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# Main risk factors of dogs with congestive heart failure diagnosed by doppler echocardiographic parameters

## *Principais fatores de risco em cães com insuficiência cardíaca congestiva diagnosticada por parâmetros ecocardiográficos*

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**ABSTRACT:** Nowadays, congestive heart failure is one of the major complications of heart disease in small animals, which is characterized by a clinical condition in which the heart is unable to eject the blood efficiently. At long term, some compensatory mechanisms it will eventually become detrimental and, mainly, due to the congestion caused by it. In dogs, the main cause of CHF is chronic mitral valve degeneration, it is responsible for the degeneration of collagen present in the mitral valve structure that will have detrimental consequences on the entire circulatory system. The aim of the present study was to perform a retrospective study of 498 echocardiographic reports collected at a veterinary cardiology service of the Bauru region, from January 2017 to June 2019. Two groups were formed according to the Doppler echocardiographic alterations found, one that included animals with characteristics of congestive heart failure (CHF), and the other formed by non-CHF patients. Of the total number of animals evaluated, 61 were classified as affected by congestive heart failure and after classification, it was considered the main epidemiological factors (race, sex and age) of animals belonging to this group. Small breed animals were overrepresented and also elderly animals, with no apparent sexual predisposition. In addition, animals with CHF presented higher values when compared to animals without CHF of LA/Ao ratio (2.31 ± 0.30 vs. 1.46 ± 0.35), E/IRTV ratio (2.96 ± 0.39 vs. 1.16 ± 0.43) and E-wave velocity (1.45 m/s ± 0.18 vs. 0.75 m/s ± 0.22) on echocardiographic examination.

**KEYWORDS:** Cardiopathy; Echocardiogram; Endocardiosis; Mitral.

**RESUMO:** A insuficiência cardíaca congestiva (ICC) é uma das principais complicações das cardiopatias em pequenos animais atualmente, sendo que é caracterizada por uma condição clínica em que o coração não é capaz de bombear a quantidade necessária de sangue para todo o corpo. A longo prazo, alguns mecanismos compensatórios acabam se tornando prejudiciais ao mesmo principalmente por decorrência do quadro de congestão que ela ocasiona. Em cães, a principal causa de ICC é a degeneração valvar crônica mitral, a qual é responsável pela degeneração do colágeno presente na estrutura da valva mitral que trará consequências prejudiciais a todo o sistema circulatório. O presente trabalho teve por objetivo a realização de um estudo retrospectivo de 498 laudos ecodopplercardiográficos provenientes de serviço de cardiologia veterinária da região de Bauru, no período de janeiro de 2017 a junho de 2019. Foi realizada a classificação em dois grupos, de acordo com as alterações ecodopplercardiográficas encontradas, sendo os grupos formados por animais portadores de insuficiência cardíaca congestiva e animais não portadores. Do número total de animais, 61 foram classificados como acometidos por insuficiência cardíaca congestiva e, após a classificação, foram avaliados os principais fatores epidemiológicos (raça, sexo e idade) dos animais pertencentes a esse grupo. As raças de pequeno porte foram as mais representadas, sendo os animais idosos mais acometidos, sem predisposição sexual aparente. Além disso, animais com ICC apresentaram valores maiores quando comparados aos animais sem ICC of LA/Ao razão (2.31 ± 0.30 vs. 1.46 ± 0.35), E/IRTV razão (2.96 ± 0.39 vs. 1.16 ± 0.43) e velocidade E-wave (1.45 m/s ± 0.18 vs. 0.75 m/s ± 0.22) no exame ecocardiográfico.

**PALAVRAS-CHAVE:** Cardiopatia; Ecocardiograma; Endocardiose; Mitral.

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## INTRODUCTION

Heart disease or heart disease is characterized by any structural abnormality in the heart, anatomical or functional. However, these anomalies may or may not result in a functional change of the heart, which depends on the degree of adaptation of the circulatory system (NELSON; COUTO, 2015).

Congestive heart failure (CHF) is considered a clinical syndrome that can occur in more advanced stages, being characterized by increased venous and capillary pressures, resulting in organs with congested vessels and possible extravasation of fluids into cavities and tissues, both caused by impaired cardiac function and a more advanced stage of heart failure (JERICÓ et al., 2017).

According to Ware (2009), the causes of HF can be gathered according to its pathophysiology as myocardial insufficiency, pressure overload, diastolic dysfunction and volume overload. The author reports that, even if they are distinct, two or more causes can be found in the same animal, especially in advanced cases.

The clinical manifestations resulting from cardiac impairment vary according to the location of the abnormality; however, some of the most frequent manifestations are cough, cyanosis, syncope, exercise intolerance, and dyspnea. When the right side is affected, signs such as ascites, pleural effusion and limb edema are common; on the other hand, when the left side is involved, the predominant sign is pulmonary edema (NELSON; COUTO, 2015).

The diagnosis of congestive heart failure is confirmed by complementary tests, in addition to the complete clinical examination including history and physical exam findings. Imaging tests include chest x-ray and mainly doppler echocardiogram, which evaluates parameters such as E/IVRT ratio (Wave E/isovolumetric relaxation time), mitral E wave velocity, and LA/Ao ratio (Left Atrium/Aorta). Electrocardiogram and Holter examination, and evaluation of certain cardiac biomarkers greatly aid in the diagnosis of CHF (SCHOBER, et al, 2010. KIM, PARK, 2015; KEENE, et al. 2019).

The main tool in the diagnosis of congestive heart failure in dogs is doppler echocardiographic evaluation. It allows the definition of anatomical, functional and hemodynamic details, due to the performance of an ultrasound examination of the heart and large vessels. However, doppler echocardiographic findings should be considered together with clinical changes and other complementary tests (VATNIKOV, et al., 2020).

Ventricular filling begins with the difference in pressure between the atria and ventricles, since those have higher pressure because they are full of blood, and the ventricles have lower pressure at the end of the systole. Therefore, the pressure of the atria, represented by the E wave, is of great value for this initial stage. As the ventricle fills, the ventricular and atrial pressures are matched; then the atria contract to complete the ventricular filling, boosting the additional volume of blood. To represent this flow resulting from atrial contraction, wave A is used on doppler echocardiogram evaluation (LEOMIL NETO; RIBEIRO, 2020).

However, in an animal with congestive heart failure, due to the elevation of the preload, there is higher atrial pressure with higher ventricular filling pressure and, consequently, higher velocity of the initial filling flow; thus, the speed of the A wave consequently increases (SCHOBER et al., 2010).

The high peak velocity of the mitral valve E wave identifies, therefore, the increase in the filling pressure of the left ventricle, which may also be predictive in the survival of dogs with myxomatous mitral valve degeneration (MMVD) (SARGENT, et al, 2015; TOALDO et al., 2018). However, only E wave measurement is limited due to the influence of other parameters that also act on the increase of this wave; so, this parameter is combined with isovolumetric relaxation time (IVRT) (TOALDO, et al., 2018).

The left atrial size Is an important indicator of prognosis in dogs with MMVD. One of the methods used to quantify it is the linear measurement of the diameter of the left atrium related to the root of the aorta (LA/Ao), which is obtained by two-dimensional echocardiographic examination (HANSSON et al., 2002). Besides this, Schober et al. (2010) state that another important variable in diastolic function is IVRT, which is basically the interval between the closure of the aortic valve and the beginning of the E wave.

One of the main parameters for the identification of cardiac decompensation in a patient is the E/IVRT ratio, which is based on the relationship between E wave E and IVRT, because according to SCHOBER et al. (2010), by combining the mitral E velocity peak, which is a variable influenced by filling and relaxation pressure, with TRIV, the effect of relaxation on the velocity peak is decreased, allowing evaluation of ventricular filling pressure. The increase in this variable is found in dogs with MMVD and dilated cardiomyopathy (BONAGURA, SCHOBER, 2009; SCHOBER et al., 2010).

The aim of this paper was to make a retrospective case study, by analyzing doppler echocardiographic reports of animals with congestive heart failure, in order to establish the main risk factors associated with breed, gender and age group.

## MATERIAL AND METHODS

A retrospective study of doppler echocardiographic reports of 498 animals (males and females) from a veterinary cardiology service was conducted between January 2017 and June 2019, without distinction of breed. The evaluation was performed by a post-graduate professional in veterinary cardiology and echocardiography.

The two-dimensional modes, M and Doppler (pulsed, continuous and color flow), were performed with a transducer of 5.0 - 7.5 MHz frequency, and the data stored in the memory of the doppler echocardiography (GE, Vivid E model, São Paulo, Brasil). The dogs were positioned in right lateral decubitus and physically contained, without the use of

sedation. Echocardiographic images were obtained in the left parasternal window on the long and apical axis, and in the right parasternal window on the short axis. All atrioventricular and semilunar valves were evaluated on echocardiographic examination, as diameters of the aorta and left atrium (left atrium/aorta ratio), thickness of the free wall of the left ventricle and interventricular septum, diastolic and systolic diameter of the left ventricle, shortening and ejection fractions, blood flows in the heart and large vessels (velocity and turbulence), mitral E/A ratio, and presence or absence of valve insufficiency due to 30 regurgitations. The measures were evaluated according to Boon (2011).

Regarding the tissue Doppler, it was performed around the mitral ring, at the parietal border, in which there is a wave for each diastole phase, known as E' and A' waves, according to Sousa et al. (2020).

Of all the animals enrolled by the study, which were referred for echocardiographic evaluation by veterinary colleagues to identify possible cardiac diseases, a division was made into two groups according to echocardiographic changes, when 437 dogs were classified as patients that did not have CHF and 61 were classified as animals with CHF. The parameters used for this classification were the E wave and Isovolumetric Relaxation Time ratio (E/IVRT greater than 2,5), the mitral E wave velocity (1.2) and left atrium/aorta ratio (LA/Ao greater than 1.6), as recommended by Schober et al. (2010).

## RESULTS

Of the total of 498 doppler echocardiographic reports analyzed, 61 (12.2%) were classified as patients affected by congestive heart failure, according to the parameters used for this classification. The remaining 437 (87.8%) did not present changes in parameters consistent with CHF. Table 1 presents the mean and standard deviation values of the evaluated parameters.

The animals with congestive heart failure were also classified according to age group, as it was observed that elderly dogs were more affected, followed by adult animals (Table 2).

Regarding the breeds of the dogs, descriptive analysis of dogs with CHF was performed, and the present study demonstrates that Poodle was the most prevalent breed, followed by mongrel dogs. The number and percentage of all breeds are shown in Table 3.

**Table1.** Mean and standard deviation of doppler echocardiographic parameters: LA/Ao ratio, E/IVRT ratio and mitral E wave velocity from patients with and without CHF.

| Animals | LA/Ao | E/IVRT | E wave velocity |
|---|---|---|---|
| With CHF | 2,31± 0,30 | 2,96 ± 0,39 | 1,45 ± 0,18 m/s |
| Without CHF | 1,46 ± 0,35 | 1,16 ± 0,43 | 0,75 ± 0,22 m/s |
| Reference value | 0,83 a 1,13 | ≤ 2,5 | ≤ 0,9 a 1,0 m/s |

**Table 2.** Descriptive analysis of age group and gender of dogs affected by CHF.

| Age group | Females | Males | Total (%) |
|---|---|---|---|
| Puppy (0-1 years old) | 0 | 0 | 0 (0%) |
| Adult (1-8 years old) | 1 | 5 | 6 (9,8%) |
| Elderly (> 8 years old) | 30 | 25 | 55 (90,2%) |
| Total | 31 | 30 | 61 (100%) |

**Table 3.** Descriptive analysis of dogs´ breeds affected by CHF.

| Breed | Number | Percentage |
|---|---|---|
| Poodle | 26 | 42% |
| Mongrel dogs | 10 | 16,30% |
| Maltese | 5 | 8,10% |
| Lhasa Apso | 5 | 8,10% |
| Yorkshire terrier | 5 | 8,10% |
| German Spitz | 3 | 4,90% |
| Teckel | 3 | 4,90% |
| Schnauzer | 2 | 3,20% |
| Doberman Pinscher | 1 | 2,00% |
| Cocker spaniel | 1 | 2% |
| Total | 61 | 100% |

## DISCUSSION

The breeds of animals with congestive heart failure found in the present study were Poodle, Mongrel dogs, Maltese, Lhasa Apso, Yorkshire terrier, German Spitz, Teckel, Schnauzer, Pinscher and Cocker spaniel, arranged according to the highest occurrence, and these results are similar to those reported by other authors, who also reported that small breeds were most prevalent to CHF (BORGARELLI., et al, 2004; MALTA et al., 2015). This finding can be justified by the fact that small dogs are more predisposed to the development of MMVD, with prevalence estimates ranging from 14-40% (VATNIKOV et al., 2020).

On the other hand, authors like Boswood, et al., (2016) found a considerable prevalence of 45.5% for Cavalier King Charles Spaniel dogs (CKCS). The genetic factor related to breed predisposition is present in CKCS dogs, which develops CHF very early when compared to other breeds. However, in our study, we had only 1 CKCS dog and it did not present parameters consistent with CHF; also, it is important to note that in the studied region CKCS dogs are not very widespread, which could justify the low occurrence.

In addition to small breed dogs, in relation to age group, the elderly patients are predisposed to the development of MMVD and, consequently, CHF, as demonstrated in the present study, because the percentage of elderly animals was considerably higher, corroborating data presented in previous studies

(CHAMAS et al., 2011; MALTA et al., 2015). Elderly dogs are predisposed to congestive heart failure because of the progression of CMD, as mitral valve degeneration is proportional to the evolution of the disease; therefore, in elderly animals, the MMVD reaches advanced stages, predisposing them to the development of CHF (MALTA et al., 2015).

According to previous studies, CHF occurs more frequently in male dogs than in females, which is a consequence of the greater sexual predilection of MMVD in male dogs, in whom it presents more severely and with faster progression (MALTA et al. 2015). However, the present study did not show a difference in the percentage in the regarding the gender of animals with CHF.

Regarding doppler echocardiographic parameters, the E/IVRT ratio in animals with congestive should be high, because the increase in left ventricular filling pressure is the main hemodynamic change found in CHF and it is closely associated with increased E wave of the transmitral flow and the decrease in IVRT (SCHOBER et al. 2008). This statement could also be confirmed by the present study, as the mean E/TRIV ratio in animals with CHF was higher, corroborating the values found in other studies (SCHÖBER et al., 2010).

Morgan et al. (2020) also state that dogs with CHF have an increase of E wave and E/IVRT ratio (mean value of 1.05 and 3.28, respectively), results very similar to those found in the present study, as shown in Table 1.

Regarding E wave velocity of the transmitral flow, the present study confirms its increase in animals with CHF, and the mean observed was higher than the value proposed for compensated animals. In studies conducted by other authors, such assertion could also be demonstrated (MANTOVANI, 2016). The velocity peak of the E wave of the transmitral flow demonstrates the rapid phase of ventricular filling, which is influenced by the atrioventricular pressure gradient; therefore, in these animals, this parameter is commonly increased (BONAGURA; SCHOBER 2009; SCHOBER et al., 2010).

Left atrium/aorta (LA/Ao) ratio, the relationship between the diameter of the left atrium and the root of the aorta, it is one of the most important parameters in the evaluation of the severity of mitral regurgitation (BORGARELLI et al., 2008) caused mainly by MMVD, which is one of the main causes of CHF symptoms in small animals (KEENE, et al., 2019; VATNIKOV, et al., 2020).

Other authors state that LA/Ao ratio values were increased (HEZZELL et al., 2018), and this statement could also be confirmed by the present study because the mean value found in animals with CHF was also higher than the standard value. This could be explained as cardiac remodeling occurs due chronic mitral regurgitation, which causes volume overload, which in turn causes left atrium and ventricular increase in relation to aorta (KIM, et al., 2018).

## CONCLUSION

In most cases, congestive heart failure is a severe condition that should be treated as an emergency to increase the survival odds. Small breed and elderly animals, without apparent sexual predisposition, are most affected, due to genetic predisposition to chronic mitral valve degeneration, one of the main causes of CHF. The values of the LA/Ao ratio, E/IVRT ratio and mitral E wave velocity, all these parameters observed on echocardiographic examination, were all higher in animals with CHF when compared to animals without CHF. Doppler echocardiogram is a fundamental tool in the diagnosis and therapeutic monitoring of this condition, and it has become increasingly accessible in several regions of Brazil, due to the increasingly affordable prices of this exam. The clinician should be aware of the importance of doppler echocardiogram and its interpretation, and also to the animals more predisposed to heart diseases, in order to improve the prognosis of these patients.

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