heart failure, which instead often relies on clinical judgement based on a combination of history, physical examination and diagnostic tests (which may include radiography, echocardiography and cardiac biomarkers).
**Physical examination**

On cardiac auscultation, there should be a mitral valve murmur and, if heart failure is present, an increase in the heart rate and loss of sinus arrhythmia. However, both a fast heart rate and absence of sinus arrhythmia can also be present if the dog is stressed in the consultation room. Importantly, the presence of sinus arrhythmia (which indicates low sympathetic tone) generally indicates that heart failure isn't present.

Respiratory assessment is also very useful and, as discussed earlier, will usually detect an increased respiratory rate and effort. Harsh lung sounds/crackles may be present, although crackles can be present with interstitial or alveolar respiratory disease (such as pulmonary fibrosis) and not every case of heart failure will have evident abnormalities on respiratory auscultation. The presence of respiratory crackles with heart failure suggests fairly severe oedema.

**Radiography**

Radiography is one of the most commonly used tools when diagnosing congestive heart failure and is often associated with a triad of clinical signs:

- **Enlarged cardiac silhouette with prominent left atrium**

Heart failure caused by mitral valve disease is typically associated with a left-sided cardiomegaly, particularly left atrial enlargement. Radiographic features of this include increased overall size of cardiac silhouette, left atrial bulge and tracheal elevation.

The vertebral heart scale (VHS) is commonly used to assess heart size. This involves measuring the long axis and short axis of the heart, plotting these against the T4 vertebrae, counting the number of vertebrae and then adding these figures together (Figure 2).

Most dogs have a VHS 2.5 has been shown to provide a 97 per cent accuracy in diagnosing heart failure5.

**Cardiac biomarkers**

The most widely used serum biomarker is N-terminal fragment of the prohormone brain-type natriuretic peptide (NT-proBNP). This is secreted in the heart and released into the circulation in response to left ventricular and left atrial wall stretch and has been shown to help with the diagnosis of heart failure caused by mitral valve disease (Table 3). A prospective multicentred study demonstrated that a value exceeding 1,829 pmol/L in a dog with respiratory signs has a positive predictive value for heart failure of 0.89 (approximately nine out of 10 failure) 7. Since the majority of dogs with heart disease in this study had mitral valve disease, it is not known how accurately this value detects heart failure in dogs with other underlying heart diseases. It is recommended this test
be only interpreted in small breed dogs with mitral regurgitation murmurs and respiratory signs that could be consistent with heart failure.

Overall, the talk was a fascinating overview, highlighting the many challenges and pitfalls associated with diagnosing heart failure. The standard therapies for canine mitral valve disease (ACE inhibitors, spironolactone, pimobendan and furosemide) are all indicated from the onset of heart failure. It is therefore vital a correct diagnosis of heart failure is made, to ensure appropriate treatments are given and that therapy is started at the optimal time.

A recording of the webinar, is available at www.cardioacademy.cevalearn.com

References

**Figure 1.** The stages of heart failure continuum\(^2\).
Speakers João Loureiro (left) and Simon Dennis (right).
Speakers João Loureiro (left) and Simon Dennis (right).
Figure 2. Measurement of the vertebral heart scale."
Figure 3. Lateral thoracic radiograph demonstrating severe cardiomegaly, tracheal elevation, a caudodorsal bulge and a straight caudal border consistent with left atrial enlargement.
**Figure 4.** Dorsoventral thoracic radiograph demonstrating severe cardiomegaly and a 2 to 3 o’clock bulge consistent with left atrial enlargement.
Figure 5. Detail of lateral thoracic radiographs showing a dilated pulmonary vein, which is ventral to the artery on the lateral (left) view and central on the dorsoventral (right) view.
Figure 5. Detail of lateral thoracic radiographs showing a dilated pulmonary vein, which is ventral to the artery on the lateral (left) view and central on the dorsoventral (right) view.
Figure 6. Thoracic radiographs demonstrating an interstitial pattern (left) and alveolar pattern (right).
**Figure 7.** Echocardiography demonstrating the left atrial: aortic ratio in a normal dog (left) and a dog with atrial enlargement (right).
Figure 7. Echocardiography demonstrating the left atrial: aortic ratio in a normal dog (left) and a dog with atrial enlargement (right).
Figure 8. Using the diastolic class to assess with the diagnosis of heart failure.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>Do not have heart disease (no heart murmur) but are genetically at risk, for example cavalier King Charles spaniels, Yorkshire terriers and dachshunds</td>
</tr>
<tr>
<td>B1</td>
<td>Heart disease present (with heart murmur) but no cardiomegaly on echocardiography, radiography or clinical signs</td>
</tr>
<tr>
<td>B2</td>
<td>Heart disease present (with heart murmur) with cardiomegaly on echocardiography, radiography but still no clinical signs</td>
</tr>
<tr>
<td>C</td>
<td>Clinical signs developed, can be further subdivided into: Acute – need hospitalisation Chronic – receive home-based therapy</td>
</tr>
<tr>
<td>D</td>
<td>Refractory cases, which develop signs despite receiving standard therapy (ACE inhibitors, spironolactone, pimobendan and furosemide)</td>
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**Table 1.** The stages of heart failure caused by mitral valve disease, as described in the ACVIM Consensus Statement 2009\(^1\)
Table 2. Vertebral heart scale figures for different breeds.²,⁸

<table>
<thead>
<tr>
<th>Breed</th>
<th>VHS (cm)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shih-tzu</td>
<td>8.4-10.7</td>
<td>VHS &lt;10.7 performs okay</td>
</tr>
<tr>
<td>Dachshund</td>
<td>8.7-10.7</td>
<td></td>
</tr>
<tr>
<td>Yorkshire terrier</td>
<td>8.7-11.1</td>
<td></td>
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<tr>
<td>Lhasa apso</td>
<td>8.0-11.2</td>
<td></td>
</tr>
<tr>
<td>Pomeranian</td>
<td>8.7-12.3</td>
<td>VHS &lt;10.7 works poorly</td>
</tr>
<tr>
<td>Pug</td>
<td>8.9-12.5</td>
<td></td>
</tr>
<tr>
<td>Boston terrier</td>
<td>8.9-14.5</td>
<td></td>
</tr>
<tr>
<td>Bulldog</td>
<td>9.3-16.1</td>
<td></td>
</tr>
</tbody>
</table>

- <900 pmol/l: Likelihood that clinical signs are due to heart failure is low.
- 900 - 1,800 pmol/l: Results equivocal and do not allow us to differentiate between clinical signs due to heart failure versus other causes.
- >1,800 pmol/l: Likelihood that clinical signs are due to heart failure is high.
**Table 3.** Interpretive criteria for assessing NT-pro BNP\textsuperscript{11}