The prevalence of dilated cardiomyopathy in the Weimaraner dog breed

Zita Filipejová[1], Benicie Kosková[1], Andrea Nečasová[2], Lucie Urbanová[2], Petr Linhart[3]
Dominik Procházka[4], Michael Fiedler[5], Alois Nečas[2]

[1]University of Veterinary Sciences Brno, Faculty of Veterinary Medicine, Small Animal Clinic, Department of Medicine, Czech Republic
[2]University of Veterinary Sciences Brno, Faculty of Veterinary Medicine, Small Animal Clinic, Department of Surgery & Orthopaedics, Czech Republic
[3]University of Veterinary Sciences Brno, Faculty of Veterinary Hygiene and Ecology, Department of Animal Protection and Welfare and Veterinary Public Health, Brno, Czech Republic
[4]Veterinary Clinic Procházka, Olomouc, Czech Republic
[5]Veterinary Clinic Slaný, Slaný, Czech Republic

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Abstract

Dilated cardiomyopathy (DCM) is a well-recognised cause of cardiac morbidity and death in humans and dogs. It causes progressive structural changes in the myocardium, which leads to congestive heart failure or sudden death. Dilated cardiomyopathy is the second most common acquired cardiac disease and the most common cardiomyopathy in dogs. The highest prevalence is found in large and giant breeds of dogs; the most frequently affected dogs are Doberman Pinschers. Other breeds such as the Great Dane, Boxer, Irish Wolfhound or Cocker Spaniel also have a high prevalence of DCM. No study has yet been reported in regard to the prevalence of DCM in the Weimaraner and its genetic causes. In the study, a total of 232 Weimaraner dogs were enrolled. Out of this total number, 223 dogs were short-haired Weimaraners and 9 dogs were long-haired Weimaraners. The most frequently diagnosed disease was DCM but other diseases were identified. In our study, the prevalence of DCM in Weimaraners was 9.8%.

Canine, DCM, CHF, cTnI, NTproBNP

Canine dilated cardiomyopathy (DCM) is an acquired heart muscle disease of unknown aetiology commonly characterized by adult onset of arrhythmias, congestive heart failure (CHF) and sudden death. It is a disease of the heart muscle characterised by left ventricular dilatation without wall thickening and systolic and diastolic myocardial dysfunction (Martin et al. 2009).

Primary or idiopathic cardiomyopathy is defined as a cardiomyopathy of unknown or unclear aetiology and is not the result of systemic disease or cardiovascular disease (Wynne and Braunwald 1997). Secondary cardiomyopathy is classified according to aetiology. These classifications are drug- or toxin-induced cardiomyopathy (Hallman et al. 2019), genetic and metabolic cardiomyopathy, and cardiomyopathy associated with nutritional deficiency L-carnitine or taurine (Kittleson et al. 1997), or inflammatory myocardial disease.

The effect of hypothyroidism as a metabolic aetiology for secondary cardiomyopathy was also described as another possible causative factor in the development of DCM (Karlapudi et al. 2012). However, in Doberman Pinchers, the role of hypothyroidism in the aetiology or progression of DCM was not confirmed (Beier et al. 2015). The hormones of the thyroid gland have a positive ionotropic and chronotropic effect on the heart. It has been suggested that hypothyroidism can play a role in the development of DCM in dogs. In some studies, the therapy of hypothyroidism led to an increased fraction

Address for correspondence:
MVDr. Zita Filipejová Ph.D.
Small Animal Clinic
Faculty of Veterinary Medicine
University of Veterinary Sciences Brno
Palackého tř. 1946/1, 612 42 Brno, Czech Republic

Phone: +420 541 562 391
E-mail: filipejovaz@vfu.cz
http://actavet.vfu.cz/

shortening and ejection fraction of the left ventricle (Tidholm et al. 2001; Karlapudi et al. 2012).

Dilated cardiomyopathy as an autosomal dominant trait has been described in the Doberman Pinscher (Meurs et al. 2007), the Newfoundland (Dukes-McEwan et al. 2003), the Irish Wolfhound (Distl et al. 2007) and the Great Dane (Stephenson et al. 2012). This disease typically presents at the age of 6 to 8 years; a juvenile form of DCM has been described in Portuguese Water Dogs (Sleeper et al. 2002) and Doberman Pinschers (Vollmar et al. 2003). The incidence of DCM as more common in males than in females was reported by some older studies (Monnet et al. 1995; Tidholm and Jönsson 1997, Meurs et al. 2001; Martin et al. 2009; Martin et al. 2010). The most recent study, however, showed equal sex distribution, but different disease manifestation and progression between male and female dogs (Wess et al. 2010b).

The occult stage of the disease is characterized by evidence of morphologic or electrical derangement in the absence of clinical signs of heart disease (Calvert et al. 1997; O'Grady and O'Sullivan 2004). The cardiac marker troponin I is a highly specific and sensitive marker for myocardial cellular damage in humans and animals (Wess et al. 2010c). N-terminal pro-B-type natriuretic peptide (NTproBNP) is a valuable biomarker that can be used to distinguish cardiac causes of dyspnoea from noncardiac causes, dogs with DCM and myxomatous degenerative mitral valve disease and hypertrophic cardiomyopathy in cats (Wess et al. 2011). In Dobermann Pinschers, the cardiac marker NTproBNP was higher in patients with DCM or in patients who developed DCM within 1.5 years. Sensitivity was 90% and specificity 75%. This marker has a sensitivity of 90.4% in detection of echocardiographic changes (Wess et al. 2011). Troponin I has 81.2% sensitivity and 73.2% specificity in diagnosis of occult DCM (Kluser et al. 2019).

The aim of the study was to determine the prevalence of DCM in the Weimaraner dog breed.

Materials and Methods

Study population and inclusion criteria

The prospective study included only dogs of the Weimaraner breed that were examined at the Small Animal Clinic, University of Veterinary Sciences Brno (VetUni Brno) and the Veterinary Clinic Slaný. All examinations and blood sampling were performed with the written informed consent of the owners. All dogs were examined without sedation. After physical examination, standard six lead electrocardiography (ECG) was performed using the SEIVA EKG Praktik Veterinary (Praha, Czech Republic) and Eickemeyer PC-ECG (Tuttlingen, Germany). If the patients were diagnosed with arrhythmias on the ECG, Holter examination was subsequently performed. Echocardiographic examinations were performed by the ALOKA 7 (Aloka CO., LTD., Tokyo, Japan) ultrasound with a 2.5–5 MHz phased array probe and by GE Vivid E95 (GE Vingmed Utrasound, Horten, Norway) with a 1.5–4.6 MHz phased array probe. All examinations were made with simultaneous ECG recording. Blood was collected from the jugular vein in all patients. Complete haematological and biochemical examination of blood was done for all pateints (total protein, albumin, urea, creatinine, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, gamma glutamyltransferase, bilirubin, glucose, Na, K, P, Cl, Ca, Mg) by clinical laboratories at the Small Animal Clinic, VetUni Brno and Idexx Catalyst Dx (Idexx Laboratories, Ins., Westbrook, Maine, USA) and Idexx ProCyte analyzer (haematology analyzer, Kobe, Japan). Thyroid hormones (thyroxine and thyroid-stimulating hormone) and myocardial hormones Troponin I and NTproBNP were analysed at the IDEXX laboratory (Hoofddorp, Netherlands).

Echocardiography examinations were performed in right and left lateral recumbency with the pet lying on a table containing a "cutout" section and in a standing position in some patients. For the examination, we followed the guide by Dukes-McEwan et al. (2003) developed for diagnosing DCM. This guide assesses the left ventricular site, sphere, and myocardial systolic dysfunction. In addition to the necessary presence of an abnormality in at least one of these criteria, they complement other related values found in echocardiography or electrocardiography.

For diagnosing occult DCM, we used all parameters together (Dukes-McEwan et al. 2003) and the Simpson's method (Wess et al. 2017). Simpson's method of discs (SMOD) is more sensitive than the M-mode to detect early echocardiographic changes in Doberman Pinschers (Wess et al. 2010a). The left ventricle (LV) volume determined by SMOD was performed in the right parasternal long-axis 4-chamber view and the left apical 4-chamber view. Right parasternal and left apical views were measured and the larger volumes were used.

Statistical analysis

Analysis of collected data was performed using the software StatSoft, Inc. (2003) and statistical analysis was performed by STATISTICA 6 (Tulsa Oklahoma, USA).

Normality of data was tested with the use of Shapiro-Wilk test. In normally distributed data (weight) ANOVA was used, in non-normally distributed data (age, NTproBNP, troponin I) Kruskal-Wallis analysis was performed to evaluate the influence of clinical status (DCM, pre-DCM, and healthy). Pearson's χ^2 test was used to analyse the statistical relationship between sex and clinical status. P value ≤ 0.05 was considered significant.

Results

A total of 232 dogs were enrolled in the study. Of these 232 dogs, 223 dogs were short-haired Weimaraners and 9 dogs were long-haired Weimaraners. Out of the total number of 223 short-haired Weimaraners, 192 Weimaraners were healthy. Of these, 100 were females, of which 1 was spayed, and 92 were males, of which 1 was neutered. The most frequently diagnosed disease was DCM but other diseases were identified: dysplasia of the tricuspid valve, dysplasia of the mitral valve, myxomatous mitral valve disease, patent ductus arteriosus, and heart base tumour (Fig.1). The prevalence of DCM in short-haired Weimaraners was 9.8%. Dilated cardiomyopathy was diagnosed in 5 dogs, occult DCM was diagnosed in 17 dogs and arrhythmogenic form of DCM was diagnosed in 4 dogs. In the clinical group of DCM, hypothyroidism was confirmed in only one patient. The metabolic cause of DCM was not diagnosed.

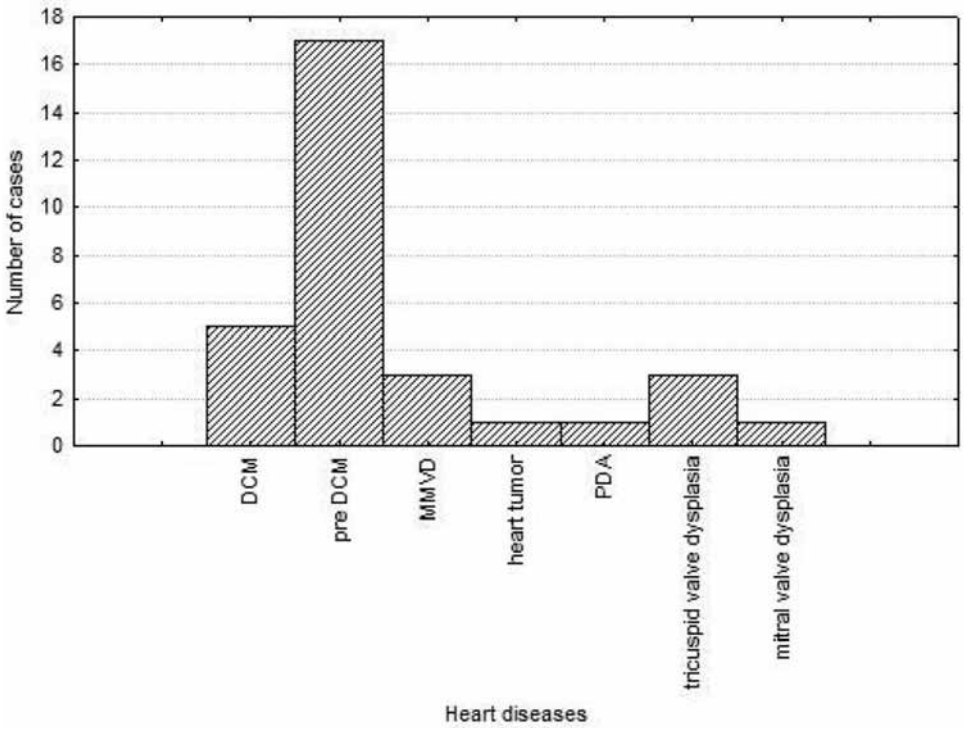

Fig. 1. The occurrence of individual cardiologic diagnoses

DCM – dilated cardiomyopathy; pre DCM – preclinical dilated cardiomyopathy; MMVD – myxomatous mitral valve disease, heart tumour – heart base tumour; PDA – patent ductus arteriosus

The total number of examined individuals of long-haired Weimaraners was 9, of which 7 were intact females and 2 were intact males. We diagnosed 1 dog with occult DCM, and 1 with an arrhythmogenic form of DCM; 7 dogs were healthy. In the occult DCM group, hypothyroidism was not diagnosed in any individual.

There was a significant difference in body weight between patients with preclinical DCM and healthy patients ($P < 0.01$) (Fig. 2).

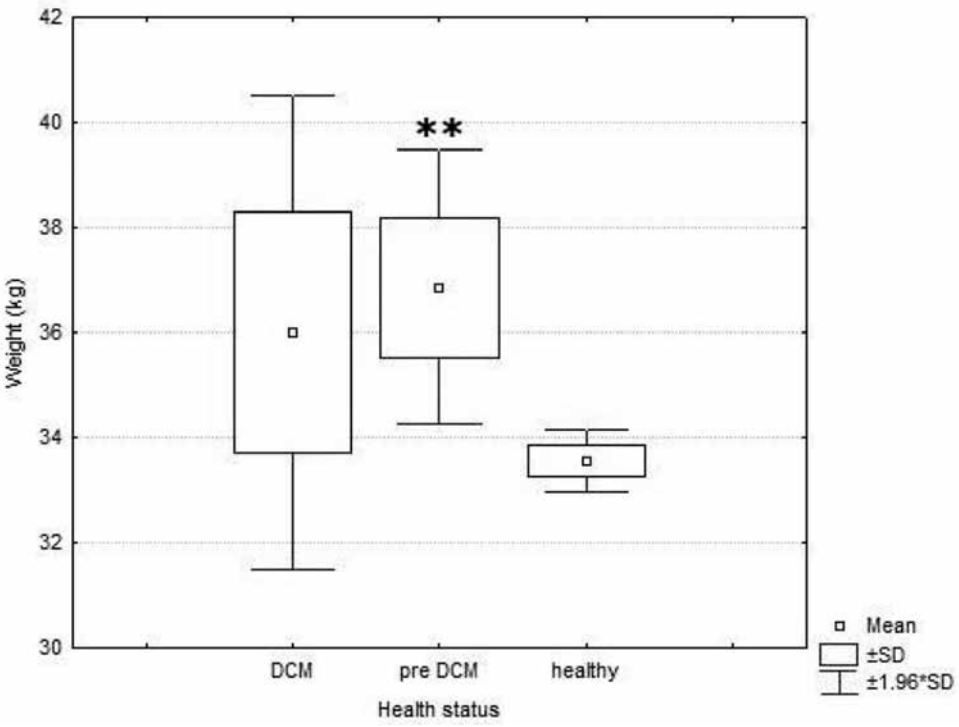

Fig. 2. Weight comparison in relation to DCM clinical status

DCM – dilated cardiomyopathy; pre DCM – preclinical dilated cardiomyopathy

There was a significant difference in age between patients with DCM and healthy dogs ($P < 0.01$) and between patients with preclinical DCM and healthy dogs ($P < 0.01$) (Fig. 3).

There was a significant difference in troponin I (ng/ml) values between patients with preclinical DCM and patients with DCM ($P < 0.01$) (Fig. 4).

There was also a significant difference in NTproBNP (pmol/l) values between patients with preclinical DCM and DCM ($P < 0.01$) (Fig. 5).

We found a sex predisposition for DCM – the incidence of DCM and preclinical DCM was significantly higher in males compared to females ($P < 0.01$).

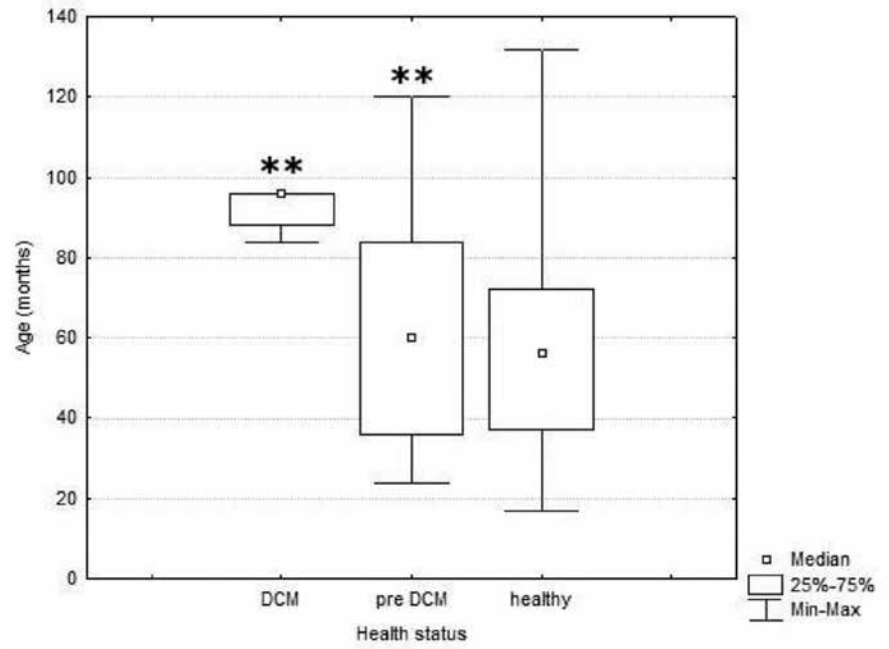

Fig. 3. Age comparison in relation to DCM clinical status

DCM – dilated cardiomyopathy; pre DCM – preclinical dilated cardiomyopathy

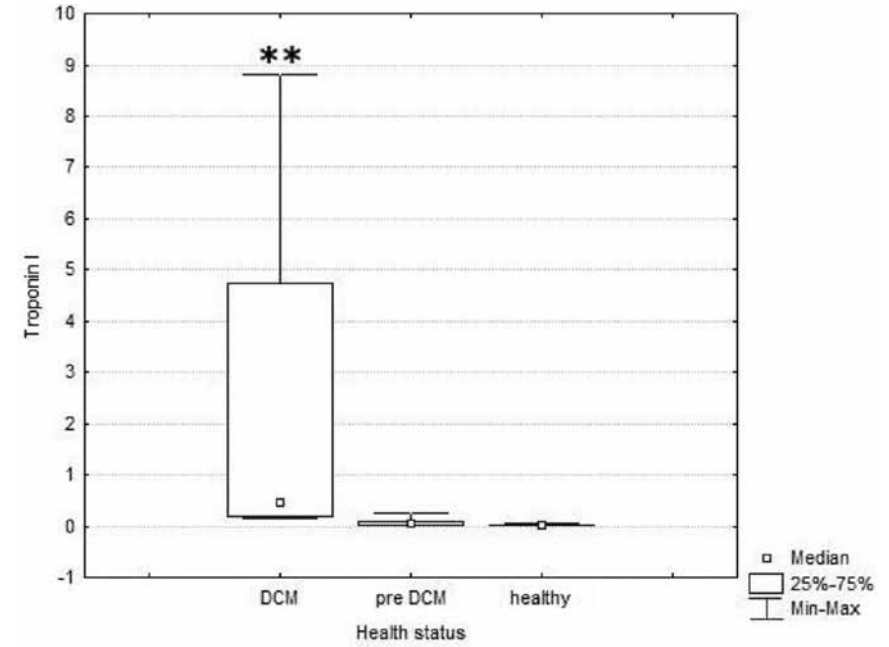

Fig. 4. Troponin I (ng/ml) comparison in relation to DCM clinical status

DCM – dilated cardiomyopathy; pre DCM – preclinical dilated cardiomyopathy

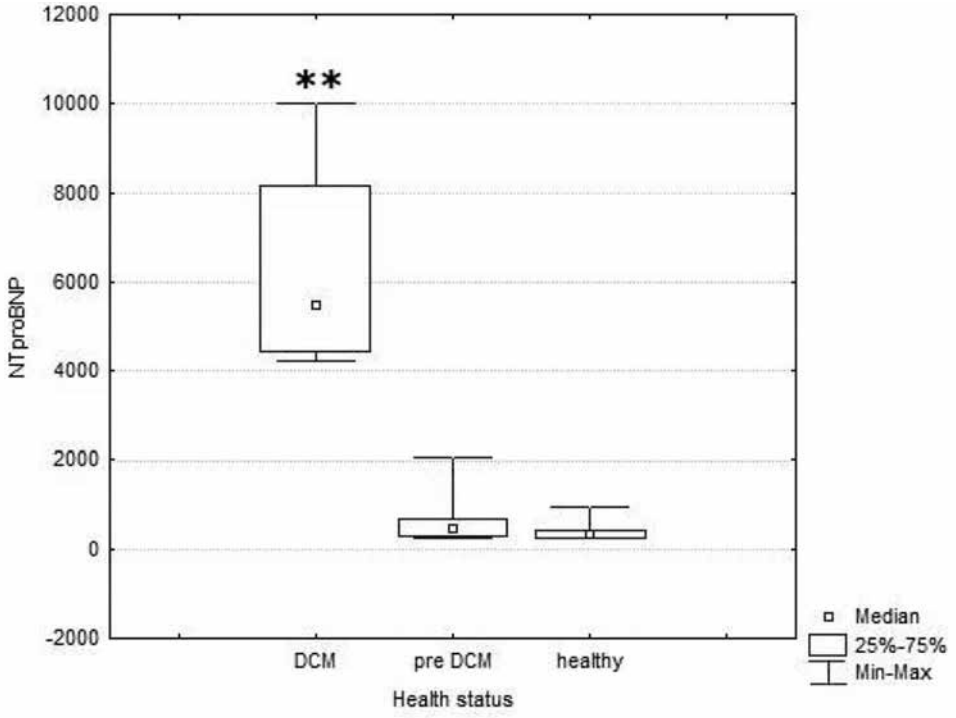

Fig. 5. NTproBNP (pmol/l) comparison in relation to DCM clinical status

DCM – dilated cardiomyopathy; pre DCM – preclinical dilated cardiomyopathy

Discussion

In many publications that focus on the diagnosis of DCM, specific breeds in which the disease has been diagnosed always predominate. According to studies conducted in Sweden (Tidholm 2006), Newfoundland dogs constitute 26% of affected patients and Weimaraners only 1.6% of patients. A study from England by Martin et al. (2009) evaluated 369 dogs with DCM of 35 different breeds, where Doberman Pinschers were the most commonly represented (16%), followed by Boxers (14%), with Weimaraners representing only 1.6%. There are currently no studies regarding the prevalence of DCM in Weimaraners. Knowledge of the prevalence is necessary to establish a screening program and be able to give recommendations for DCM screening. The aim of this study was to evaluate the prevalence of DCM in Weimaraners in the Czech Republic and Slovakia. However, the prevalence of DCM in Weimaraners may be different in other countries, with different populations and popularity of the breed. Our study found the prevalence of DCM in Weimaraners examined in our study to be at 9.8%. In the study by Wess et al. (2010b), which included dogs from the Netherland, Italy, Austria, Switzerland and some Eastern Europe countries, the prevalence of DCM in Doberman Pinchers was 58.2%.

The age of the examined patients is an influencing factor in DCM incidence in Doberman Pinschers (Wess et al. 2010). In a study by Petric et al. (2002) the average age at diagnosis of DCM was 6.5 ± 1.9 years in Doberman Pinschers and 7.2 ± 2.8 years in other breeds.

The average age of Irish Wolfhounds diagnosed with DCM was found to be 4.7 years (Vollmar 1999). The average age of our patients of the breed Weimaraner with DCM was 92 months, but for patients with preclinical DCM, it was 62.11 months, which corresponds with a study by Wess et al. (2017), where preclinical DCM in Doberman Pinschers was diagnosed at the age of 60–84 months.

One case report on arrythymogenic right ventricular cardiomyopathy (ARVC) in a Weimaraner was published (Bryan et al. 2015). We did not find any patients with ARVC in addition to DCM. It is well-known that Weimaraners are one of the breeds predisposed to DCM. Furthermore, we also found other diseases in this breed, such as mitral and tricuspidal dysplasia, and degenerative mitral valve disease. The age of Weimaraners with myxomatous mitral valve disease was 102 months. This fact agrees with another study by Keene et al. (2019), which confirmed that the disease was typical for older patients. In our study, we diagnosed 3 patients with tricuspid dysplasia. Notably, all 3 patients were females and 2 of them had the same sire. The average age was 40 months. Regarding the heredity of DCM, it is assumed that this disease occurs in specific lines and certain breeds. Unfortunately, up to the present, no gene for DCM has been identified in Weimaraners.

Ventricular premature contractions (VPCs) are described in Doberman Pinschers and Boxers. In these breeds, ECG has been shown to be a useful tool for diagnosis in patients with preclinical DCM. To avoid false-positive results during short time ECG recording, 24-h Holter's examination is recommended to show the real prevalence of arrhythmias. Finding ventricular arrhythmia in Doberman Pinschers with preclinical DCM precedes echocardiologic changes by several months or even years. Regardless of echocardiologic changes, more than 300 VPCs/24 h or finding of 50–300 VPCs/24 h in 2 sequent reports during 1 year is considered diagnostic for occult DCM in Doberman Pinschers.

The association between atrial fibrillation and the development of DCM was described in the Irish Wolfhound (Vollmar et al. 2019). Other breeds for which the Holter's examination has advantages for more commonly detecting VPCs are Weimaraners and Great Danes (Dukes-McEwan et al. 2003), and also Rhodesian Ridgebacks (Meurs et al. 2016). We diagnosed 4 patients with an arrhythmogenic form of DCM using a Holter recorder. All dogs had no abnormality other than ventricular premature complexes mostly in the form of isolated ventricular premature beats, but also more complex forms of ventricular bigeminy, trigeminy and ventricular couplets.

The prognosis for survival in dogs with DCM is poor (Calvert et al. 1982; Calvert 1986). Factors that play a role in the survival of patients with DCM include the breed, class of heart failure, arrhythmias and echocardiography (Calvert et al. 1982; Calvert 1984; Calvert 1986).

Greyhounds and Boxers might have inherently higher cardiac troponin I (cTnI) concentrations than other breeds (Baumwart et al. 2007; LaVecchio et al. 2009). In our study, we confirmed that cardiac markers have a major prognostic importance. Patients with clinical DCM had significantly elevated biomarkers (NTproBNP, troponin I). Increased troponin concentrations occur in dogs and humans with DCM. In the study by Wess et al. (2010), troponin had the highest level in patients with DCM, and NTproBNP was significantly higher in a patient with DCM compared to healthy dogs in a study by Wess et al. (2011), which was confirmed by our study. We had 5 patients with clinical DCM and these patients had pulmonary oedema too. Pulmonary oedema was found to be predictive of survival time in dogs with DCM and these patients had a poorer prognosis than dogs presented for other problems such as excessive intolerance, collapse or syncope (Monnet et al. 1995). Three of our patients with DCM and pulmonary oedema died within 3 months. The one and only patient with DCM and concurrent hypothyroidism died 1 year after the diagnosis. Monnet et al. (1995) reported in their study that 50% of patients with DCM had a survival time of 2.3 months, which confirms the findings of our study.

The occurrence of DCM is more common in males than in females (Monnet et al. 1995; Calvert et al. 1997; Tidholm and Jönsson 1997; Meurs et al. 2001; Petric et al. 2002; Borgarelli et al. 2006; Tidholm 2006; Martin et al. 2009; Martin et al. 2010). Our study is also in agreement with these findings, where the higher prevalence of the disease in males compared to females was confirmed as significant.

However, the aetiological importance of hypothyroidism for the development of DCM is controversial and unexplained, and it was not confirmed in the study evaluating Doberman Pinschers (Beier et al. 2015). Likewise, our study did found no association between DCM and hypothyroidism.

The prevalence of preclinical DCM in long-haired Weimaraners was 22.22%. It was diagnosed in 2 patients, both of them were females. Having confirmed the fact that the Weimaraner is one of the breeds predisposed to the development of DCM, we still recommend performing a preventive examination of a Weimaraner dog to decrease the risk of sudden death. Based on the results, it is recommended to examine the stud dog every year.

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