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RESEARCH ARTICLE

Retrospective Evaluation of Cardiopulmonary Diseases in Cats and Dogs: 570 Cases

Ekrem Çağatay ÇOLAKOĞLU[1]*, Kadir SEVİM[1], Aslan KALINBACAK[1], Ufuk KAYA[2]

[1]Ankara University Faculty of Veterinary Medicine, Animal Hospital, Department of Internal Medicine, Cardiology Unit, Ankara, Turkey
[2]Hatay Mustafa Kemal University Faculty of Veterinary Medicine, Department of Biostatistics, Hatay, Turkey

ABSTRACT

Retrospective evaluation of the cardiopulmonary data is the main point in prevention and treatment of the diseases. In this study, it was aimed to retrospectively evaluate the data of 570 client-owned patients (321 dogs and 249 cats) referred to cardiology unit. The clinical findings, electrocardiographic data, echocardiography and blood analyses were evaluated. Acquired heart disease in 214 patients (37.54%), congenital heart disease in 38 patients (6.6%), and diseases affecting the lower and/or upper respiratory tract in 98 patients (17.19%) were found. Dilated cardiomyopathy was the most common acquired heart disease, and patent ductus arteriosus was the most common congenital heart disease in dogs. In cats, hypertrophic cardiomyopathy was the most common acquired heart disease, while tricuspid valve dysplasia was the most common congenital heart disease. It was concluded that clinical findings, physical examination and diagnostic applications should be evaluated together in the diagnosis of cardiopulmonary diseases.

Key words: Cardiopulmonary, cat, dilated cardiomyopathy, dog, heart disease, mitral

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Kedi ve Köpeklerde Kalp Hastalıklarının Retrospektif Değerlendirilmesi: 570 Hasta

ÖZ

Kardiyopulmoner verilerin retrospektif değerlendirilmesi hastalıkların önlenmesinde ve tedavisinde temel noktadır. Bu çalışmada kardiyoloji birimine getirilen 321'i köpek ve 249'u kedi olmak üzere toplam 570 sahipli hastanın verilerinin retrospektif değerlendirilmesi amaçlandı. Hastaların klinik bulguları, elektrokardiyografik verileri, ekokardiyografileri ve kan analizleri değerlendirildi. 214 hastada (%37,54) edinsel kalp hastalığı, 38 hastada (%6.6) konjenital kalp hastalığı, 98 hastada (%17,19) alt ve/veya üst solunum yollarını etkileyen hastalıklara rastlandı. Köpeklerde edinsel kalp hastalıklarından en çok dilate kardiyomyopati, konjenital kalp hastalıklarından ise patent ductus arteriosus tespit edildi. Kedilerde ise hipertrofik kardiyomyopati en çok karşılaşılan edinsel kalp hastalığı olurken, triküspit kapak displazisi ise en çok görülen konjenital kalp hastalığıydı. Sonuç olarak kardiyopulmoner hastalıkların teşhisinde klinik bulgular, fiziksel muayene bulguları ve diyagnostik metodların beraber değerlendirilmesi gerektiği kanısına varıldı.

Anahtar kelimeler: Dilate kardiyomyopati, kalp hastalıkları, kardiyopulmoner, kedi, köpek, mitral.

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ORCID ID; *EÇÇ: 0000-0003-2789-035X, KS: 0000-0002-1959-1010, AK: 0000-0002-8057-2871, UK: 0000-0002-4805-0993*
*Corresponding author e-mail: colakoglu@ankara.edu.tr

INTRODUCTION

Quality time between pets and owners has increased associated with the restrictions in people's social lives due to COVID-19 pandemic in all over the world (Ho et al. 2021). Increased interest and concern of owners with their pets has resulted in increased contact between veterinarians and owners as well (Jalongo 2021).

According to the data collected from different veterinary clinics in 2014, Özen et al. reported that the number of client-owned cats and dogs in Ankara region is between 15-20 thousand and 25-30 thousand, respectively (Doğukan et al. 2014). A better understanding of the absolute and relative prevalences of common diseases in a certain population can be used to identify differential diagnoses and prioritize breed, research, and health control efforts. In addition, results from prevalence studies can facilitate the identification of strategic plans necessary for animal welfare. For this purpose, the prevalence of the diseases in 3,884 dogs were evaluated and published with data obtained from different centers (O'Neill et al. 2014b). Cardiopulmonary system diseases were among the most frequently described disorders. Similarly, in a study conducted on 3584 cats, it was reported that the prevalence of cardiac diseases was particularly high (O'Neill et al. 2014a).

Cardiopulmonary diseases are common in dogs and cats. Late diagnosis in early stages of cardiac disorders leads late treatment applications with poor prognosis. Defining the etiology and incidence of cardiopulmonary disorders is the main point in preventing the disease and treatment applications. Although the presence of some retrospective studies including cardiopulmonary disorders in Turkey (Cihan and Yılmaz 2011, Kibar et al. 2008), there is few cases in these studies.

The purpose of the current study was therefore to reflect the retrospective evaluation of cardiopulmonary disorders in dogs and cats.

MATERIAL and METHOD

Animals

The study population consisted of 570 non-pregnant client-owned dogs and cats referred with cardiopulmonary signs or routine cardiopulmonary examination during the time period between 26.09.2020-26.09.2021. All cases were evaluated for signalment, anamnesis, clinical signs and cardiopulmonary examination findings. Cardiopulmonary diagnosis were defined by the conbinations of clinical applications including blood analyses (WBC, LYM, NEUT, EOS, LYM, RBC, HCT, MCV, MCH, MCHC, RDW, PLT, Urea, Creatinin, Glucose, Total Bilirubin, ALP, ALT, GGT, CK, Na, K, P) and imaging procedures (Electrocardiography, echocardiography). 2D B and M mode, color-flow and spectral doppler Echocardiography (Philips Affinity 50® Echocardiography System) obtained from the right and left parasternal long and short axis positions and apical views were performed to identify the structural heart disease in all cases. Clinic ECG were recorded by a 12-lead ECG machine (Edan SE 1201®, 50 mm/sec,10 mm/mV) for 2 minutes in some cases lying right lateral recumbency without any sedation. Laterolateral and ventrodorsal thoracic radiographic images were also obtained in some cases. Diagnosis of heartworm disease were performed using rapid test kits (Uranotest Quattro®) and peripheral smears. All cases had antiparasitic therapy and routine vaccination. All cases were treated with appropriate medications.

Statistical Analysis

Descriptive statistics were performed using IBM SPSS Statistics software Version 23.0. Categorical variables included in the study were calculated as "Frequency (n) - Percent (%)". Quantitative variables were shown as "Mean ± Standard deviation". Results were presented as a table in all data.

RESULTS

The data of 570 client-owned dogs and cats referred with cardiopulmonary clinical signs or routine cardiopulmonary examination were retrospectively evaluated. While 214 patients (37.54%) had acquired heart disease, congenital heart disease was diagnosed in 38 patients (6.6%) (Table 1). The most common acquired heart disease in dogs was dilated cardiomyopathy (DCM) (45.19 %), followed by myxomatous mitral valve disease (MMVD) with 34.07 %. In cats, hypertrophic cardiomyopathy (HCM) (68.35%) was the most common acquired heart disease, followed by restrictive cardiomyopathy (RCM) with 10.13% (Table 1). In other referred patients; chronic bronchitis (42/570, 7.36%), tracheitis/laryngitis (25/570, 4.38%), lung metastasis following mammary tumor operation (8/570, 1.40%), acute bronchitis (6/570, 1.05%), bronchopneumonia (5/570, 0.87%), tracheal collapse (6/570, 1.05%), tracheobronchitis (6/570, 1.05%), diaphragmatic hernia (3/ 570, 0.5%), idiopathic pleural effusion (3/570, 0.5%), brachiocephalic syndrome (2/570, 0.35%), and peritoneopericardial diaphragmatic hernia (PPDH) (2/570, 0.35%) determined. 111 (19.47%) patients were referred for preoperative cardiopulmonary examination, while 99 (17.36%) were referred for routine cardiopulmonary controls.

Breed distributions in patients with various heart disease were shown in Table 2. Distribution of clinical signs in patients with DCM included exercise intolerance and dyspnea (15/61, 24.59%), ascites (10/61, 16.39%), exercise intolerance and coughing

(8/61, 13.11%), coughing (7/61, 11%), 47), dyspnea (6/61, 6.5%), dyspnea and ascites (2/61, 3.27%) and exercise intolerance (15/61, 24.59%). Secondary hypothyroidism in 10 dogs with DCM were also defined. Clinical signs in MMVD dogs were coughing (23/47, 48.93%), exercise intolerance (16/47, 34%), coughing and exercise intolerance (7/47, 14.89%), and dyspnea (1/47, 2.12%). Mitral regurgitation with concomitant tricuspid disease was defined in 8 MMVD dogs. The most common clinical signs in cats with HCM was dyspnea (43/54, 80%). There was no clinical signs in 11 cats (20.37%) diagnosed with HCM. In RCM cats, the most common clinical sign was also dyspnea.

Electrocardiographic findings in dogs with DCM (n=38) included atrial fibrillation (n=15, 39.47%), left ventricular enlargement pattern (n=9, 23.7%), ventricular tachycardia (n=8, 21%), biventricular enlargement pattern (n=3, 7.9%), left bundle branch block (n=2, 5.26%) and P mitrale (n=1, 2.63%). Echocardiographic examinations revealed left ventricular dilatation (n=32, 51%), left ventricular and atrial dilatation (n=18, 29%), biatrial dilatation (n=6, 9.7%), and mitral regurgitation (n=6, 9.7%). The electrocardiographic findings (n=27) of dogs with MMVD were as follows; P mitrale (n=12, 44%), sinus arrhythmia (n=8, 26.6%), ST depression (n=3, 11%), P pulmonale (n=3, 11%), and biphasic T wave (n=1, 3%). In echocardiographic examinations in MMVD dogs, mitral regurgitation (n=47, 100%), left atrial enlargement (n=19, 40.47%), tricuspid regurgitation (n=8, 17%) and mitral prolapse (n=5,10.6%) was determined as well. In cats with HCM (n=20), electrocardiography revealed ventricular premature complex (n=8 , 40%), atrial fibrillation (n=5, 25%), ventricular tachycardia (n=3, 15%), atrial premature complex (n=2, 10%) and sinus tachycardia (n=2, 10%). Echocardiographic examination of cats with hypertrophic cardiomyopathy revealed thickening of the intraventricular septum and/or left ventricular free wall in all cats. Obstructive aortic stenosis was detected in five cats (9%). Other findings were left atrial enlargement (n=24, 44%), systolic anterior motion (SAM) (n=12, 22.2%) and smoke in the left atrium (n=7, 13%), respectively.

Table 1. Characterisation of Cardiac Diseases

				Age		**Sex**	
AQUIRED HEART DISEASE	**Dog n (%)**	**Cat n (%)**	**Total n (%)**	**Dog**	**Cat**	♂	♀
DCM (n:10/65 hypothyroid dogs)	61 (45.19)	4 (5.06)	65 (30.37)	8.64±3.67	7.75±4.19	33	28
HCM (HOCM included)	-	54 (68.35)	54 (25.23)	-	5.41±3.91	41	13
MMVD	46 (34.07)	-	46 (21.50)	11.72±3.14	-	31	16
RCM	-	8 (10.13)	8 (3.74)	-	8±4.6	7	1
Endocarditis		5 (6.33)	5 (2.34)	-	3±2.01	2	3
Cardiac Mass	3 (2.22)	-	3 (1.40)	8±2.11	-	2	1
Dirofilariasis	2 (1.48)	-	2 (0.93)	4±3.12	-	2	0
Cardiorenal Syndrome	13 (9.63)	-	13 (6.07)	7±2.12	-	9	4
Mitral Regurgitation	4 (2.96)	3 (3.80)	7 (3.27)	8±3.21	5±2.1	5	2
FATE	-	5 (6.33)	5 (2.34)	-	3±1.2	3	2
Mitral Prolapse	3 (2.22)	-	3 (1.40)	6±3.2	-	1	2
Tricuspid Prolapse	3 (2.22)	-	3 (1.40)	3±1.1	-	1	2
CONGENITAL HEART DISEASE							
PDA	7 (29.17)	-	7 (18.42)	5±2.5	-	7	-
ASD	2 (8.33)	4 (28.57)	6 (15.79)	4.5±1.0	1±1.8	2	4
TVD veya TR	2 (8.33)	4 (28.57)	6 (15.79)	11±2.0	0.8±2.2	4	2
VSD (Muscular, Supracristal VSD included)	1 (4.17)	5 (35.71)	6 (15.79)	2	1.4±2.0	2	4
AS	5 (20.83)	-	5 (13.16)	11±1.9	-	2	3
PS	5 (20.83)	-	5 (13.16)	2.4±1.2	-	3	2
Aortopulmonary Window	1 (4.17)	-	1 (2.63)	1	-	-	1
SSS	1 (4.17)	-	1 (2.63)	5	-	-	1
Kartegener Syndrome	-	1 (7.14)	1 (2.63)	-	4	-	1
TOTAL	**159**	**93**	**252**				

DCM: Dilated Cardiomyopathy, HCM: Hypertrophic Cardiomyopathy, HOCM: Hypertrophic Obstructive Cardiomyopathy, MMVD: Myxomatous Mitral Valve Disease, RCM: Restrictive Cardiomyopathy, FATE: Feline Arterial Thromboembolism, PDA: Patent Ductus Arteriosus, ASD: Atrial Septal Defect, VSD: Ventricular Septal Defect, TVD: Tricuspid Valve Dysplasia, TR: Primary Tricuspid Regurgitation, AS: Aortic Stenosis, PS: Pulmonary Stenosis, SSS: Sick Sinus Syndrome.

Table 2. Breed Distributions

Dog Breeds	DCM, n (%)	MMVD, n (%)	HCM, n (%)	RCM, n (%)
Golden Retriever	22 (36.1)	-	-	-
Mix Breed Dogs	10 (16.4)	-	-	-
Cocker Spaniel	8 (13.1)	1 (2.1)	-	-
Malaklı	1 (1.6)	-	-	-
Pomeranian	1 (1.6)	-	-	-
Setter	2 (3.3)	-	-	-
Terrier types	3 (4.9)	18 (38.3)	-	-
Kurzhaar	2 (3.3)	-	-	-
Kangal	5 (8.2)	-	-	-
Bulldog	1 (1.6)	-	-	-
Belgian Malinois	1 (1.6)	-	-	-
Rottweiler	4 (6.6)	-	-	-
Beagle	1 (1.6)	-	-	-
Cavalier King Charles	-	7 (14.9)	-	-
Kai	-	3 (6.4)	-	-
Pekingese	-	13 (27.7)	-	-
Chihuahua	-	3 (6.4)	-	-
Pincher	-	1 (2.1)	-	-
Jack Russell	-	1 (2.1)	-	-
Cat Breeds				
British Short Hair	-	-	12 (22.2)	1 (12.5)
Mix Breed Cats	-	-	13 (24.1)	4 (50)
Scottish Fold	-	-	18 (33.3)	-
Persian	-	-	9 (16.7)	-
Chinchilla	-	-	1 (1.9)	-
Siamese	-	-	1 (1.9)	-
Van Cat	-	-	-	1 (12.5)
Ankara Cat	-	-	-	2 (25)

DCM: Dilated Cardiomyopathy (n:61 dogs), HCM Hypertrophic Cardiomyopathy (n:54), MMVD: Myxomatous Mitral Valve Disease (n:46), RCM: Restrictive Cardiomyopathy (n:8).

DISCUSSION

Although some difficulties are possible in determining the prevalence of congenital heart disease in dogs and cats, some malformations can cause directly perinatal mortality without any cardiac murmurs. Breed predispositions may also affect the type of possible congenital heart disease (Oliveira et al. 2011). In the study presented here, congenital heart disease was detected in 24 dogs and 14 cats. In accordance with the current literatures (Côté et al. 2011a, Oyama and Strickland 2015, Garncarz et al. 2017), the most common congenital heart diseases in dogs and cats were patent ductus arteriosus (PDA, n=7) and tricuspid valve dysplasia (n=6), respectively. Dilated cardiomyopathy (DCM) characterized by systolic dysfunction and poor prognosis usually affects large breed dogs (Martin et al. 2010). Researches have reported the predispositions in large breed dogs including Doberman Pincher, Irish Wolfhound, Great Danes, Boxer, American Cocker, Bulldog, Golden Retriever and Saint Bernard (Dukes-McEwan et al. 2003, Vollmar et al. 2013, Bélanger et al. 2005, Fascetti et al. 2003, Backus et al. 2006, Backus et al. 2003). In the current study, similar findings were also observed. 22 dogs diagnosed with DCM phenotype were Golden Retrievers. It is also known the reasons of genetic, nutrition, inflammation, infiltration, ischemia, drug/toxin-induced cardiomyopathy, immunological disorders, metabolic diseases, biochemical changes and chronic tachycardia are the possible etiological factors in DCM (McCauley et al. 2020, Freid et al. 2021, Beier et al. 2015). Therefore, other predisposing factors should be considered in patients with DCM. In this study, many of them have been ruled out by the diagnostic procedures and concomitant hypothyroidism was detected in 10 dogs with dilated cardiomyopathy. In the present study, most of the dogs with DCM were male and over the middle-aged as consistent with the reports previously reported (Freid et al. 2021, Çolakoğlu et al. 2017, Martin et al. 2009, Dukes-McEwan 2016).

Similar to the results of previous studies, atrial fibrillation was most common arrhythmia in

electrocardiographic records of dogs with DCM (Martin et al. 2009). Echocardiographic examination findings in this study have also been found to be compatible with the literature (Bonagura and Visser 2021, Tidholm et al. 2001).

Myxomatous mitral valve disease (MMVD) is a chronic degenerative heart disease usually occurring in middle-aged small breed dogs. Degenerative changes preventing valve function over time cause mitral insufficiency. Concomitant degenerative changes on tricuspid valves have also been defined with mitral valve changes. Congestive heart failure, pulmonary hypertension, pulmonary edema and arrhythmias may occur in the later stages of the disease as well (Borgarelli and Buchanan 2012). In the study here, all MMVD dogs were small breeds (<15 kg) as consistent with the previous studies (Mattin et al. 2015, Kim et al. 2017). 6 years or older dogs with MMVD in the study presented here have supported the fact that mitral valve disease was more common in older ages of dogs (Çolakoğlu et al. 2017, Kim et al. 2017, Mattin et al. 2015, Borgarelli and Buchanan 2012). Similar to the studies reporting that degenerative mitral valve disease was more common in male animals (Keene et al. 2019, Mattin et al. 2015, Petrič 2015), male dogs were majority among dogs with MMVD. Although myxomatous mitral valve disease mainly affects the mitral valve, it is known that the tricuspid valve is also affected in 30% of cases (Keene et al. 2019). In the study, degenerative changes and related tricuspid regurgitation were observed in the tricuspid valve in 8 dogs. Kim et al. have reported the sinus arrhythmia in 40 dogs (40/168, 23.8%) as a result of their retrospective study of MMVD (Kim et al. 2017). These results appear to be similar to our study. Increased LA volume and stroke volume in dogs with MMVD occurs due to regurgitant flow from the left ventricle. This is a compensatory mechanism necessary to prevent pulmonary congestion and maintain ventricular filling (Höllmer et al. 2017). In the study here, left atrial enlargement was also remarkable in 19 dogs (n=19, 40.47%).

Hypertrophic cardiomyopathy (HCM) is the most common acquired heart disease in cats. The disease is characterized by a non-dilated and thickened left ventricle free wall. For the exact diagnosis of the disease as primary cardiomyopathy, secondary disorders including hypertension and hyperthyroidism associated with left ventricular thickening should be ruled out (Trehiou-Sechi et al. 2012, Payne et al. 2013). While the disease can cause congestive heart failure, thromboembolism or sudden death, some cats may remain asymptomatic for years and may not cause any systemic disorders (Payne et al. 2013). In accordance with the literatures (Wilkie et al. 2015, Payne et al. 2015), HCM fenotype was most frequently identified in cats with heart disease referred to cardiology unit. Although there are studies showing a higher risk of developing HCM in pure breeds (Luis Fuentes et al. 2020), further studies are required. In this study, the majority of cats with HCM phenotype were pure breeds (n=40). We think this situation is associated with the distribution of cats in Ankara region. In consistent with the reports previously described (Trehiou-Sechi et al. 2012, Spalla et al. 2016, Payne et al. 2013, Rush et al. 2002), cats with HCM are predominantly male (n=41) in this study as well. The higher incidence of ventricular premature complexes and atrial fibrillation in our study is consistent with the reports (Trehiou-Sechi et al. 2012, Payne et al. 2010). Echocardiography is the best method for diagnosing HCM. Thickening of the left ventricular free wall, interventicular septum or papillary muscles are the main echocardiographic changes in this disease (Ware and Ward 2019). The echocardiographic findings in the study were similar to the data previously published (Trehiou-Sechi et al. 2012, Spalla et al. 2016, Ferasin et al. 2003).

Restrictive cardiomyopathy (RCM) is a myocardial disease characterized by severe diastolic dysfunction, atrial enlargement, normal left ventricular wall thickness, and normal/slightly decreased systolic function. Echocardiography is also the best method for the diagnosis of RCM including myocardial and endocardial forms (Locatelli et al. 2018). In retrospective studies, RCM has been described as the second most common cardiomyopathy in cats (Locatelli et al. 2018, Spalla et al. 2016). RCM cats in this study were also the second most common cardiomyopathy as consistent with the reports previously described. In a necropsy study of 304 cats, Kimura et al. (Kimura et al. 2016) most observed the endocardial form of RCM and reported that RCM is much more common in cats contrary to popular belief. They have attributed the reasons why the incidence of the disease is known to be low to the localization of endocardial fibrotic tissues, the quality of the devices for imaging, and the experience of the operator. The predominance of male sex (8/9) in cats with RCM in our study was consistent with previous studies (Kimura et al. 2016, Locatelli et al. 2018). Similar to the studies reporting the wide age range of the RCM (Locatelli et al. 2018, Kimura et al. 2016, Chetboul et al. 2019), in the study herein we also observed the wide age range in cats (3-15 years).

Although the prevalence of dilated cardiomyopathy in cats is not clearly known, it is known that it is less common compared to hypertrophic cardiomyopathy. Despite the addition of taurine to commercial cat foods, it is still possible to observe the dilated cardiomyopathy in cats (Côté et al. 2011b). The main cause of idiopathic dilated cardiomyopathy in cats with normal taurine levels is not fully understood (Sevim and Çolakoğlu 2021, Ferasin et al. 2003). In our study, dilated cardiomyopathy was diagnosed in 4 cats known to be fed commercial foods. Levels in 2 cats measured taurine concentrations were observed

within reference ranges. As a result, only two cats could be classified as idiopathic dilated cardiomyopathy. In remaining two cats, the taurine level could not be determined due to economic concerns.

CONCLUSION

It was concluded that clinical symptoms and physical examination findings with diagnostic applications should be considered together in the evaluation process of cardiopulmonary diseases. It was also considered that DCM and MMVD were the most common heart disease in dogs.

Ethics Committee Information: This study does not present any ethical concerns.

Conflict of interest: The authors declare that there is no conflict of interest.

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