©Copyright reserved

# Feline Cardiomyopathy - Part 2

Dr J Pieter Hanekom, Hillcrest Veterinary Hospital

## Introduction

Part two of this article will focus on the echocardiographic appearance of the feline cardiomyopathies, emphasising its relevance to the general practitioner.

Although there is a summary of the standard views and basic measurements, refer to the literature on how to perform a basic echocardiographic examination.

## Views and basic measurements

It is good practice to obtain all the standard echocardiographic views for each patient. However, right-sided views are generally easier to obtain and are most relevant for the general practitioner.

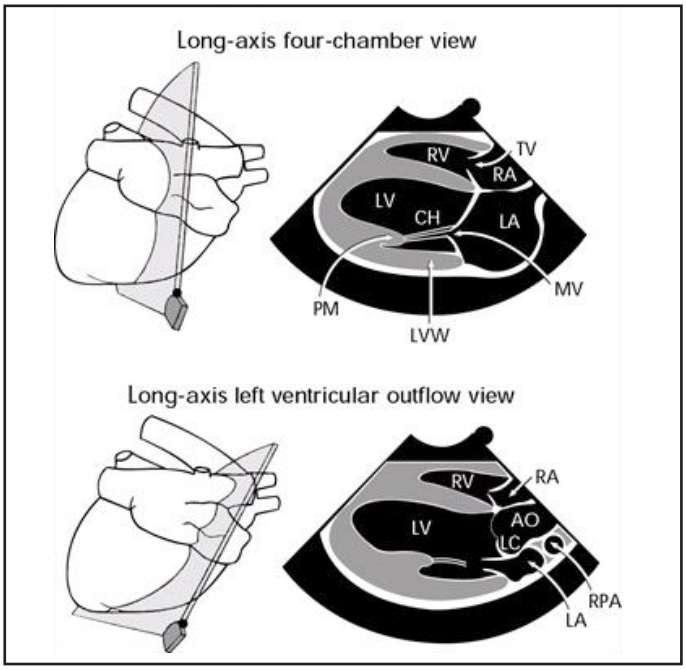
These are where the basic measurements are made (as opposed to left-sided views primarily used for Doppler studies and required to perform a best practice scan).

A summary of the views and what they are used for is given in the table below:

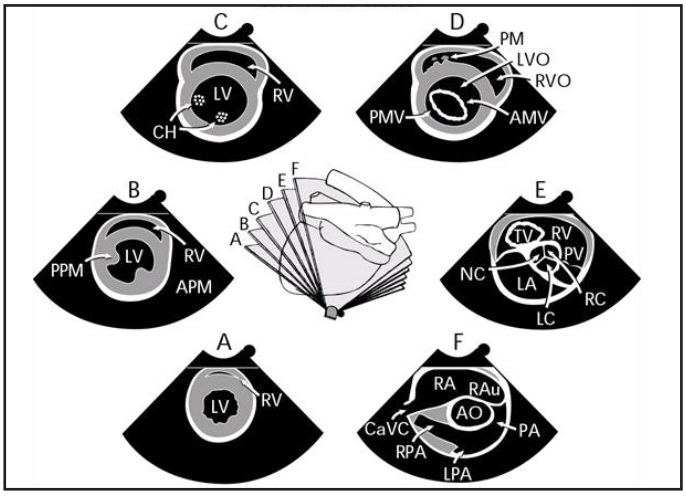
| View: | Used for: |
|---|---|
| RPS LA 4 chamber | Subjective assessment of ventricular & atrial function, 2D measurement of LA, evaluate and measure wall thickness |
| RPS LA outflow | Subjective assessment of LV function, evaluate for SAM of the mitral valve, evaluate aortic valve |
| RPS SA papillary muscle level | Evaluate ventricular wall and IVS thickness, papillary muscles, evaluate RV size & function, M-mode of LV |
| RPS SA mitral valve level | Evaluate LV wall motion & thickness, evaluate mitral valve, M-mode of mitral valve |
| RPS SA aortic cusp level | Evaluate LA size, evaluate aortic valve, 2D and m-mode measurement of LA and aorta |
| RPS SA RV outflow tract | Evaluate RV outflow tract, pulmonic valve and pulmonary artery |
| Left apical 4 chamber | Evaluate mitral & tricuspid valve, Doppler evaluation of valve regurgitation and ventricular filling |
| Left apical 5 chamber | Doppler evaluation of mitral regurgitation and LV outflow tract |
| M-mode - Papillary muscle level | From R LA or SA views: evaluate LV wall & IVS thickness and systolic function, measure LV internal dimensions |
| M-mode - Mitral valve level | From R LA or SA views: Evaluate mitral valve motion and SAM |
| M-mode - Aortic cusp level | From R LA or SA views: Evaluate aortic valve, L atrial size |

***Abbreviations: ARVC - arrythmogenic right ventricular cardiomyopathy, DCM - dilated cardiomyopathy, DLVOTO - dynamic left ventricular outflow tract obstruction, EPSS – E-point to septal separation, HCM - hypertrophic cardiomyopathy, IVSd - interventricular septum diastole, LA:Ao - left atrium: aorta ratio, LA - left atrium, LA FS% - left atrial fractional shortening percentage, LV FS % - left ventricle fractional shortening percentage, LVFWd - left ventricular free wall diastole, LVFWs – left ventricular free wall systole, LVIDd - left ventricular internal diameter diastole, LVIDs - left ventricular internal diameter systole, LVNC - left ventricular non-compaction, RCM - restrictive cardiomyopathy, RPS LA - right parasternal long axis, RPS SA - right parasternal short axis, SAM - systolic anterior motion, UCM - unclassified cardiomyopathy***

**Right parasternal location**




**Short-axis views**



Reference intervals for feline cardiac measurements are available but have generally been derived from older M-mode studies and did not include body weight as a factor. More recent studies have shown that body weight can significantly impact measurements, and tables reflecting measurements for varying body weights have been published. A standard of care scan involves the following measurements: Measure in 2D views - IVSd, LVFWd, LVIDs and LVIDd, LA:Ao ratio, LA diameter. Measure in M-mode - IVSd, LVFWd, LVIDd and LVIDs, calculate LV FS% and LA FS%. Also, note papillary muscle hypertrophy, observe for SAM of the mitral valve, presence of spontaneous echo-contrast or thrombus formation. End-diastolic (beginning of QRS complex on ECG) wall thickness of the IVS and LV posterior wall should be measured in multiple locations on the right parasternal (RPS) long axis and short axis 2D views as Hypertrophy may be regional. End-diastolic and end-systolic LV internal diameter is measured from M-mode and 2D views. LA systolic diameter is measured on the right parasternal long-axis and short-axis views. On a short axis view that includes the aortic valve cusps, measure the LA and aortic diameters at the first frame following aortic valve closure and calculate the left atrial-to-aortic root diameter ratio (LA:Ao, N=< 1.5). LA fractional shortening can be measured using an M-mode view of the same right parasternal short-axis view used for calculating the LA:Ao ratio. M-mode in different planes: One at the level of papillary muscles to obtain IVS and LV free wall thickness in end-diastole and LV internal dimensions in systole and diastole, the other at mitral valve level to observe for SAM. Also, use the right parasternal long axis outflow view to evaluate SAM. The left apical 4 chamber view is best to assess trans-mitral and trans-tricuspid flow patterns.

**Hypertrophic cardiomyopathy (HCM)**

Hypertrophic cardiomyopathy is the most common cardiomyopathy in cats and is characterised by concentric Hypertrophy of the ventricular walls resulting in diastolic dysfunction (Figure 1, RPS SA M-mode). It is a diagnosis of exclusion once secondary causes of Hypertrophy (systemic hypertension, hyperthyroidism, acromegaly) have been ruled out. The LV wall thickening may be regional or affect the whole ventricle. It is thus essential to examine the whole heart in several 2D images and ensure that papillary muscles are not included when measuring.

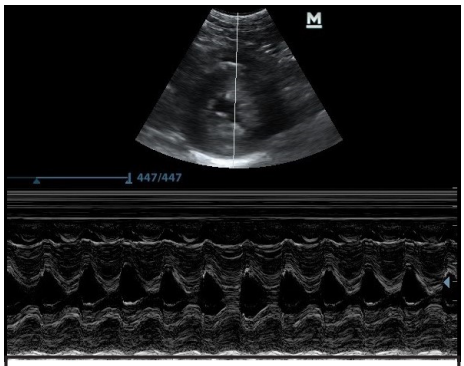



***Figure 1***

Generally, a measurement of the LV wall or IVS in diastole of ≥ 6mm is regarded as abnormal. Papillary muscle enlargement is frequently observed and, in some cats, can be the only indication of the presence of HCM. LA dilation is usually present. Systolic anterior motion (SAM) of the mitral valve is present in some cats with HCM and can result in dynamic left ventricular outflow obstruction (DLVOTO).

Normally the mitral valve sits in a position away from the LV outflow tract during systole, but in cases of SAM, the septal leaflet of the valve is pulled into the outflow tract by the hypertrophied papillary muscles, causing an obstruction.

The movement of the mitral valve can be followed on the long axis and short axis 2D views. Color-flow Doppler can demonstrate a bi-lobed turbulent jet, one going into the LA and one into the aorta.

Figures 2 and 3 are subsequent frames of RPS long axis outflow views of a cat with HCM and SAM. During systole, the septal leaflet of the mitral valve can be observed touching the IVS (white arrow = septal leaf of the mitral valve, red arrow = aorta, blue arrow = left atrium)

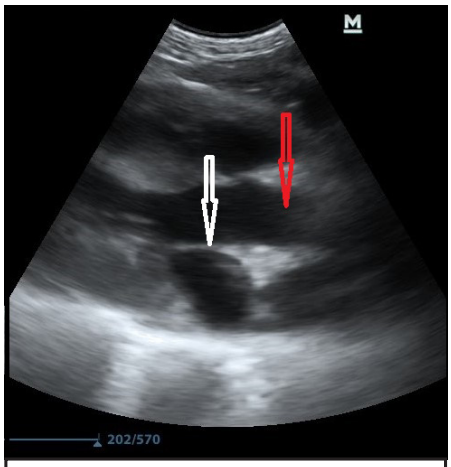



***Figure 2***

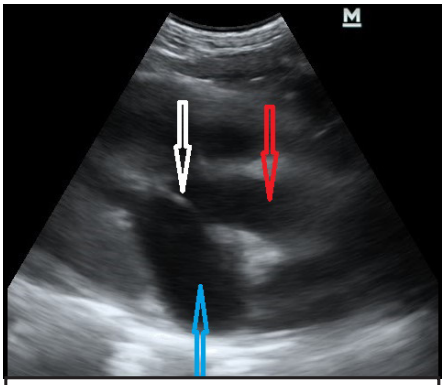



***Figure 3***

**Restrictive cardiomyopathy (RCM)**

Restrictive cardiomyopathy is the second most common cardiomyopathy in cats and can be further divided into a myocardial and endomyocardial forms.

This disease also results in diastolic dysfunction.

There is a "restrictive" filling of the LV, meaning that ventricular compliance reduction results in increasing LA pressure (and progressive dilation).

In the endomyocardial form, there is thickening and fibrosis of the endocardium and sometimes the adjacent myocardium, which appears as an opaque, white/grey film covering portions of the LV. Some cases also have trabecular or irregular broad, fibrous bands that bridge the LV free wall, papillary muscles and IVS. Figure 4 is an RPS LA view demonstrating a wide fibrous band across the LV (white arrow).

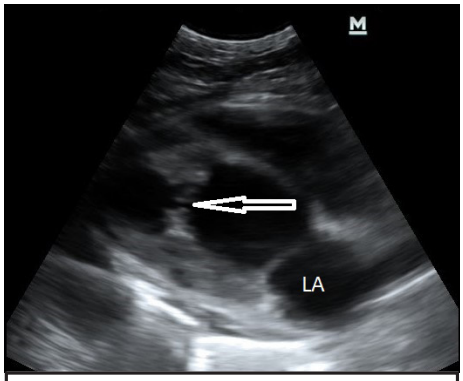



***Figure 4***

However, the more common presentation is the myocardial form, where the LV appears normal, and there is a large LA or commonly bi-atrial dilation (Figure 5).

There is neither concentric nor eccentric Hypertrophy of the ventricles.

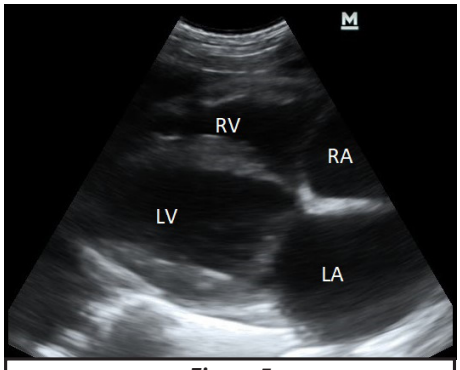



***Figure 5***

If diastolic dysfunction of the LV can be proven (with a Doppler study and probably not possible for the general practitioner), then this may be classified as RCM.

If diastolic dysfunction is not explicitly demonstrated, RCM may be suspected, but it would be correct to use the term unclassified cardiomyopathy (UCM).

**Dilated cardiomyopathy (DCM)**

Dilated cardiomyopathy was once the most common cardiomyopathy in cats, but since the discovery of the role of taurine in this disease, it has become rare. However, cases still present, and they are by no means always taurine deficient. The hallmark of this disease is systolic dysfunction of the LV, characterised by decreased contractility and secondary compensatory ventricular dilation (eccentric Hypertrophy).

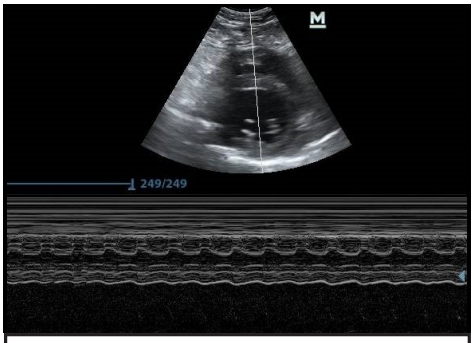



***Figure 6***

There is an increase in diastolic and systolic LV internal diameters with fractional shortening reduced below 25%. Mitral valve movement is often diminished, resulting in increased EPSS (>4mm), and mitral regurgitation may occur.

The left side only or both sides may be affected. Figure 6 is an RPS SA M-mode view of a cat with DCM demonstrating the reduced contractility and low fractional shortening of the LV.

**Arrythmogenic right ventricular cardiomyopathy (ARVC)**

ARVC is a rare form of cardiomyopathy in cats. It is the "Boxer cardiomyopathy" of cats and is characterised by RA and RV dilation. The cause in cats is unknown, but in Boxers, it is due to mutations in the genes that encode for proteins in the desmosome.

The right ventricular myocardium is destroyed and replaced by fibrous and fatty tissue. There is secondary tricuspid valve annulus dilation leading to tricuspid valve regurgitation. The first detection often occurs when an adult or older cat presents with ascites. Figure 7 is an RPS LA view demonstrating the extensive RA and RV.

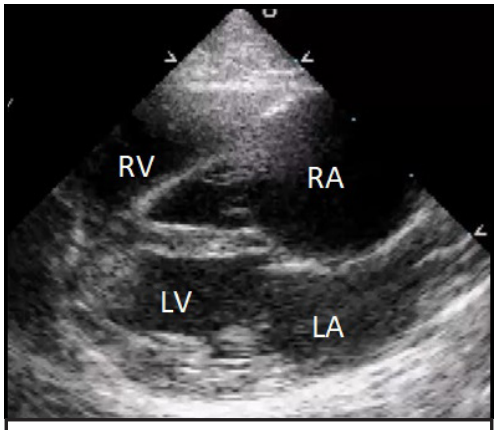



***Figure 7***

**Other cardiomyopathies**

Left ventricular non-compaction cardiomyopathy (LNVC) is thought to be a form of arrested development of the embryonic myocardium. The endocardium is trabeculated to increase the surface area and allow oxygenation in the embryo.

As embryogenesis proceeds, the myocardium undergoes a process of compaction and becomes the normal dense ventricular walls. Failure of this process is termed ventricular non-compaction (Figure 8).

Endocardial fibroelastosis (EFE) has been documented in Siamese and Burmese cats, but it is not clear if this is a separate disease from the endomyocardial form of RCM or not.



***Figure 8***

**Conclusion**

When evaluating for feline cardiomyopathy, it is always preferable to have a best practice echocardiogram performed by a specialist and ideally by a veterinary cardiologist.

However, since that is not always possible or feasible, the general practitioner should be aware of the different forms of feline cardiomyopathy and their main echocardiographic characteristics and should at least be able to perform a point of care scan.

**References**


1. Abbot JA, Maclean HN, Two-Dimensional Echocardiographic Assessment of the Feline Left Atrium, J Vet Intern Med 2006;20:111-119
2. Armbrust L, Variablity of Feline Thoracic Imaging, Wild West Veterinary Conference, 2018
3. Barr F, Gaschen L, BSAVA Manual of Canine and Feline Ultrasonography, BSAVA, 2012
4. Borgeat K, Feline Cardiomyopathy: An update and review of recent understanding, WSAVA Congress, 2018
5. Brister J, Cardiomyopathy Restrictive (Feline), VINCyclopedia of Diseases
6. Brister J, Lake-Bakaar G, Heart Failure, left sided, VINCyclopedia of Diseases
7. Campbell FE, Kittleson MD, The Effect of Hydration Status on the Echocardiographic Measurements of Normal Cats, J Vet Intern Med 2007 Sep-Oct;21(5):1008-15
8. Cote E, Uncommon Feline Cardiomyopathies, ABVP, 2018
9. Fuentes L, Abbott J, Chetboul V, Cote E, Fox R, Haggstromm J, Kittelson D, Schober K, Stern J, ACVIM consensus statement guidelines for the classification, diagnosis and management of cardiomyopathies in cats, J Vet Intern Med 2020;1-16
10. Fuentes L, Rush J, Glaus T, et al, Efficacy of Pimobendan in Cats with Hypertrophic Cardiomyopathy and previous Congestive Heart Failure, ACVIM, 2019
11. Fuentes VL, Swift S, BSAVA Manual of Small Animal Cardiorespiratory Medicine and Surgery, 1998
12. Haggstrom J, Anderson AO, Falk T, et al, Effect of Body Weight on Echocardiographic Measurements in 19866 Pure-bred cats with or without heart disease, J Vet Intern Med 2016;30:1601-1611
13. Karsten S, Savino S, Yildiz V, Reference intervals and allometric scaling of two dimensional echocardiographic measurements in 150 healthy cats, J Vet Med Sci 79(11): 1764-1771, 2017
14. Kittleson D, Rishniw M, Pimobendan, Medical FAQs, Veterinary Information Network (VIN)
15. Lake-Bakaar G, Cardiomyopathy, Dilated (Feline), VINcyclopedia of Diseases
16. Lake-Bakaar G, Kittleson M, Cardiomyopathy, Hypertrophic (Feline), VINcyclopedia of Diseases
17. Miller M, Feline Myocardial Disease: Thick Hearts, Thin Hearts and Clots, Southwest Veterinary Symposium, 2018
18. Payne JR, Borgeat K, Connolly DJ, Boswood A, Dennis S, Wagner T, Menaut P, Maerz I, Evans D, Simons VE, Brodbelt DC, Dunetes L, Prognostic Indicators in Cats with Hypertrophic Cardiomyopathy, J vet Intern Med 2013;27:1427-1436
19. Silva AC, Muzzi RAL, Oberlender G, Nogueira RB, Muzzi LAL, Feline Hypertrophic Cardiomyopathy: an Echocardiographic Approach, Arch Med Vet 45: 1-6, 2013
20. Smith E, Caring for cats with cardiomyopathies, DVM 360, 2019
21. Rishniw M, Feline murmurs and Gallop Sounds, Medical FAQs, Veterinary Information Network (VIN)
22. Oldach M, Ueda Y, Ontiveros ES, Fousse SL, Harris SP, Stern JA, Cardiac Effects of a single dose of Pimobendan in cats with Cardiomyopathy; A randomised, placebo-controlled, crossover study, J Front Vet Sci 6:15
23. Orvalho JS, Feline cardiomyopathies: Not always HCM, Wild West Veterinary Conference, 2018
24. Porciello F, Cardiomyopathies in the Cat; Echocardiography of the Dog, Cat and Horse, 2019
25. Porciello F, Echocardiographic Measurements and Indices of Cardiac Function, Echocardiography of the Dog, Cat and Horse, 2007
26. Strickland KN, Left Atrial Global Shortening Fraction in cats with Cardiomyopathy, ACVIM, 2001
27. Oldach MS, Stern J, Ueda Y, Ontiveros E, Guther-Harrington C, Visser L, Acute Pharmacodynamic Effects of Pimobendan in 22 client-owned cats with Hypertrophic Cardiomyopathy, ACVIM 2019
28. Ward JL, Kussin E, Tropf MA, Tou SP, Defrancesco TC, Keene BW, Retrospective Evaluation of the safety and tolerability of Pimobendan in Cats with obstructive versus nonobstructive hypertrophic cardiomyopathy, 29th ECVIM-CA Congress, 2019

# MULTIPLE-CHOICE QUESTIONS

**QUESTION 1**

**Which statement is false? The RPS LA 4 chamber view is used for:**

a. Subjective assessment of ventricular and atrial function
b. Measurement of LV wall and IVS thickness
c. 2D measurement of the LA
d. Evaluation of mitral valve morphology and movement
e. Evaluation of the pulmonic valve

**QUESTION 2**

**The following view is used to calculate the LA:Ao ratio:**

a. RPS long-axis 4 chamber view
b. RPS short-axis view
c. Left apical 4 chamber view
d. M-mode at mitral valve level
e. None of the above

**QUESTION 3**

**Diastolic dysfunction is associated with:**

a. Hypertrophic cardiomyopathy
b. Dilated cardiomyopathy
c. Restrictive cardiomyopathy
d. a and c
e. b and c

**QUESTION 4**

**Which statement about cardiac measurements is false?**

a. Body weight does not influence measurements in cats
b. Often preferable to measure wall thickness in 2D rather than M-mode
c. LA diameter can be measured from an RPS 4 chamber long-axis view
d. Normal LA:Ao ratio is less than 1.5
e. LA diameter can be measured from an RPS short-axis view

**QUESTION 5**

**Regarding LV FS%, which statement is false?**

a. Typically decreased in cases of DCM
b. Calculated from two measurements: LVIDd and LVIDs
c. Is a measurement of ventricular systolic function
d. Typically normal in cases of RCM
e. None of the above

**QUESTION 6**

**Which statement regarding HCM is false?**

a. Characterised by concentric Hypertrophy
b. Hypertrophy may be regional and asymmetric
c. SAM is a consistent feature
d. Atrial dilation is commonly present
e. DLVOTO may be present

**QUESTION 7**

**Which statement regarding RCM is false?**

a. There is no concentric or eccentric hypertrophy of the ventricles
b. There is a myocardial and endomyocardial form
c. There may be fibrous bands spanning the LV
d. There is usually substantial atrial dilation
e. None of the above

**QUESTION 8**

**Which statement about DCM is true?**

a. It is the most common feline cardiomyopathy
b. There are decreased LVIDd and LVIDs diameters
c. Fractional shortening is increased above normal
d. Thrombotic masses may be found in the left atrium
e. The EPSS is often decreased

**QUESTION 9**

**Which statement about ARVC is false?**

a. The myocardium is replaced by fat and fibrous tissue
b. Often results in ascites
c. There is RA and RV dilation
d. Dysplasia of the tricuspid valve is a differential
e. None of the above

**QUESTION 10**

**Which statement about LVNC is false?**

a. An extremely rare form of feline cardiomyopathy
b. Thought to be a form of arrested embryonic development
c. The myocardium in the embryo is trabeculated
d. Myocardial compaction during embryogenesis is abnormal
e. None of the above

**SAVC CPD Accreditation Code:**
**AC/0378/20**
**To answer the questions and obtain your CPD points for this article visit the Online On Demand Journals page on www.veted.online.**