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Retrospective study of 942 small-sized dogs: Prevalence of left apical systolic heart murmur and left-sided heart failure, critical effects of breed and sex

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KEYWORDS

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Abstract Objectives: The main goals of this study were (1) to carry out a retrospective study of the prevalence of left apical systolic heart murmurs, which are considered to clinically reflect the presence of MVD, in the 6 small canine breeds most popular in France, i.e., Yorkshire Terrier, Bichon Maltese, Dachshund, Poodle, Lhasa Apso and Shi Tzu and (2) to compare the results with those obtained in a recent report published by our group on MVD in 451 CKC.

Background: Mitral valvular disease (MVD) has been extensively studied in Cavalier King Charles spaniels (CKC) but seldom studied and compared in other small-breed dogs. The first clinical sign of MVD is the early appearance of a left apical systolic heart murmur.

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Animals: Nine hundred and forty-two adult dogs were included in the present study (mean \pm SD, age = 6.5 ± 4.4 years, weight = 6.2 ± 2.6 kg).

Results: The average total prevalence of left apical systolic heart murmur was 14.4% compared with 40.6% in CKC. It was significantly more prevalent in males (18.5%) than in females (9.8%). Shi Tzu and Dachshunds were the most affected breeds investigated. Most (81%) of the dogs with left apical systolic murmur were classified in ISACHC heart failure class I.

Conclusion: This large retrospective study suggests that the prevalence of MVD is higher in CKC than in the 6 small breeds investigated. Moreover, most of the dogs do not develop congestive heart failure.

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Introduction

Mitral valve disease (MVD) is characterized by myxomatous valvular degeneration and is the most common heart disease in small-breed dogs.^{1–4} It results in early mitral valve insufficiency, which in turn leads to the appearance of a left apical systolic murmur. The progression of MVD includes left atrial and ventricular dilations, supra-ventricular arrhythmias, and at a later stage, pulmonary edema, myocardial failure, and pulmonary hypertension.

The prevalence of MVD is known to increase dramatically with age. Both prevalence and progression are believed to be higher and faster in males than females.⁵ Mitral valve disease has been extensively investigated in Cavalier King Charles spaniels.^{6–15} A few studies have focused on other canine breeds such as Dachshunds^{16–19} and more recently, large breed dogs such as German Shepherds.²⁰ As a result, it has often been hypothesized that these breeds are more likely to develop MVD, despite the fact that, since the main reports of the 1970–1980s,^{1,2} their epidemiological, clinical and echocardiographic features have seldom been compared with those of other breeds. Furthermore, MVD has not been specifically investigated in some of the small-sized breeds, such as Shi Tzu and Lhasa Apso, that are now becoming increasingly common in Europe.

The aim of this descriptive report was therefore (1) to retrospectively assess the prevalence of left apical systolic murmurs, which are considered to indirectly reflect the presence of MVD, in a large population of adult male and female small-breed dogs, and (2) to compare the results with those obtained in a recent report on MVD in 451 Cavalier King Charles spaniels published by our group and using the same methodology.⁶ Only 6 small breeds of dogs (Yorkshire Terrier, Bichon Maltese, Dachshund, Poodle, Lhasa Apso and Shi Tzu) were included in this report as a preliminary study (data

not shown) demonstrated that these were the 6 most popular small breeds in France.

Animals, materials and methods

Animals, inclusion and non-inclusion criteria

Adult dogs (more than 1-year old) of 6 small breeds, i.e., Yorkshire Terrier, Bichon, Dachshund, Poodle, Lhasa Apso and Shi Tzu, were recruited between September 1991 and June 2004 from the Cardiology Unit of the National Veterinary School of Alfort (UCA) and 2 veterinary hospitals (Paris, France) working in collaboration with UCA. Dogs for which age and/or weight had not been indicated were not included in the study. Dogs that had been examined during a specialized cardiology consultation were also excluded. We therefore selected a population that should be reasonably representative of the current French canine population. The main epidemiological (age, weight, sex, and breed) and clinical characteristics of the included animals were extracted from computerized databases.

Clinical examinations

The clinical exams in all 3 veterinary hospitals involved in the study had been particularly exhaustive and were thoroughly described in the computerized databases. Any left apical systolic murmur detected was graded according to a 1–6 classification.⁴ Finally, the degree of heart failure was classified according to the ISACHC recommendations.²¹

Echocardiographic exams

Some of the dogs with left apical systolic murmur had echocardiographic and Doppler examinations. As previously mentioned, animals primarily referred

for an echocardiographic exam were not included in the study in order to avoid a selection bias and limit the risk of overestimating the prevalence of canine MVD.

The echocardiographic examination was performed as previously described.⁶ Briefly, standard transthoracic echocardiography with continuous ECG monitoring was performed by the same trained observer (VC, Dipl. ECVIM-CA Cardiology) using an ultrasound equipped with a 7.5–10 MHz phased-array transducer. All conventional ultrasound examinations were carried out in awake dogs, gently restrained in the standing position. This method has already been shown to have good repeatability and reproducibility.²² Ventricular measurements were taken from the right parasternal location (short-axis view) using the 2D-guided M-mode according to the recommendations of the American Society of Echocardiography.²³ Measurements of the aorta and the left atrium were obtained using a 2D method²⁴ from the short-axis right-sided parasternal view at the level of the aortic valve, where the commissures of the cusps could be observed during diastole. The internal short-axis diameter of the aorta (Ao) was measured along the commissure between the non-coronary and left coronary aortic valve cusps. The diameter of the left atrium (LA) was measured in the same frame along a line extending from and parallel to the commissure between the non-coronary and left coronary aortic valve cusps. The LA/Ao ratio was calculated. The severity of the cardiac alteration was then scored from 1 to 4 according to the following previously validated classification⁶:

- echocardiographic grade 1: MVD (thickening of the mitral leaflets and mitral regurgitation confirmed by color flow Doppler) without any heart chamber dilation,
- echocardiographic grade 2: MVD with left atrial dilation (LA/Ao > 1.2),²⁵

- echocardiographic grade 3: grade 2 with left ventricular diastolic dilation,
- echocardiographic grade 4: grade 3 with left ventricular systolic dilation.

Solely the conclusions of the echocardiographic exam, i.e., the 1–4 echocardiographic MVD classes, were recorded and analyzed in the present study.⁶

Statistical analysis

The age and weight values are expressed as mean \pm SD. In contrast, the prevalence of left apical systolic murmurs is expressed as percentage \pm 95% confidence interval. These values were calculated for the whole population and for specific subgroups based on sex and breed. These different subgroups were compared using a Chi-Square test. However, the different breeds could not be compared as prevalence strongly depended on age and the ages between breeds were different. Accordingly, the prevalence of left apical systolic murmurs, in yearly increments, was also determined in the whole population and according to sex and breed. The prevalence was not calculated, however, if there were fewer than 10 dogs in a particular 1-year subclass. The Spearman correlation coefficient between the murmur grade and age of the dog was determined. The selected level of significance was $p < 0.05$.

Results

Nine hundred and forty-two dogs were included in the present study: 165 Yorkshire Terriers, 124 Lhasa Apsos, 176 Poodles, 164 Bichons, 162 Dachshunds and 151 Shi Tzus. Age, weight and distribution according to sex are shown in Table 1.

Table 1 Age (year), weight (kg), sex and breed distribution of dogs included in this retrospective report

	n	Age (year) (mean \pm SD)	Weight (kg) (mean \pm SD)	Male (%)		Female (%)	
				Non-sterilized	Sterilized	Non-sterilized	Sterilized
All breeds	942	6.5 \pm 4.4	6.2 \pm 2.6	46	8	27	19
Different breeds							
Yorkshire Terrier	165	6.7 \pm 4.1	3.5 \pm 1.7	39	11	28	22
Lhasa Apso	124	5.0 \pm 4.1	7.0 \pm 2.2	47	6	28	19
Poodle	176	9.8 \pm 3.9	6.7 \pm 2.6	42	8	27	23
Bichon	164	4.9 \pm 3.9	5.0 \pm 2.0	51	7	29	13
Dachshund	162	6.7 \pm 4.2	7.5 \pm 2.6	46	7	27	20
Shi Tzu	151	4.8 \pm 3.6	5.8 \pm 1.8	49	8	25	18

Prevalence of left apical systolic murmur

A left apical systolic murmur was detected in 136 dogs out of the overall population of 942 ($14.4 \pm 2.2\%$). This prevalence was strongly and significantly lower than that observed in a previous study in 451 Cavalier King Charles spaniels in the same area ($40.6 \pm 4.5\%$).⁶ Fig. 1 shows the prevalence of left apical systolic murmurs is strongly dependent on age in Cavalier King Charles as well as in other small-breed dogs. However, the maximal prevalence observed in this study was 50% compared with 100% in the previous report concerning Cavalier King Charles spaniels.⁶

As shown in Table 2, the prevalence of left apical systolic murmurs was significantly higher in males than in females ($p < 0.05$). This prevalence also increased more rapidly in males than in females (Fig. 2). Prevalence in both male and female groups was not significantly changed by sterilization.

Table 3 shows the prevalence of left apical systolic murmurs in the different breeds. However, these global prevalence values could not be compared because of the differences in age between breeds (Table 1). Instead, as illustrated in Fig. 3, the relationship between age and the prevalence of left apical systolic murmurs was investigated. Compared to the population as a whole, Dachshunds and Shi Tzus breeds were more predisposed to left apical systolic murmurs, whereas Yorkshire Terriers and Lhasa Apso were less predisposed than the other breeds. The potential difference regarding left apical systolic murmurs between breeds was further assessed by determining the

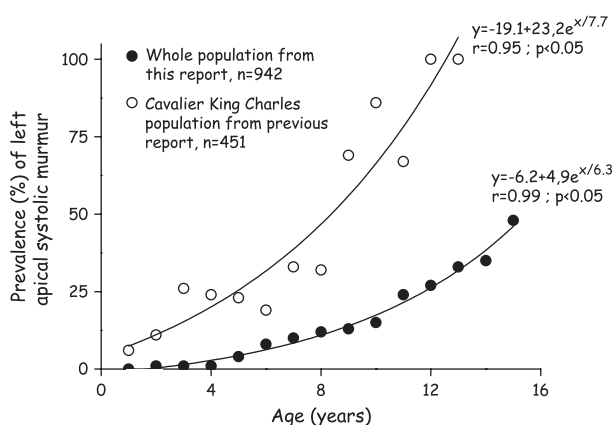


Figure 1 Relationship between the prevalence of left apical systolic murmurs (%) and the age of dogs (years) in our population (solid circle). Also given is this relationship in a population of Cavalier King Charles spaniels that was recently investigated using the same methodology and in the same area (open circle).⁶

Table 2 Prevalence of left systolic apical murmurs in males and females (sterilized or non-sterilized)

	<i>n</i>	Prevalence as % ± 95% confidence interval
Male		
All males	503	18.5 ± 3.4
Non-sterilized	429	17.9 ± 3.6
Sterilized	74	22.0 ± 9.4
Female		
All females	439	9.8 ± 2.8*
Non-sterilized	258	9.3 ± 3.5*
Sterilized	181	10.5 ± 4.5*

* $p < 0.05$ as compared to corresponding males.

theoretical age at which 20% of dogs of a given breed developed such a murmur. This theoretical age was 8.6, 9.5, 10.4, 11.1, 12.7 and 13.2 years in Shi Tzus, Dachshunds, Bichons, Poodles, Yorkshire Terriers and Lhasa Apso, respectively. It confirms that Shi Tzus and Dachshunds seem more predisposed than the other breeds and that Yorkshire Terriers and Lhasa Apso are less affected.

Table 4 shows the age of males and females in the 6 specifically investigated breeds and the corresponding MVD prevalence. In Bichons and Poodles this prevalence was significantly higher in males compared to females ($p < 0.05$). It also tended to be increased in male Yorkshire Terriers ($p = 0.09$) and male Dachshunds ($p = 0.06$) and to a lesser extent in male Shi Tzus ($p = 0.11$).

Auscultation grades, clinical class of heart failure and MVD echocardiographic class in dogs with left apical systolic murmur

Auscultation grades and ISACHC classes of heart failure were evaluated in 105 and 130 dogs,

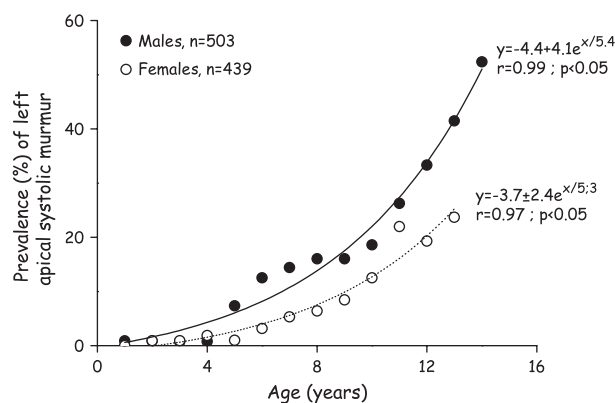


Figure 2 Relationship between the prevalence of left apical systolic murmurs (%) and the age of dogs (years) in our population of males (solid circle) and females (open circle).

Table 3 Prevalence of left systolic apical murmurs in the 6 investigated canine breeds

	<i>n</i>	Prevalence, as % ± 95% confidence interval
All breeds	942	14.4 ± 2.2
Different breeds		
Yorkshire Terrier	165	8.5 ± 4.3
Lhasa Apso	124	6.5 ± 4.3
Poodle	176	22.7 ± 6.2
Bichon	164	11.6 ± 4.9
Dachshund	162	22.2 ± 6.4
Shi Tzu	151	12.6 ± 5.3

respectively, out of the 136 dogs with left apical systolic murmur. Table 5 shows that the murmur grades were mainly between 1 and 4 (94%) and that grades of 5 or more were very rare (6%). The murmur grade was significantly correlated with age of the animal ($r = 0.3$, $p < 0.01$).

Interestingly, a large majority (81%) of dogs with left apical systolic murmurs belonged to the first class of the ISACHC heart failure classification, i.e., they did not have any symptom of heart failure (Table 5). Classes 2 and 3 of this classification represented only 12 and 7% of the dogs, respectively.

Sixty-three of the 136 dogs with left apical systolic murmurs were also subjected to an echocardiographic examination. As shown in Table 5, most of these dogs could be assigned to echocardiographic class 1, and only 16 and 14%, respectively, to classes 2 and 3. No dog was assigned to class 4.

Discussion

To our knowledge, this is the first report to extensively compare both the prevalence and the influence of age on left apical systolic murmurs in small-breed dogs. We have reasonably presumed that such prevalence is an indirect reflection of MVD and have therefore demonstrated that Cavalier King Charles spaniels are much more predisposed to MVD than other small breeds. Males are also more predisposed than females. Dachshunds and Shi Tzus were the most predisposed of the 6 breeds investigated. Finally, we demonstrated that the heart failure score and echocardiographic classes in dogs with MVD were rather low to moderate, and seldom high.

The main cause of left apical systolic murmurs in small-breed dogs is mitral regurgitation either due to degenerative mitral valve disease (i.e., MVD) or, more rarely, to mitral valve dysplasia.

Mitral valve dysplasia is a congenital valvular disease associated with a murmur of very early appearance whereas in MVD the murmur is detected much later.^{1–4} As dogs < 1-year old were excluded from this study and as the prevalence of left apical systolic murmurs was very low in the youngest class of age in the present report (0.8% for the 1–2 years class), its main origin in our population was probably degenerative MVD.^{1–4} The corresponding relationships between age and disease prevalence and severity in dogs^{3,4} and humans²⁵ have been well described in the literature. As we did not perform echocardiography in all the dogs, some dogs without murmurs might still have suffered from mild MVD. It is consequently impossible to formally extrapolate the observed prevalence of left apical systolic murmurs to that of actual MVD. Conversely, we cannot confirm that all left apical systolic murmurs were actually due to MVD and not due to dilated cardiomyopathy. Such a disease could, however, be considered as exceptional in the breeds investigated.

The prevalence of MVD in our whole population of small breeds attained 14.4 ± 2.2%. Interestingly, the average value was only 4.5 ± 0.5% in dogs of all sizes ($n = 5222$) studied from 1973 to 1975 at the University of Pennsylvania¹ and 3.5 ± 0.3% ($n = 16948$) in a similar study at the University of Edinburgh during the 1980s.² This again indicates that small breeds are strongly predisposed (3 to 4-fold) to MVD, compared to the dog population as a whole. The prevalence of MVD indicated in a previous report was much higher (40.6 ± 4.5%),⁶ in Cavalier King Charles spaniels than in the present study. We have demonstrated here that disease progression was also more rapid in CKC than in other small breeds. This further confirms that MVD in the Cavalier King Charles spaniel breed is a “model” of accelerated MVD and that the usual findings in this breed cannot easily be extrapolated to other canine breeds.

It was concluded from several investigations that both prevalence and progression of MVD could be sex dependent.^{1–3} We have indeed demonstrated that prevalence was increased 1.9-fold in males compared to females whereas previous reports have described 1.4-fold and 1.5-fold increases in dogs of all sizes.^{1,2} As observed in humans,²⁶ this higher prevalence occurs mainly in old rather than in young dogs³ and has sometimes been observed in Cavalier King Charles spaniels²⁷ but not systematically.^{5,6,13,15} Insufficient statistical power in some studies or the particularities of certain breeds might explain these discrepancies. Unfortunately, the origin of a critical sex

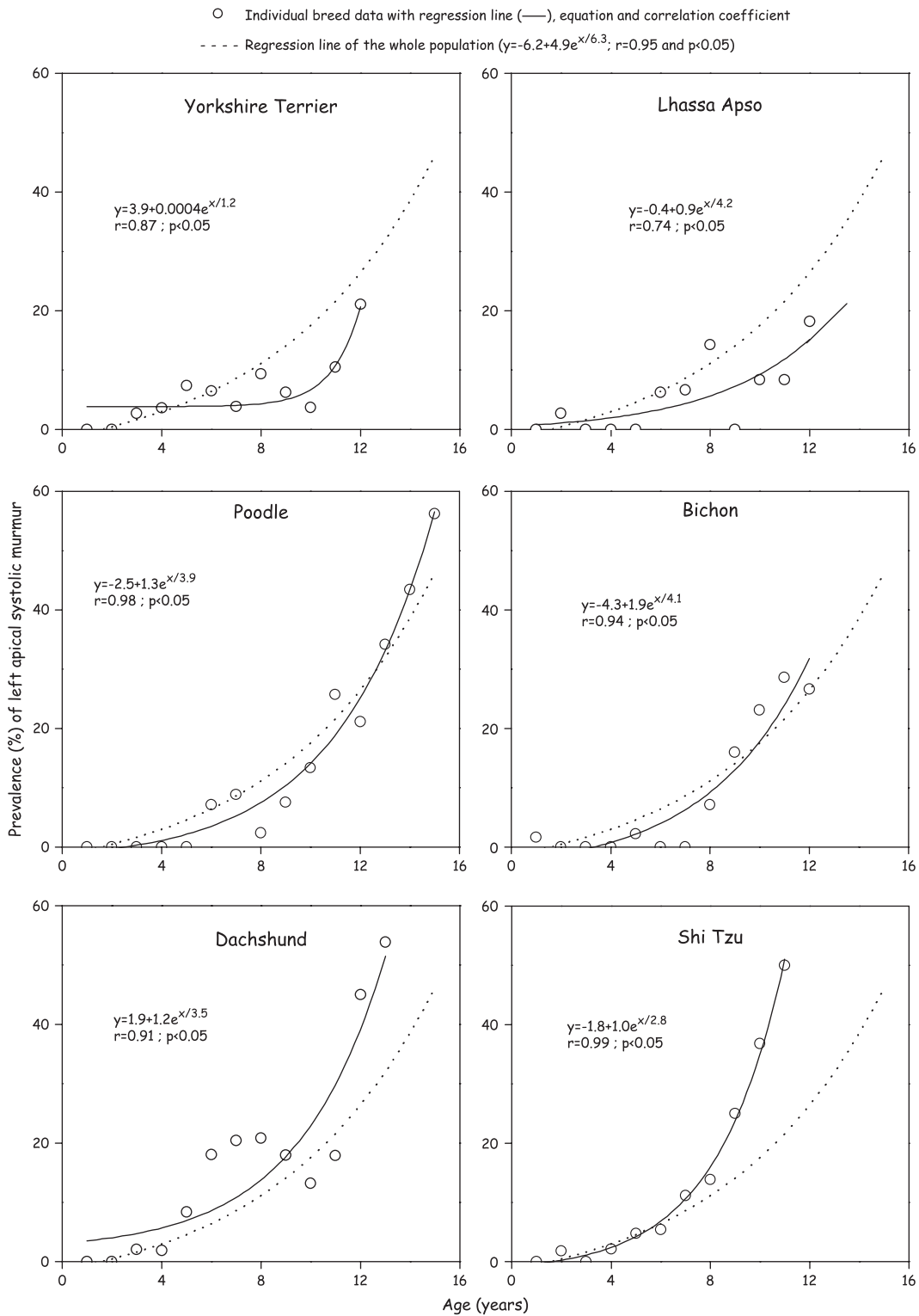


Figure 3 Relationship between the prevalence of left apical systolic murmurs (%) and the age of dogs (years) in the 6 investigated canine breeds (open circle, solid line). Dashed line represents the regression line of this relationship in the whole population.

effect has not yet been investigated. Although an estrogen-induced protective effect can be hypothesized, we found that sterilization did not significantly alter the prevalence of MVD in our

population. Swenson et al. suggested a polygenic origin.²⁷

The present study also demonstrates that the development of MVD in the main small breeds of

Table 4 Age (year) and prevalence of left systolic apical murmurs in males and females of the 6 investigated canine breeds

Breed	Male			Female		
	<i>n</i>	Age (mean ± SD)	Prevalence, as % ± 95% confidence interval	<i>n</i>	Age (mean ± SD)	Prevalence, as % ± 95% confidence interval
Yorkshire Terrier	82	7.1 ± 4.0	12.1 ± 7.1	83	6.3 ± 4.3	5.0 ± 4.8
Lhassa Apso	66	4.5 ± 4.0	4.7 ± 5.1	58	5.5 ± 4.0	8.6 ± 7.5
Poodle	88	9.9 ± 4.2	29.7 ± 9.5	88	9.6 ± 3.6	15.7 ± 8.3*
Bichon	95	5.2 ± 4.1	16.6 ± 7.5	69	4.5 ± 3.5	4.8 ± 5.2*
Dachshund	86	6.8 ± 4.1	28.1 ± 9.5	76	6.6 ± 4.2	15.7 ± 8.7
Shi Tzu	86	5.2 ± 3.5	16.5 ± 7.8	65	4.4 ± 4.0	7.5 ± 6.7

**p* < 0.05 as compared to corresponding males.

dogs in France occurs with closed prevalence, compared to the “accelerated” disease observed in Cavalier King Charles spaniels. As it was not appropriate to compare the total prevalence in several breeds of different ages, we further compared the relationships between age and MVD prevalence in the 6 small breeds investigated. It was apparent that Shi Tzus and Dachshunds were more predisposed than the other breeds. To our knowledge, this is the first report to mention the particular predisposition of Shi Tzu, although

several reports have already noted this for Dachshunds.^{16–19}

Finally, the present study confirms that MVD is usually a well-compensated disease with a long evolution.^{3,6} The heart failure scores and echocardiographic classifications were indeed low to moderate in dogs with left apical systolic murmurs. However, a limitation of our study was the related clinical and echocardiographic information that were not available for most of these dogs.

In conclusion, the data presented here confirm the critical effect of breed, age and sex on left heart disease in small-breed dogs. The particular predisposition of Shi Tzu is indicated for the first time. Finally, our echocardiographic and clinical data confirm that MVD is often well tolerated in the dog. However, these conclusions are limited to the 6 breeds investigated.

Table 5 Intensity of the left apical systolic murmurs, ISACHC class for heart failure and echocardiographic class of MVD in dogs with left apical systolic murmurs

	<i>n</i>	Proportion (%)
Systolic left apical murmur intensity		
Population with available information	105	—
Grade 1	23	22
Grade 2	35	33
Grade 3	19	18
Grade 4	22	21
Grade 5	5	5
Grade 6	1	1
ISACHC class for heart failure		
Population with available information	130	—
Class 1	105	81
Class 2	16	12
Class 3	9	7
Echocardiographic class for heart failure		
Population with available information	63	—
Class 1	44	70
Class 2	10	16
Class 3	9	14
Class 4	0	0

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