

# Retrospective analysis of co-occurrence of congenital aortic stenosis and pulmonary artery stenosis in dogs

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## Abstract

The study has focused on the retrospective analysis of cases of coexisting congenital aortic stenosis (AS) and pulmonary artery stenosis (PS) in dogs.

The research included 5463 dogs which were referred for cardiological examination (including clinical examination, ECG and echocardiography) between 2004 and 2014. Aortic stenosis and PS stenosis were detected in 31 dogs. This complex defect was the most commonly diagnosed in Boxers – 7 dogs, other breeds were represented by: 4 cross-breed dogs, 2 Bichon Maltais, 3 Miniature Pinschers, 2 Bernese Mountain Dogs, 2 French Bulldogs, and individuals of following breeds: Bichon Frise, Bull Terrier, Czech Wolfdog, German Shepherd, Hairless Chinese Crested Dog, Miniature Schnauzer, Pug, Rottweiler, Samoyed, West Highland White Terrier and Yorkshire Terrier. In all the dogs, the murmurs could be heard, graded from 2 to 5 (on a scale of 1-6). Besides, in 9 cases other congenital defects were diagnosed: patent ductus arteriosus, mitral valve dysplasia, pulmonary or aortic valve regurgitation, tricuspid valve dysplasia, ventricular or atrial septal defect. The majority of the dogs suffered from pulmonary valvular stenosis (1 dog had supra- and subvalvular pulmonary artery stenosis) and subvalvular aortic stenosis (2 dogs had valvular aortic stenosis).

Conclusions and clinical relevance – co-occurrence of AS and PS is the most common complex congenital heart defect. Boxer breed was predisposed to this complex defect. It was found that coexisting AS and PS is more common in male dogs and the degree of PS and AS was mostly similar.

**Key words:** aortic stenosis, pulmonary valve stenosis, complex congenital heart defects

## Introduction

Congenital heart defects represent an essential cause of morbidity and mortality in dogs during the first year of life (Buchanan 1999). Coexistence of aortic stenosis (AS) and pulmonary artery stenosis (PS) is the most common complex heart malformation (Domanjko – Petric and Cvetko 2009, Oliveira et al. 2011). Dogs can present with typical symptoms of left or right heart failure, or general (both sided) heart insufficiency depending on severity of each malformation. The aim of this study was to analyse and elaborate epidemiological prevalence of congenital AS and PS co-occurrence in dog population in Poland based upon the data from the Wrocław University of Environmental and Life Sciences and the University of Warmia and Mazury in Olsztyn, in 2004-2014.

## Materials and Methods

The analysis included 5463 dogs which were referred for cardiological examination at the Department of Internal Medicine and Clinic of Diseases of Horses, Dogs and Cats, Wrocław University of Environmental and Life Sciences and the Department of Clinical Diagnostics, University of Warmia and Mazury in Olsztyn. The analysis considered data between January 2004 and September 2014.

All the dogs were examined as follows: clinical examination, electrocardiography (ECG) and echocardiography. Heart murmurs severity was classified on a scale of 1-6 grade, where 1 stands for the softest murmur and 6 represents the loudest one. Echocardiographical examination in the standard right and left parasternal views, as well as the subcostal view, was performed using ALOKA 4000+ or ALOKA  $\alpha$ 7, 3.5-8 MHz probe (Bussadori et al. 2000, Pasławska 2012). The aortic and pulmonic peak velocities were measured with continuous wave Doppler. The peak velocity in the aorta was measured in the 5<sup>th</sup> left five-chamber apical view and the subcostal view. The maximum velocity and pressure gradient was taken into consideration. Localization of stenosis as well as the aneurysmal aortic dilatation (often seen in the background) were visualized in the right parasternal long axis view and the left five-chamber apical view. The blood flow velocity in the pulmonary artery was measured in the 4<sup>th</sup> right parasternal short axis view. In the same view, the location of the stenosis, any lesions occurring in the pulmonic valve and poststenotic aneurysm were observed. In Boxers, stenosis was diagnosed when the blood flow velocity was higher than 2.0 m/s in the aorta, and 1.8 m/s in the pulmonary artery. In other breeds, AS was confirmed

when the flow rate in the aorta exceeded 1.7 m/s, and, likewise, PS was claimed when the flow rate in the pulmonary artery exceeded 1.6 m/s. The patients were divided into three groups depending on blood flow velocity through the pulmonic and aortic valve, and the blood pressure in the pulmonic artery and aorta according to the binding standards. Light degree stenosis referred to the velocity from 2.25 to 3.5 m/s (blood pressure from 20 to 49 mmHg), moderate degree stenosis – velocity from 3.5 to 4.5 m/s (blood pressure from 50 to 80 mmHg) and severe degree stenosis – velocity over 4.5 m/s (blood pressure over 80 mmHg) (Kienle 1998, Bussadori et al. 2000, Locatelli et al. 2013).

Standard ambulatory electrocardiogram was performed using BTL-08-SD apparatus with alligator clip electrodes in standing patients, as the lateral recumbency was less tolerated. Previous studies did not show significant differences in ECG obtained in standing and right lateral position with the exception of the mean electrical axis (Rishniw et al. 2002, Pasławska et al. 2005). Nine-lead surface electrocardiogram was recorded for each patient to analyse heart rhythm.

## Results

In 410 dogs a congenital heart disease was diagnosed. Co-occurrence of AS and PS was detected in 31 dogs representing 7.6% of the group of dogs with congenital heart defects and was the most common congenital complex heart disorders. This complex defect was diagnosed mostly in Boxers – 7 dogs. Other breeds were represented by: 4 cross-breed dogs, 2 Bichon Maltais, 3 Miniature Pinschers, 2 Bernese Mountain Dogs, 2 French Bulldogs, and individuals of following breeds: Bichon Frise, Bull Terrier, Czechoslovakian Wolfdog, German Shepherd, Hairless Chinese Crested Dog, Miniature Schnauzer, Pug, Rottweiler, Samoyed, West Highland White Terrier and York shire Terrier. In 9 of 31 dogs diagnosed with PS and AS there were also other congenital defects (Table 1). Sixty eight dogs were diagnosed with a complex heart defect, therefore, the dogs with AS and PS represented almost half of this group – 45.6%, and the dogs with PS and AS without any other accompanying defect accounted for 32.4%. It was the most frequently diagnosed complex defect in dogs.

Most patients with the complex defect AS + PS did not show any clinical symptoms and they were referred for cardiological examination because of heart murmur which could be heard in each single patient. Systolic murmur was audible in all the patients on the left side over the base of the heart: both

Table 1. Number of dogs and sex distribution in groups of varying degrees of AS and PS.

Grade of stenosis	Number of dogs	Females	Males
Mild AS, mild PS	6	1	5
Mild AS, moderate PS	3	0	3
Mild AS, severe PS	4	3	1
Moderate AS, moderate PS	3	0	3
Moderate AS, severe PS	3	2	1
Severe AS, mild PS	2	2	0
Severe AS, moderate PS	4	0	4
Severe AS, severe PS	6	2	4

Table 2. Defects in dogs associated with congenital AS and PS.

Breed	Number of dogs	Concomitant cardiac malformation
Boxer	1	patent ductus arteriosus
French Bulldog	1	mitral valve dysplasia
French Bulldog	1	aortic regurgitation and atrial septal defect
Miniature Pinscher	1	pulmonary valve regurgitation
Cross-breed dog	1	tricuspid valve dysplasia
Cross-breed dog	1	aortic regurgitation
West HighlandWhite Terrier	1	ventricular septal defect
Pug	1	aortic regurgitation and ventricular septal defect
Newfoundland crossbreed	1	pulmonic and aortic regurgitation and atrial septal defect

Table 3. Compilation of the number of dogs referred for cardiological examination, number of dogs diagnosed with congenital heart defect and number of dogs with coexisting PS and AS.

Year	Total number of dogs	Number of dogs with congenital heart disease	Number of dogs with AS+PS (% representation in group with congenital heart disease)
2004	382	14 (3.7%)	0
2005	421	15 (3.6%)	0
2006	453	22 (4.86%)	1(4,5%)
2007	446	22 (4.9%)	2 (9%)
2008	479	53 (11%)	6 (12%)
2009	519	60 (11.6%)	4 (6.7%)
2010	619	42 (6.8%)	4 (9.5%)
2011	579	50 (8.6%)	6 (12%)
2012	528	26 (4.92%)	5 (12%)
2013	493	42 (8.51%)	1 (3.8%)
2014	544	49 (9%)	2 (4.1%)

over the aortic valve and pulmonary artery. In severe stenosis, the murmur was also audible on the right side of the chest. Murmur volume depended on the degree of stenosis of the aorta and pulmonary artery. In all the dogs, these were the murmurs ranging from grade 2 to 5 (on a scale of 1-6). The ECG examination did not show any arrhythmias.

According to the age of 31 dogs with PS and AS, 12 dogs were under the age of 6 months and besides the murmur these patients were completely asymptomatic. Nine dogs aged between 6 months and 2 years represented the group with minor symptoms involving exercise intolerance, apathy or occasional cough. Dyspnoea, syncope and advanced exercise intolerance

were observed in 5 out of 10 dogs aged over 2 years. Three dogs from this group with mild AS and mild PS were examined because of the systolic murmur, however, they did not show any other symptoms. Neither ascites nor hydrothorax were detected in dogs with AS and PS. Almost all of the dogs had pulmonary valvular stenosis – only 1 dog was diagnosed with supravalvular PS. Most common form of AS (29 dogs) was subaortic stenosis and only 2 cases of valvular AS were diagnosed.

The summary of the severity of AS and PS in the dogs is shown in a table (Table 1). In 15 cases the degree of aortic and pulmonic stenosis was the same – mostly mild or severe (6 cases). In 10 dogs PS was

more severe than AS, while it was the opposite in 6 other animals. The male dogs were more affected (21 animals) in contrast to the females (10 dogs). In some cases AS and PS were a part of most complex malformation. We found the presence of different anomalies without visible domination with any of them (Table 2). The analysis showed the prevalence of congenital heart disease at the level of 3.6-11.6% (mean 6.3% per year) with AS and PS prevalence at the level of 3.8-12% (mean 8.2% per year) of congenital heart malformation (Table 3).

## Discussion

Co-occurrence of AS and PS in 7.6% of dogs with congenital heart defects represents a higher percentage in comparison to the results published by Gregori (Gregori et al. 2008). Aortic stenosis and PS were detected in seven Boxers, this breed represented 22.5% of all the dogs with the complex heart defect, while in previous studies, Boxer dogs accounted for 100% of the group with this complex heart defect (Bussadori et al. 2001, Gregori et al. 2008). Frequent diagnosis of AS and PS in Boxers gives rise to suspicion that the breed is predisposed to them. Predisposition of the Boxer breed to AS or PS occurring alone has been proved (Höpfner et al. 2010).

The analysis of the sex distribution shows that males predominate among dogs with any complex defect, the ratio of males to females is 29:11, and among individuals with PS and AS – 21:10. In Boxers the ratio was 4:3, the predominance of male Boxers with isolated PS or AS was indicated earlier (Höpfner et al. 2010).

Classification of the severity of stenosis is based upon the measurement of the maximum flow rate and blood pressure at the stenosis. There is a variety of thresholds for mild AS diagnosis depending on the resources – more than 1.5 m/s (Yuill and O'Grady 1991), 2.3-3.2 m/s or from 2.25-3.5 m/s (Bussadori et al. 2000, Menegazzo et al. 2012). We assessed the severity of aortic and pulmonic stenosis according to the criteria recommended by Bussadori (Bussadori et al. 2000). In the last few years the number of cardiologically examined dogs and the number of dogs with congenital heart disease including multiple heart defects, has increased (Table 3). Based on the present research we are not able to decide if it is an actual increase in the number of dogs with congenital heart defects or if this is a secondary effect connected with the growing knowledge about congenital heart malformations among veterinarians as well as the increased accessibility of echocardiographic examination. Since 2008, the number of dogs with congenital

heart failure is quite stable. In some cases AS and PS are a part of most complex heart problems, but we could not find any connection with specific congenital problem. According to the dogs diagnosed with PR and AR, the authors cannot be sure if the regurgitations were congenital or only appeared secondarily to the cardiac remodelling. The prophylactic cardiologic examination should be performed on pure breed dogs, especially on Boxers, to eliminate affected individuals from breeding. In any condition the earlier recognition allows to achieve better results in the treatment and increase in average survival time.

## Conclusions

Co-occurrence of AS and PS is the most common complex congenital heart defect, with stable prevalence at mean level of 8.2% of dogs with congenital heart malformation. In dogs, the Boxer breed was predisposed to this complex defect. It was found that concomitant AS and PS is more common in male dogs and the degree of PS and AS was mostly similar.

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