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FELINE HEART DISEASE: PREVALANCE, RISK FACTORS, AND STAGING

K.H. Khor^{1,*}, A. Zakaria and A. Rasedee¹

¹Faculty of Veterinary Medicine, Universiti Putra Malaysia, UPM Serdang, Selangor, Malaysia

²Department of Veterinary Services, Ministry of Agriculture and Agro-Based Industry, Putrajaya, Malaysia

SUMMARY

Heart disease in cats can lead to congestive heart failure if untreated. This retrospective study on feline heart disease was conducted at University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) using data collected for the period of 2013 to 2015. In this study, the prevalence of cats with heart disease was 1% ($n=155/15,493$) and the cases diagnosed were on the increase during that period. The mean age of feline heart disease patients were 5.2 years with age range of 2-month to 20-year-old. Male (57%) were more often diagnosed with heart disease than female (43%) cats. The two most common breeds of cats presented with heart diseases were Domestic Shorthair (54%) and Persian (26%). Ten of 155 cat patients diagnosed with heart diseases were asymptomatic while the rest were presented with various clinical signs predominantly of congestive heart failure. Most cats were diagnosed with acquired heart diseases (98%) with hypertrophic cardiomyopathy as the most prevalent (51%), followed by dilated cardiomyopathy (19%), restrictive cardiomyopathy (15%), and various other types of heart disease (pericardial effusion, aortic insufficiency, heart base tumor, and feline heartworm disease) (6%), and myocarditis (7%). Congenital heart diseases (2%) diagnosed in the cats were atrial and ventricular septal defects. Based on staging using a modified New York Heart Association Classification, the majority of the feline heart patients were of Class II ($n=52$) and III ($n=67$), followed by Class IV ($n=26$), and Class I ($n=10$). Echocardiography remains the best diagnostic tool for the diagnosis of heart disease in cats.

Keywords: feline heart disease, prevalence, acquired heart diseases, congenital heart diseases, staging of feline heart diseases

INTRODUCTION

Hypertrophic cardiomyopathy (HCM) is the most common heart disease in cats, affecting up to 10% of the adult population and accounting >50% of all feline heart disease cases. Cats with heart disease may be free of symptoms but remain at risk for overt congestive heart failure (CHF), feline arterial thromboembolism (FATE), and sudden death (Fox, 2015). Asymptomatic heart diseases in cats often go undiagnosed (Paige *et al.*, 2009). However, upon presentation, these cats may show heart murmur, tachycardia (Ferasin *et al.*, 2003, 2009a, 2009b; Paige *et al.*, 2009), and symptoms of respiratory system disorders such as dyspnoea, abdominal breathing, and tachypnoea (Spalla *et al.*, 2015).

Dilated cardiomyopathy (DCM) is a heart disease that affects the ventricular muscle and is characterized by dilated, or enlarged heart chambers, and compromised contraction ability. In DCM, radiography provides the primary means of assessing heart size. However, the accuracy and validity of radiographic interpretations in feline patients with HCM remains questionable (Rishniw, 2000). Currently, echocardiography, a non-invasive approach to diagnose heart diseases, is the gold standard for assessing structural and functional changes of the heart. Echocardiography also provides a means of confirming the accuracy of radiographically interpreted cardiomegaly and the confirmatory diagnostic work-up for heart diseases (Ferasin, 2009b). This study retrospectively determined the prevalence, risk factors, and staging of heart diseases.

MATERIALS AND METHODS

Source of Data

Information on cat patients were obtained from the Case Log Book (CLB) of the Clinic and Diagnostic Imaging (specifically ultrasound) Unit, University Veterinary Hospital, Universiti Putra Malaysia (UVH-UPM) for the period of January 2013 to December 2015. Data of cats diagnosed with cardiomegaly and suspected and confirmed heart diseases were recorded.

Inclusion Criteria and Data Collection

Inclusion criteria for data collection were retrievable radiographic and echocardiographic images. The age, body weight, sex, breed, clinical signs, and physical examination findings for each cat patient were recorded. The age of the cats were categorised based on the American Association of Feline Practitioners (AAFP) and American Animal Hospital Association (AAHA) (2010) guidelines. The feline heart disease patients were grouped according to intact male, castrated male, intact female or spayed female.

Clinical signs in cat patients with suspected or confirmed heart diseases recorded were dyspnoea, lethargy, exercise intolerance, coughing, cachexia, and distended abdomen. Findings based on thoracic auscultation noted included heart murmur, tachycardia or bradycardia, gallop rhythm, arrhythmia, muffled heart sound, and abnormal respiratory sounds.

The Vertebral Heart Score (VHS) for each cat patient were determined by measuring the cardiac long axis (CLA) and cardiac short axis (CSA) on the lateral

*Corresponding authors: Dr Khor Kuan Hua (K.H. Khor);
Phone No: 03 8609 3926; Email: khkhor@upm.edu.my

view of thoracic radiograph and comparing with the length of mid-thoracic vertebrae from the cranial edge of 4th thoracic vertebra (T₄). The CLA was measured perpendicular to the measurement of CLA at the point of maximum heart width, that is, from the ventral border of largest main stem bronchi at the tracheal bifurcation point to the most distant points of the heart apex. CSA was measured perpendicular to the measurement of CLA at the point of maximum heart width (Guglielmini *et al.*, 2015). The VHS is either <8 indicating normal heart size or ≥ 8 indicating cardiomegaly.

The lung patterns were described as alveolar, bronchial or interstitial with patchy or diffuse distribution. Abdominal radiography was also reviewed to rule out ascites. Echocardiographic provided the definitive diagnosis of the feline heart disease and the images were reviewed to determine heart disease in the cat patients (Ferasin, 2009b).

Staging of Feline Heart Disease Patients as Asymptomatic of Symptomatic

Heart diseases in patients was staged according the New York Heart Association (NYHA) Classification with modification as follows: Asymptomatic - Class I; and Symptomatic – Class II, III and IV sub-stages (Table 1). This staging method for feline heart disease is semi-quantitative. Upon confirmation of diagnosis by echocardiography, the feline heart disease were then staged accordingly to history, clinical signs, and physical examination findings.

Data Analysis

All the data were statistically analysed using descriptive analysis and the normality of distribution determined. The data was reported as percentage, mean, and range.

RESULTS

Of a total 15,493 feline cases reviewed and 155 were diagnosed with heart disease, that is, with a prevalence rate of 1%. The highest prevalence of heart diseases was in the Domestic Shorthair, followed by the Persians, and Maine coons (Table 2). The mean body weight of feline heart disease patients was 3.3 kg (range; 0.4 to 9.0 kg) and the mean age was 5.2 years with age range of 2-month to 20-years-old. The majority of these cats were within the prime age of 3 to 6 years old. More male cats were inflicted with the heart disease than females.

Clinical Signs and Physical Examination

The majority of feline heart disease patients presented at UVH were symptomatic. The four most common presented clinical signs were dyspnoea, tachypnoea, exercise intolerance, and coughing (Table 3).

Feline heart disease patients were most often presented with tachycardia and heart murmur, followed in order by gallop rhythm, arrhythmia, bradycardia, and muffled heart sound. The frequency of feline heart disease patients with normal and abnormal lung sounds was similar. Among abnormal lung sounds, the most frequent was harsh lung sound, followed by dull lung sound, crackles, and wheezing (Table 4).

Thoracic Radiographic Findings

Overall findings from the thoracic radiography were consistent with those from lung auscultation. Seventy-four feline heart disease patients had normal thoracic radiographic findings, while 48 were diagnosed with pulmonary oedema and 33 with pleural effusion. The majority of patients (n=116) had cardiomegaly. Twenty-three cats showed the normal VHS of <8. VHS in 16 patients could not be evaluated because of severe pleural effusion that totally obscured cardiac silhouette.

DISCUSSION

This is a first report on the prevalence of feline heart diseases presented to the UVH, UPM a teaching hospital that accepts referrals, primary medical, surgical, and routine preventative health care medicine cases. Although similar to that seen in the Swedish Veterinary Hospital under similar setting (Tidholm *et al.*, 2015), the overall prevalence of feline heart diseases at 1% is low. The majority of the cats had acquired heart diseases, with HCM being the most commonly diagnosed (Ferasin *et al.*, 2003; Guglielmini *et al.*, 2015; Spalla *et al.*, 2015). The majority of heart disease patients recruited in the study were at their prime mean age of 5.2 years. Junior and mature cat patients afflicted with the disease were few. This phenomenon was also shown by Ferasin *et al.* (2003), although their study showed that the mean age of their feline patients was a little higher at 6.8 years. However, it should be noted that expression of the disease could be in cats of all ages.

Table 1. Staging of the feline heart disease patient based on a modified New York Heart Association (NYHA) Classification - Adopted from Atkins *et al.* (1992)

Category	Class	Description
Asymptomatic	I	No evident clinical signs even with exercise
	II	Clinical signs only during strenuous exercise
Symptomatic	III	Clinical signs during routine daily activities or mild exercise
	IV	Severe clinical signs even at rest

Table 2: Distribution of the cats diagnosed with heart disease based on the breeds, age group, and sex

Feline patients		Frequency	(%)
Breed	Domestic Shorthair	84	54
	Persian	40	26
	Maine Coon	11	7
	Others		
	American Curl	2	1.5
	Siberian	2	1.5
	Domestic Longhair	3	2.0
	Exotic Shorthair	3	2.0
	Bengal	5	3.0
	Siamese	5	3.0
	Total	155	100
Age group	Kitten (<7 month old)	17	11
	Junior (7 month - 2 years old)	41	27
	Prime (3-6 years old)	44	28
	Mature (7-10 years old)	36	23
	Senior (11-14 years old)	10	6
	Geriatric (≥15 years old)	7	5
	Total	155	100
Sex	Male		
	Intact	54	35.0
	Castrated	34	22.0
	Female		
	Intact	35	22.0
Spayed	32	21.0	
	Total	155	100

Table 3. Distribution of cats diagnosed with asymptomatic and symptomatic heart disease and the auscultation findings

Symptoms	Frequency	%
Clinical signs:		
Asymptomatic	10	6
Symptomatic	145	94
Dyspnoea	(80)	(85)
Tachypnoea	(38)	(40)
Exercise intolerance	(31)	(33)
Coughing	(25)	(27)
Open-mouth breathing	(15)	(16)
Cyanosis	(14)	(15)
Pot-bellied	(12)	(13)
Seizure	(7)	(7)
Paralysis, paresis or weakness	(9)	(10)
Cold extremities	(5)	(5)
Cachexia	(5)	(5)
Hypertension	(4)	(4)
Weak or no femoral pulse	(4)	(4)
Syncope	(1)	(1)

Note: An animal may show more than one symptom. Thus, numbers in brackets were frequencies and % of symptoms seen in all 155 animals, NOT number of animals with symptoms.

Table 4. Distribution of cats diagnosed with heart disease and the auscultation findings of the cardiorespiratory system

Auscultation findings:	Frequency	%
Heart		
Tachycardia	37	33
Murmur	32	39
Gallop	18	16
Arrhythmia	10	9
Bradycardia	8	7
Muffled heart sound	7	6
Lung		
Normal lung sound	79	51
Abnormal lung sound	76	49
Harsh	54	35
Dull	14	9
Crackles and wheezing	8	5

Note: An animal may show more than one symptom. Thus, numbers were frequencies and % of symptoms seen in all 155 animals, NOT number of animals with symptoms.

Cats are sedentary in nature and do not show signs of heart disease until the bodily compensation for condition is overwhelmed. Cats owners often see their young cats occasional panting, but most assumed that this is a normal behaviour and do not suspect any underlying disorder. Due to lack of clear clinical signs, the heart diseases in these cats often go unnoticed while the condition would progressive worsen without any intervention. Unfortunately, the heart diseases only become symptomatic at the chronic stages when the heart could longer compensate for the deficiency. This state of affairs may be the reason for the wide age range of cats finally diagnosed with heart disease.

In this study, the most common breeds of cats diagnosed with heart disease were the DSH and Persian cats. This could be the result of over-presentation of these cats at veterinary hospitals and clinics (Spalla *et al.*, 2015). Maine Coon cats are not commonly bred (Ferasin *et al.* 2003; Spalla *et al.*, 2015; Tidholm *et al.*, 2015), thus, they are under-represented in this study. However, Maine Coon cats is a breed that carries the autosomal dominant mode of inheritance caused by a mutation in the heart myosin binding protein C3 (MYBPC3) (Meurs *et al.*, 2005). The predisposition of this breed of cats to HCM was evidently shown by Tidholm *et al.* (2015). Other cats showing predisposition to HCM because of dorminant familial inheritance pattern include the mix-breed, Persian, and American Shorthair cats (Meurs *et al.*, 2005; Abbott, 2010).

Like that shown in other studies (Payne *et al.*, 2010; Spalla *et al.*, 2015; Tidholm *et al.*, 2015), more male than female cats were diagnosed with heart diseases. It is has been suggested that hormones are responsible for more males being more prone to acquiring heart diseases than females. In humans, males with low testosterone level treated with testosterone showed significant reduction in incidence of myocardial infarction and stroke (Morgentaler, 2016). Testosterone treatment diminishes the imbalance between interleukin-10 and TNF- α ,

suppresses ventricular remodeling and improves cardiac function (Zhang *et al.*, 2007). It is possible that estimation of blood testosterone concentration may be beneficial in determining predisposition to heart disease in cats since the study showed more intact male than castrated male cats had heart disease. Other studies similarly showed that the majority of the cats diagnosed with HCM were males (Atkins *et al.*, 1992; Tidholm *et al.*, 2003; Spalla *et al.*, 2015).

Feline heart disease patients were grouped into asymptomatic ($n=10$) and symptomatic cats ($n=145$). We observed that asymptomatic cats were only incidentally diagnosed with heart disease during their annual health screenings or annual vaccinations. Echocardiography findings in asymptomatic cats revealed thickened left ventricular muscle. However, these findings do not fulfil the criteria for HCM because the thickness of the left ventricular wall at diastole were within 5.5 to 6.0 mm (grey zone HCM), when it should be > 6.0 mm. It seems that, as shown by other studies, the lack of sign of pain or discomfort in cats with heart disease is quite a common phenomenon (Ferasin *et al.*, 2003; Paige *et al.*, 2009).

The common clinical findings in cats with symptomatic heart disease were dyspnoea, tachypnoea, heart mummur, and exercise intolerance (Ferasin *et al.*, 2003; Spalla *et al.*, 2015). Dyspnoea or tachypnoea is highly associated with congestive heart failure (Cote *et al.*, 2004; Smith and McEwan, 2012) while heart murmur frequently develops in conjunction with structural heart disease, a clinically latent state. Tachycardia are often noted in feline patients, but this could a symptom of stress rather than heart disease (Quimby *et al.*, 2017).

Some feline heart disease patients in our study showed abnormal respiratory sound. In cats with congestive heart failure, harsh lung sound have been associated with pulmonary oedema whilst dull lung sound with pleural effusion (Cote *et al.*, 2004). These abnormal respiratory sound findings were consistent with radiographic findings (Wagner, 2010; Guglielmini & Diana, 2015).

The VHS was a method that allows veterinarians to evaluate heart size and provide an accurate assessment of true cardiac enlargement. There was good correlation between heart size and vertebral body length. The cut-off VHS for a normal sized heart is ≤ 7.9 and values ≥ 8 suggest cardiomegaly (Guglielmini *et al.*, 2015). Based on these values, 23 feline heart disease patients in this study had normal heart size while 112 had cardiomegaly. Thus, although radiograph is used more for the diagnosis of heart disease, determination of heart size using the VHS could be useful to ascertain the severity of the disease (Litster and Buchanan, 2000; Winter, 2015).

We compared between the radiography and echocardiography findings in feline heart disease using the modified NYHA Classification. Atkins *et al.* (1992) adopted the classification for canine heart disease patients but discovered it did not meet the criteria for canine patients. The classification is suitable and adaptable for the staging of feline heart diseases based on clinical signs. Most of the feline heart disease patients were stage as NYHA Class III, with critical signs including dyspnoea, tachypnoea, and exercise intolerance.

In this study, among feline patients with normal heart size, 19 were diagnosed with HCM. At the early stage of HCM development, the heart of cats may appear normal in size because of lack of obvious chamber enlargement (Ferasin, 2012). At this stage, only echocardiography will show abnormalities in heart structure and function, because this technique can accurately determine thickness of LVFW and/or IVS at diastole (Cote *et al.*, 2004). In comparison, radiography is insensitive for the diagnoses of heart disease, however, it is still an important screening tool for the determination of VHS and development of pulmonary oedema and pleural effusion (Cote *et al.*, 2004).

The diagnosis of heart disease in the cat population of this study had increased gradually from year 2013 to 2015. The main contributing factor to this increase is suggested to be due to availability of echocardiography as a mean of diagnosis. In addition, the ongoing training afforded to clinicians on a regular base had increased their knowledge and awareness on feline heart disease. Also, of late, pet owners are become more aware of the need for regular health check of their cats, which have increased the rate of early detection of heart disease, especially in asymptomatic patients.

There is no ideal treatment to improve survival and/or quality life of the feline heart disease patients (Ferasin, 2009b). Owners often expressed that the high medical cost for long-term treatments is the main reason for non-compliance to treatment regime. However, there was an increase of follow-ups to the cases presented, especially by owners who diligently monitor the health status of their cats.

Limitation of the study: The prevalence of feline heart disease in UVH, UPM in this study could be underestimated from under-diagnosis. Records show that many deceased patients were presented with critical clinical signs, including dyspnoea, tachypnea, or recumbency, which are signs of heart conditions. Some owners has opted out of additional diagnostic procedures because of financial constraints, thus, the disease were left without definitive diagnosis.

CONCLUSION

The prevalence of heart disease in pet cats presented to UVH, UPM was 1% and the mean age of these patients was 5.2 years with age range of 2 months to 20 years. The feline heart disease patients were predominantly males. The DSH and Persian cats were the most frequent heart patients commonly showing dyspnoea, tachypnoea, and exercise intolerance as clinical signs. In feline heart disease, radiography is a crucial diagnostic tool, however, the technique is insensitive because it does not determine heart structure and function abnormalities. However, radiography is still useful to determine development of heart failure-associated pulmonary edema and pleural effusion. Echocardiography remains the most important and noninvasive diagnostic tool for the diagnosis feline heart disease. Annual heart screening is recommended for cats to detect early signs of heart diseases, especially in patients that do not show symptoms.

CONFLICT OF INTEREST

None of the authors of this paper has any financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

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