Use of Echocardiography in the Diagnosis of Dilated Cardiomyopathy in Irish Wolfhounds

The purpose of this study was to compare the echocardiographic features of Irish wolfhounds with clinically inapparent dilated cardiomyopathy (DCM) (n=33) to dogs with advanced DCM (n=33) and to normal dogs (n=262). Significant differences were detected between the three groups. In dogs with DCM, the most sensitive diagnostic measurements were: end-systolic volume index (ESVI), E-point to septal separation (EPSS), fractional shortening (FS), and left ventricular internal dimensions (LVIDd and LVIDs). Left atrial diameter was increased markedly in dogs with DCM and 83.3% of affected Irish wolfhounds had concurrent atrial fibrillation. Compared with early DCM, in advanced DCM there was a significant increase in end-diastolic right ventricular diameter, often combined with extensive pleural effusion, the leading sign of congestive heart failure in Irish wolfhounds. **J Am Anim Hosp Assoc 1999;35:279–83.**

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Introduction

In dilated cardiomyopathy (DCM), a weakening of systolic contraction is associated with left and potentially right cardiac chamber dilatation. Echocardiography is diagnostic; myocardial dysfunction can be quantified, and other causes of heart disease, such as acquired valvular or pericardial disease, can be excluded. Recognition of DCM in dogs without evidence of overt heart failure (occult DCM) is becoming increasingly common. This can be very important under breeding considerations, because in several breeds of dogs, such as Doberman pinschers,[1–5] deerhounds,[6] or Irish wolfhounds,[7] extensive line breeding with familial expression of DCM suggests a hereditary component to the disease. The purposes of this study were to define, contrast, and compare the echocardiographic features of normal Irish wolfhounds and Irish wolfhounds with DCM, with and without clinical evidence of heart failure.

Materials and Methods

Cardiovascular examinations were carried out in 400 Irish wolfhounds (156 males and 244 females). After physical examination, standard six-lead electrocardiography[a] was performed. Echocardiography was carried out by means of an ultrasound machine[b] with color-flow Doppler capabilities. In dogs with evidence of DCM on echocardiography, thoracic radiographs were taken to determine if changes consistent with congestive heart failure (CHF; i.e., cardiomegaly, left atrial enlargement [LAE], pulmonary venous distension, pulmonary edema, and pleural effusion) were present.

Echocardiograms were obtained using a 5- or a 3.5-MHz transducer. Most dogs were examined in a standing position; some dogs were placed in right-lateral and, afterward, left-lateral recumbency. Two-dimensional (2D) and M-mode echocardiograms were recorded and analyzed according to the recommendations of the American Society of Echocardiography as described by Kienle and Thomas.[8] The leading edge of each respective endocardial or epicardial echocardiographic image was used. M-mode and 2D examinations of the heart were carried out in the standard right

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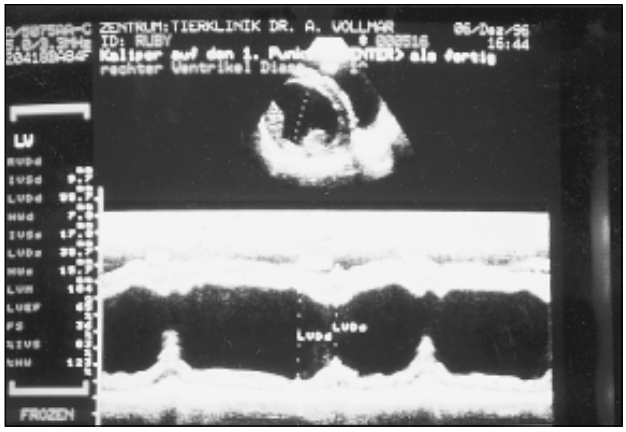

Figure 1—M-mode echocardiogram of a normal Irish wolfhound.

Figure 2—Two-dimensional (2D) echocardiogram of a three-year-old male Irish wolfhound with clinically inapparent dilated cardiomyopathy (DCM). Left atrial and left ventricular internal dimensions are enlarged (LAs=66.0 mm; LVIDs=46.7 mm; LVIDd=66.2 mm). The echogenicity of the mitral leaflets is increased. There is evidence of pericardial effusion.

parasternal long-axis view. Left and right ventricular dimensions always were measured on a portion of the echocardiographic sweep below the mitral and the tricuspid valves, respectively. Two-dimensional systolic measurements of both atria were made at the level of their maximal diameter parallel to both atrioventricular valves. Values for each parameter were determined by the average of three to five (not necessarily continuous) cardiac cycles. Doppler (pulsed and continuous wave) and color-flow imaging techniques were used to determine the amount of valvular incompetence in patients with DCM and to determine the location and severity of heart murmurs. For the calculation of end-systolic volume indices (ESVI), the left ventricle was measured during systole in the right parasternal short-axis view with M-mode echocardiography.

End-systolic volume index was calculated (cube formula according to Teichholz):[9,10]

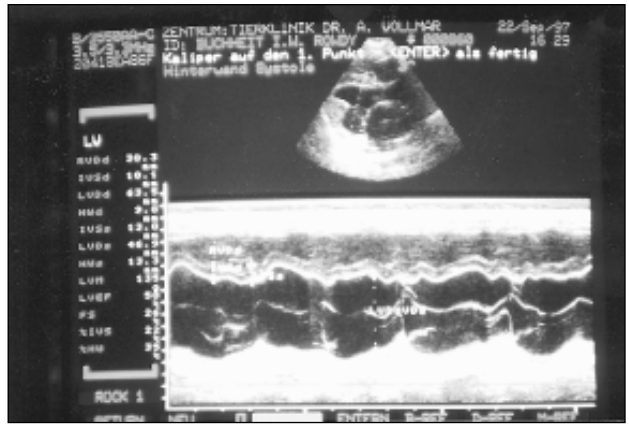

Figure 3—M-mode study from the same dog as in Figure 2. Due to atrial fibrillation, ventricular contractions are irregular. The contractility is reduced (FS=26%), although this dog is already receiving digoxin.

$$ESVI\ (ml/m^2) = \frac{7\ (LVIDs)^3}{2.4 + LVIDs} \times \frac{1}{BSA}.$$

(where BSA=body surface area)

Based on the results of the cardiovascular examination and the dog's history (e.g., signs of exercise intolerance, weakness, dyspnea, inappetence, or weight loss), three groups of Irish wolfhounds were established: normal dogs, dogs with DCM without clinical signs, and dogs with DCM and clinical evidence of heart failure.

Statistical Analysis

Data collected from all dogs was pooled according to the three groups, and mean values and standard deviations (SD) were calculated for all 13 echocardiographic parameters, ESVI, age, and body weight. For each parameter, differences between the three groups were tested with unpaired, two-tailed Student's *t*-test. A P value of less than 0.05 was considered significant.

Results

Out of 400 Irish wolfhounds, 262 dogs had a completely normal cardiovascular examination (group 1). Dilated cardiomyopathy was diagnosed in 66 (16.5%) of the 400 Irish wolfhounds examined. Males were affected relatively more often than females (30 males [19.2% of all males] versus 36 females [14.75% of all females]). Dilated cardiomyopathy without clinical signs of heart failure was present in 33 dogs (group 2), while 33 dogs had clinical evidence of heart failure confirmed by thoracic radiography (group 3). Of the 33 dogs in the latter group, CHF was severe in 13 dogs, with pleural effusion being the most dramatic finding. Group 3 consisted of more males (18) than females (15), while in group 2, representing occult DCM, 21 females versus 12 males were defined. Irish wolfhounds with occult DCM, on the average, were 11 months older than normal dogs (P less than

Table

Echocardiographic Measurements* in the Normal Irish Wolfhound, in Dogs With Occult Dilated Cardiomyopathy (DCM), and in Dogs With Advanced DCM

	Normal Dogs n=262 Mean (±SD)	P1†	Occult DCM n=33 Mean (±SD)	P2‡	Advanced DCM n=33 Mean (±SD)
LVIDs (mm)	35.4 (2.8)	<0.001	42.1 (4.4)	<0.001	52.4 (8.0)
LVIDd (mm)	53.2 (4.0)	<0.001	60.1 (6.4)	0.00027	67.4 (6.2)
FS (%)	34.0 (4.5)	<0.001	25.6 (4.5)	0.020	20.7 (8.3)
FWs (mm)	14.9 (2.2)	NS	14.4 (2.6)	NS	13.5 (3.6)
FWd (mm)	9.8 (1.6)	NS	9.4 (1.7)	NS	8.9 (2.3)
IVSs (mm)	13.7 (2.4)	0.038	12.6 (2.9)	NS	12.4 (3.5)
IVSd (mm)	9.3 (1.8)	0.033	8.4 (3.2)	NS	47.3 (11.1)
LA (mm) M-mode	32.9 (3.4)	<0.001	42.4 (9.2)	NS	47.3 (11.1)
AO (mm) M-mode	33.1 (2.8)	NS	33.5 (2.6)	NS	31.7 (5.3)
EPSS (mm)	6.8 (1.6)	<0.001	10.3 (1.9)	0.028	13.4 (5.2)
LA (mm) 2D	47.3 (4.3)	<0.001	54.9 (5.5)	0.0067	71.2 (18.6)
RA (mm) 2D	40.4 (7.5)	NS	44.4 (7.7)	NS	47.8 (7.0)
RVIDd (mm) 2D	29.1 (3.9)	NS	31.3 (6.1)	0.03	36.6 (7.1)
ESVI (ml/m^2)	28.7 (5.7)	<0.001	56.9 (8.1)	0.0049	105.7 (59.2)
Age (yrs)	3.4 (1.6)	0.01	4.3 (1.4)	NS	4.7 (2.6)
Body weight (kg)	65.0 (8.75)	NS	62.8 (8.4)	NS	61.1 (9.4)

* LVIDs and LVIDd=end-systolic and end-diastolic left ventricular internal dimensions; FS=fractional shortening; FWs and FWd=left ventricular free wall thickness during systole and diastole; IVSs and IVSd=septal thickness during systole and diastole; LA (M-mode)=left atrial diameter during systole by M-mode; AO=aortic root diastolic diameter by M-mode; EPSS=E-point to septal separation; LA, RA, RVIDd (2D)=systolic left atrial diameter, systolic right atrial diameter, and diastolic right ventricular diameter measured during two-dimensional echocardiography; ESVI=end-systolic volume index

† P=P value; P1=difference between normal dogs and dogs with occult dilated cardiomyopathy (DCM), tested with unpaired, two-tailed Student's *t*-test; NS=not significant at P less than 0.05

‡ P2=difference between dogs with occult DCM and dogs with clinical signs of DCM, tested with unpaired, two-tailed Student's *t*-test; NS=not significant at P less than 0.05

0.01), but the age difference between the dogs with occult DCM and dogs with advanced DCM was not significant. Body weights of normal dogs and of dogs with DCM were similar.

In only three dogs suffering from DCM was left ventricular contractility extremely reduced (fractional shortening [FS] values between 4% and 7%). One of these dogs, a female who was 7.5 months old, was the youngest dog in the study suffering from end-stage DCM (FS, 5%).

Comparison of the echocardiographic measurements revealed significant differences among the three groups [see Table]. When comparing dogs with clinically inapparent DCM (group 2) to normal dogs (group 1), the most apparent combination of abnormalities consistent with reduced myocardial function were: increased left ventricular end-systolic and end-diastolic diameters (LVIDs and LVIDd), a markedly increased ESVI, excessive E-point to septal separation (EPSS), and decreased left ventricular FS. The left atrium (LA) was commonly markedly enlarged, which likely contributed to the high percentage (55/66 dogs; 83.3%) of atrial fibrillation identified in the Irish wolfhounds with DCM in this study. There was a significant decrease of systolic and diastolic interventricular septal thickness (IVSs and IVSd) observed in dogs with occult DCM, but the slight decrease in both systolic and diastolic left ventricular free wall thickness (FWs and FWd, respectively) was not statistically significant.

When comparing dogs with clinical signs of heart failure (group 3) to the occult DCM dogs (group 2), the most significant differences in group 3 dogs, evident from echocardiographic examination, were: a significant increase in end-diastolic right ventricular diameter

Figure 4—Two-dimensional echocardiogram of a two-year-old male Irish wolfhound with advanced DCM. All four cardiac chambers are enlarged (LVIDs=57.1 mm; LVIDd=74.4 mm; RVIDd=58.2 mm; LAs=76.5 mm; RAs=62.5 mm). Pleural effusion is observed.

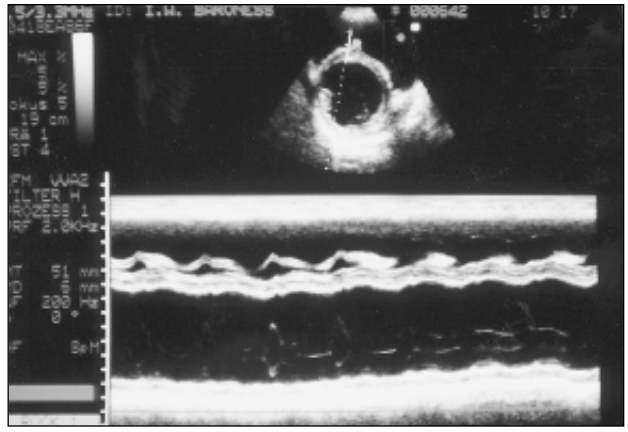

Figure 5—M-mode echocardiogram of a five-year-old female Irish wolfhound with advanced DCM. The left ventricle is markedly dilated (LVIDd=74.7 mm; EPSS=16.2 mm); septal and free wall contractions are difficult to identify.

(RVIDd), further increases in left ventricular end-systolic and end-diastolic diameters, EPSS and LA systolic diameter, and a further statistically significant deterioration of FS and ESVI.

Discussion

Echocardiography is useful in the diagnosis of early DCM in clinically normal Irish wolfhounds. It allows an estimation of severity in diseased dogs and provides a means for the monitoring of disease progression and response to therapeutic intervention.

According to the results of this study, echocardiography makes it possible to detect occult DCM in Irish wolfhounds before onset of clinical signs; however, it is not possible to make the diagnosis based on a single echocardiographic parameter. Even though statistically significant differences in several echocardiographic measurements were found between normal Irish wolfhounds and those with occult DCM, the ranges of all echocardiographic measurements overlapped. This is in contrast to a study of Calvert and Brown,[2] where no overlap of the EPSS was found between normal and asymptomatic DCM Doberman pinschers. E-point to septal separation measurement was regarded as specific and sensitive for the detection of cardiomyopathy before the onset of overt heart failure in this breed. In Irish wolfhounds, there was a little overlap of EPSS ranges between normal dogs and dogs with occult DCM; therefore, EPSS cannot be regarded to be as sensitive as it is in Doberman pinschers in the detection of early cardiomyopathy. According to the author's experience, calculation of ESVI can be a helpful tool in the diagnosis of early DCM; however, especially in dogs with borderline measurements, it is extremely important to evaluate the complete echocardiographic examination. In a completely relaxed Irish wolfhound with a slow normal sinus rhythm showing mildly reduced systolic myocardial function during echocardiography (suspicious for early DCM), it can be very helpful to stress the dog during echocardiography (i.e., by showing him another animal or food). As soon as heart rate increases, contractility in normal dogs should increase into reference ranges. If still uncertain, it may be necessary to repeat the echocardiographic examination some months later.

According to the results of this study, in most asymptomatic Irish wolfhounds with DCM, an impaired systolic left ventricular function was accompanied by only a slight to moderate dilatation of the left ventricle. The walls of the left ventricle and septum were usually normal in thickness, but there was markedly decreased inward motion during systole.

In Irish wolfhounds with clinical evidence of DCM, only left ventricular contractility (FS) was as low as reported in Doberman pinschers.[2] Out of 33 Irish wolfhounds with advanced DCM, only three had an extremely decreased FS (between 4% and 7%), and a marked reduction in left ventricular free wall thickness was observed in only five dogs suffering from advanced CHF. However, in dogs with clinical evidence of DCM, right ventricular dilatation and insufficiency were common findings, often leading to extensive pleural effusion, which in the author's study represented the most important clinical sign of CHF in Irish wolfhounds. In most DCM patients with marked left or right ventricular enlargement, concurrent mild mitral or tricuspid regurgitation was observed, presumably due to increased annular circumference of the mitral and tricuspid valves. Valve leaflets often appeared mildly to moderately thickened with an increased echogenicity. In dogs with moderate to severe mitral regurgitation, asymmetric contraction of the left ventricle could be observed with greater septal than posterior wall motion. In the latter dogs, excursions of the mitral valve leaflets were diminished, and mitral valve closure in some cases was delayed.

According to the results of this study, Irish wolfhounds may be affected with DCM at a relatively young age. The mean age of Irish wolfhounds with advanced DCM in this study was 4.7 years; the median age was 4.4 years. This is almost two years younger than the mean and median age (6.6 years) of dogs with clinical signs of DCM reported by Tidholm, *et al.*,[11] analyzing data from 189 dogs of 38 different breeds. In a study by Calvert, *et al.*,[5] 66 Doberman pinschers with CHF were, on the average, even older; the majority of dogs were five to 10 years of age, with mean and median ages of 7.6 and 7.5 years, respectively.

Conclusion

Dilated cardiomyopathy in Irish wolfhounds is a chronic, insidious, slowly progressive disease that is characterized by myocardial failure and rhythm disturbances (most often atrial fibrillation) which eventually leads to one of two clinical manifestations: sudden cardiac death or end-stage CHF.

By means of echocardiography, recognition of DCM without evidence of overt heart failure is possible early in the disease. However, it is important to understand the limitations of echocardiography for determining prognosis in an individual dog, as normal test results merely indicate an absence of evidence of cardiomyopathy at that time. Therefore, if a breed like the Irish wolfhound demonstrates a high familial incidence of DCM, regular heart examinations including echocardiography should be recommended.

[a] Cardiovit AT-10; Schiller AG, Switzerland

[b] SIM 7000 CFM Challenge; Esaote Biomedica, Italy

References

1. Calvert C, Chapman WL, Toal RL. Congestive cardiomyopathy in Doberman pinscher dogs. J Am Vet Med Assoc 1982;181(6):598–602.
2. Calvert CA, Brown J. Use of M-mode echocardiography in the diagnosis of congestive cardiomyopathy in Doberman pinschers. J Am Vet Med Assoc 1986;189(3):293–7.
3. O'Grady MR, Horn R. Occult dilated cardiomyopathy: an echocardiographic and electrocardiographic study of 193 asymptomatic Doberman pinschers. J Vet Int Med 1992;6:112 (abstract).
4. Calvert CA. Update: canine dilated cardiomyopathy. In: Kirk RW, Bonagura JD, eds. Current veterinary therapy XI, small animal practice. Philadelphia: WB Saunders, 1992:773–9.
5. Calvert CA, Pickus SW, Jacobs GJ, Brown J. Signalment, survival, and prognostic factors in Doberman pinschers with end-stage cardiomyopathy. J Vet Int Med 1997;11(6):323–6.
6. Sisson DD, Thomas WP. Myocardial diseases. In: Ettinger SJ, Feldman EC, eds. Textbook of veterinary internal medicine. Philadelphia: WB Saunders, 1995:995–1005.
7. Vollmar A. Kardiologische untersuchungen beim Irischen wolfshund unter besonderer berücksichtigung des vorhofflimmerns und der echokardiographie. Kleintierpraxis 1996;41(6):393–468.
8. Kienle RD, Thomas WP. Echocardiography, recommended methods for echocardiographic measurements. In: Nyland TG, Mattoon JS, eds. Veterinary diagnostic ultrasound. Philadelphia: WB Saunders, 1995:206–8.
9. Kittleson MD, Eyster GE, Knwlen GG, Olivier NB, Anderson LK. Myocardial function in small dogs with chronic mitral regurgitation and severe congestive heart failure. J Am Vet Med Assoc 1984;184(4):455–9.
10. Knight DH. Pathophysiology of heart failure and clinical evaluation of cardiac function. In: Ettinger SJ, Feldman EC, eds. Textbook of veterinary internal medicine. Philadelphia: WB Saunders, 1995:864.
11. Tidholm A, Svensson H, Sylvén C. Survival and prognostic factors in 189 dogs with dilated cardiomyopathy. J Am Anim Hosp Assoc 1997;33:364–8.

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page 284