

Feline cardiomyopathies: aetiology and breed predisposition

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DEFINITION

Cardiomyopathy, or heart muscle disease, describes a heterogeneous group of conditions that affect the heart muscle functionally and/or structurally.

The primary cardiomyopathies are idiopathic, and no underlying disease can be identified. The secondary cardiomyopathies are a consequence of underlying pathology (Table 1).

CLASSIFICATION

The World Health Organisation classifies human cardiomyopathies into idiopathic (dilated, hypertrophic, restrictive, arrhythmogenic) and specific (hypertensive, endocrine, metabolic, ischaemic)

Dr Fox has more appropriately classified feline cardiomyopathies by morphological phenotype (hypertrophic or dilated), by aetiology (primary idiopathic or secondary), by type of myocardial dysfunction (systolic and/or diastolic), by pathological findings (e.g. infiltrative cardiomyopathy) or by the underlying pathophysiology (e.g. restrictive cardiomyopathy).

Hypertrophic cardiomyopathy (HCM) is predominantly (but not only) a disease of the left heart characterised by

inappropriate symmetrical or asymmetrical concentric hypertrophy of the ventricular myocardium. Often the initial hypertrophy only involves papillary muscles (Fig. 1). In some subcategories hypertrophy of the interventricular septum causes dynamic obstruction of the left ventricular outflow tract (hypertrophic obstructive cardiomyopathy) (HOCM). The histopathological hallmark of HCM is myocyte disarray.



Fig. 1: Echocardiographic short-axis view of a hypertrophied left ventricle with severe thickening of the papillary muscles.

Restrictive cardiomyopathy (RCM) indicates that ventricular restriction by endocardial stiffness causes diastolic dysfunction. Increased ventricular filling pressure

is followed by severe biatrial enlargement with normal ventricular wall thickness (Fig. 2). Two types of RCM are recognised in cats: the myocardial form (most prevalent) and the endomyocardial form (rare).



Fig. 2: Post-mortem specimen of feline restrictive cardiomyopathy (severe atrial enlargement).

contractility) of the ventricular myocardium leading to progressive dilation of first the ventricle(s) and later the atria (Fig. 3).



Fig. 3: Echocardiographic long-axis view of DCM in a cat.

The **dilated form of cardiomyopathy** (DCM) is characterised by impaired systolic function (loss of

Arrhythmogenic right ventricular cardiomyopathy (ARVC) is characterised by partial or total fibrous and/or fatty replacement of the right ventricular and atrial wall, and to a lesser extent the interventricular septum and the left ventricular wall. Characteristic changes include marked right ventricular (sometimes aneurysmal) dilation and right atrial enlargement (Fig. 4). Histopathologically two

TABLE 1: Aetiology of feline cardiomyopathies

Primary idiopathic	
Hypertrophic cardiomyopathy (HCM)	
Restrictive cardiomyopathy (RCM)	
Unclassified cardiomyopathy (UCM)	
Dilated cardiomyopathy (DCM)	
Arrhythmogenic right ventricular cardiomyopathy (ARVC)	
Secondary	
Genetic	
Metabolic:	hypertension uraemia
Endocrine:	hyperthyroidism diabetes mellitus acromegaly (rare) hyperadrenocorticism (extremely rare)
Nutritional:	taurine deficiency obesity
Infiltrative:	neoplasia (lymphoma) glycogen storage disease (rare) mucopolysaccharidoses (rare)
Neuromuscular:	muscular dystrophies
Infectious/inflammatory:	FIP - toxoplasma parvovirus? endomyocarditis
Others:	ischaemic moderator band cardiomyopathy atrial cardiomyopathy (persistent atrial standstill) toxic: doxorubicin (less toxic than in dogs) endocardial fibro-elastosis

groups can be differentiated: the predominant fibro-fatty form and the less common form with fatty myocardial replacement.



Fig. 4: Echocardiographic long-axis view of the aneurysmal dilation of the right ventricle in a cat with ARVC.

Atrial cardiomyopathy is characterised by progressive destruction of the atria associated with atrial standstill.

However, one has to be aware that many feline cardiomyopathies do not fit in any of these groups or overlap between different groups. Therefore a group of **unclassified cardiomyopathies** (UCM) has arisen (Fig 5).

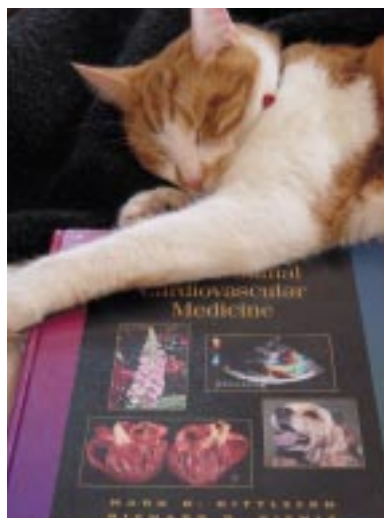


Fig. 5: Cats do not read the textbooks.

AETIOLOGY

The aetiology of many feline cardiomyopathies remains unknown and these are therefore classified as idiopathic (Table 1). However, there are also many secondary forms (Table 1), where reversible myocardial changes may be present.

The cause of **primary HCM** has still to be elucidated. In humans several sarcomeric gene mutations have been identified and in cats there is also strong evidence for a sarcomeric genetic mutation (autosomal dominant inheritance pattern possibly modified by modifier genes or

by environmental triggers). Interesting work by Kittleson and others (1992) has suggested a potential aetiological role for excessive growth hormone secretion in some cases.

Both forms of **RCM** are idiopathic. The endomyocardial form has been associated with an endomyocarditis in some cases. Recently parvoviral genomic material has been isolated in some feline hearts with RCM (and HCM).

In cats taurine deficiency used to be the most common reason for developing **DCM**. Taurine is an essential amino acid for cats and inappropriate intake (e.g. home made diet, dog food) and/or predisposing factors for taurine depletion (urinary acidification and K⁺ depletion) are predisposing factors. Taurine deficiency can cause or contribute to the development of myocardial failure. The exact mechanism of the secondary cardiomyopathy remains unknown but taurine's beneficial action has been related to its modulatory effects on angiotensin II, its stimulatory function on salt and water excretion and its direct positive inotropic and lusitropic mechanisms. Taurine deficiency is also a cause of central retinal degeneration.

In humans with **ARVC** the discovery of a deletion in the plakoglobin (key component of desmosomes and adherens junctions) gene has suggested that the proteins involved in cell-cell adhesion may play an important role in myocyte disintegration and hence cell death and fibro-fatty replacement. It has also been suggested that early inflammation may lead to fibrosis and scarring.

The aetiology of **atrial cardiomyopathy** remains unknown.

PREVALENCE

Feline cardiomyopathies develop at any age and in any breed, including the moggy. However, there is a known breed predisposition for certain types (Table 2). **HCM** is now the most common feline cardiomyopathy. The non-obstructive form is more common than the obstructive form. **RCM** is seen in all breeds of all ages. **DCM** has nearly disappeared completely with adequate taurine supplementation of the commercial cat foods. **ARVC** seems to be an emerging disease although it is possible that formerly many cats that supposedly had tricuspid dysplasia were misdiagnosed.

CHARACTERISTICS OF SOME SECONDARY FORMS

Hyperthyroidism is the most common endocrine disorder in cats and is associated with multiple cardiovascular abnormalities including arrhythmias, secondary HCM, hypertension and congestive heart failure. The echocardiographic features of cats in a hyperthyroid state

can vary but most commonly a combination of mild ventricular hypertrophy, left ventricular dilation (eccentric hypertrophy, Fig. 6) and left atrial enlargement are seen.

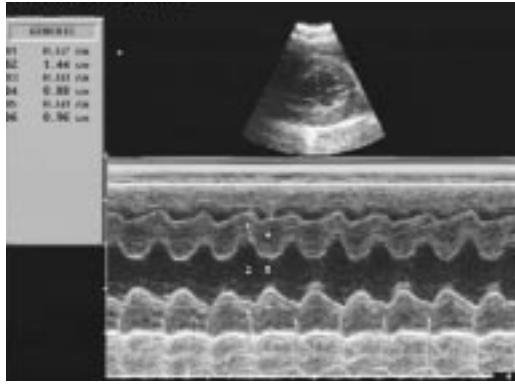


Fig. 6: Echocardiographic M-mode view of eccentric hypertrophy in a cat with hyperthyroidism.

Systemic hypertension is associated with a variety of systemic diseases in cats (eg. chronic renal failure, hyperthyroidism, idiopathic systemic hypertension). Hypertensive cats have a thicker interventricular septum and left ventricular free wall (both in diastole and systole) compared to normal cats. The pathological features of hypertensive HCM might be difficult to distinguish from idiopathic HCM. The aortic root is often increased in diameter.

FURTHER READING AND REFERENCES

KITTLESON and OTHERS (1992) Increased serum growth hormone in feline HCM. *JVIM* 6 (6): 320-4.

KITTLESON and KIENLE (1998) *Small Animal Cardiovascular Medicine* (Mosby).

FOX, SISSON, MOISE (2000) *Textbook of canine and feline cardiomyopathy* (WB Saunders).

TABLE 2: Breed predisposition for certain feline cardiomyopathies

Type	Breed	Gender	Age
HCM	Maine coon	Male>female	All ages, as young as 3 months old. Males often less than 2 years old and females less than 3 years old.
	American Shorthair	Male>female	All ages, mainly young
	Persian	Male>female	All ages, mainly young
	Cornish Rex	Male>female	
	Ragdoll	Male>female	Less than 1 year old
	British Shorthair	Male=female	All ages, mainly young
RCM	None known	Male=female	Middle age and older
ARVC	All breeds	?	All ages
DCM	Abyssinian	Male>female	All ages but mostly middle-aged
	Siamese	Male>female	
	Burmese	Male>female	
Moderator band	Persian	?	All ages
Persistent atrial standstill	Burmese	?	?

These multiple choice questions are based on the above text. Readers are invited to answer the questions as part of the RCVS CPD remote learning program. Answers appear on the inside back cover. In the editorial panel's view, the percentage scored, should reflect the appropriate proportion of the total time spent reading the article, which can then be recorded on the RCVS CPD recording form.

1. Which statement is false regarding Idiopathic HCM in the cat :

- Male predominance is seen in most but not all affected breeds.
- There is strong evidence for a sarcomeric genetic mutation.
- It has been associated with taurine deficiency.
- There is an autosomal dominant inheritance pattern in many breeds.
- It is mostly a disease of the left heart.

2. Which statement is false regarding Idiopathic RCM in the cat:

- It is an uncommon disease.
- It is mostly a disease of the left heart characterised by inappropriate concentric hypertrophy of the ventricular myocardium.
- The cause of primary RCM in cats remains unknown.
- RCM is seen in all breeds of all ages.
- Two types of RCM are recognised in cats: the myocardial form (most prevalent) and the endomyocardial form (rare).

3. Which statement is false regarding DCM in the cat:

- DCM has almost disappeared completely with adequate taurine supplementation of commercial cat foods.
- Abyssinian, Siamese and Burmese seem to be predisposed breeds.
- It can be associated with hypertension.
- Systemic taurine deficiency used to be the most common aetiology; these days the idiopathic form is the most common form.
- DCM is characterised by impaired systolic function (loss of contractility) of the ventricular myocardium.

4. Which statement is false regarding ARVC in the cat:

- It is an emerging disease.
- Right ventricular aneurysmal dilation is a nearly pathognomonic finding.
- It is a very common form of cardiomyopathy in the cat.
- It can easily be mistaken for tricuspid dysplasia.
- No breed predilection is known.

5. Which statement is false regarding HCM in the cat:

- Systemic hypertension is a common cause of secondary HCM.
- Hypothyroidism is a common cause of secondary HCM.
- In some subcategories hypertrophy of the interventricular septum can cause dynamic obstruction of the left ventricular outflow tract.
- It has been suggested that excessive growth hormone secretion might have a potential aetiological role in some cases.
- The pathological features of hypertensive HCM might be difficult to distinguish from idiopathic HCM.

