UF College of Veterinary Medicine UNIVERSITY of FLORIDA

IDEXX

Radiographic pulmonary vasculature dimensions in drug naive and medically managed dogs with left heart failure from chronic mitral valve insufficiency

Huguet E., Sleeper M., Robertson J.B., Berry C.R.

INTRODUCTION

Chronic mitral valve insufficiency (CMVI) is the most common acquired cardiac disease in dogs. Progressive valvular degeneration results in excessive cardiovascular congestion and decompensation into left-sided heart failure (LHF).

Echocardiography is the gold standard to diagnose CMVI; however, diagnosis of LHF is supported by the presence of pulmonary venous enlargement and cardiogenic pulmonary edema on thoracic radiographs.

Normal measurements of the pulmonary vasculature in patients with LHF have been anecdotally observed after initiation of therapy in dogs diagnosed with CMVI and may not rule out a diagnosis of LHF.

PURPOSE

Compare radiographic variations in the lobar pulmonary vasculature of patients with CMVI in LHF with or without chronic +/- acute cardiac pharmaceutical support.

HYPOTHESES

Patients medically managed for CMVI will have cranial and caudal pulmonary lobar vessels measuring within normal limits on thoracic radiographs despite having radiographic signs of cardiogenic pulmonary edema.
In contrast, drug naive dogs are speculated to have significant enlargement of their pulmonary lobar veins with CVMI.

MATERIALS & METHODS

Dogs with an echocardiographic diagnosis of CMVI and radiographic evidence of LHF were retrospectively selected if diagnostic 3-view thoracic radiographs were available. The patient's breed, age, body weight and sex were obtained without inclusion limitations. A negative heartworm test had to be obtained within the last 6 months from the time of presentation. If available, physical findings recorded included heart rate, heart murmur grade, blood pressure, degree of dyspnea and oxygen dependency. Objective measurements of the vertebral heart score (VHS), and pulmonary lobar arteries (PA) and veins (PV) and subjective assessment of the pulmonary edema grade, were obtained by a board-certified radiologist. Dogs were divided into a control (drug naive) group or a total of 10 groups based on the type of chronic +/- acute cardiac pharmaceutical support received. Summary statistics were measured for all data and for calculation of PV/PA, pulmonary vein to 4th rib (PV/4th rib), and pulmonary artery to 4th rib (PA/4th rib) ratios. A ratio greater than 1.2 was suggestive of pulmonary venous enlargement. Comparisons between all dogs who did and did not receive furosemide pre-rads were done via Welch-corrected t test.

RESULTS

- 200 radiographic studies from **163 total dogs** were reviewed
- Most prevalent dog **breeds**: mixed breed dogs **(n=37)**; chihuahuas **(n=35)**
- **Mean age** and **weight**: **11.7 years** and **6.9 kg**
- Prevalent **sex**: Spayed females **(n=86)**; Neutered males **(n=70)**
- **Heart murmur grade**: III/VI **(4.3%)**, IV/VI **(39.9%)**, V/VI **(47.9%)**, VI/VI **(6.1%)**
- **Mean heart rate**: **147 beats per second**
- **Mean blood pressure**: **149 mmHg**
- **Mean (range) VHS**: **12.1 (9.8-16.5)**

- Most dogs **severely dyspneic** (49.7%) and **oxygen dependent** (63.8%)
- **Cardiogenic pulmonary edema grade**: Mild (6.9%); Moderate (25.6%); Severe (67.5%)
- In all studies:
  - **higher frequency of PV>PA and PV>4th rib with increased pulmonary edema grade**
  - **PV>PA with PV>4th rib only in right caudal lung lobe**
  - **higher PV/PA ratios in right caudal lung lobe**
- No dogs in the control group who represented with LHF after initiation of therapy (n=10) had asymmetry or enlargement of the pulmonary vasculature (Table 1). Two of these dogs received furosemide pre-rads.
- In dogs chronically treated, no distinct treatment group resulted in normal pumonary vessel size (Table 1). Too few dogs in group 7 & 9 to interpret.
- In group 6, dogs given furosemide pre-rad had fewer PV>PA.
- The median pulmonary artery and vein size in dogs who received furosemide pre-rads showed no asymmetry or enlargement (Table 1).
- A statistically significant association between furosemide administration pre-rads and normal PV size was identified in all lung lobes (Table 2).

TREATMENT GROUPS

Chronically treated +/- furosemide on pre-rads

Group 0 (n=50):	Drug naive (control)
Group 1 (n=5):	Furosemide
Group 2 (n=18):	Pimobendan
Group 3 (n=2):	Benazapril/enalapril
Group 4 (n=10):	Furosemide, pimobendan
Group 5 (n=13):	Furosemide, benazapril/enalapril
Group 6 (n=33):	Furosemide, pimobendan, benazapril/enalapril
Group 7 (n=1):	Furosemide, pimobendan, spironolactone
Group 8 (n=7):	Furosemide, pimobendan, benazapril/enalapril, spironolactone
Group 9 (n=2):	Pimobendan, benazapril/enalapril
Group 10 (n=22):	Only received furosemide on presentation pre-rads

DISCUSSION

- In accordance with prior reports (Chetboul et al.), CMVI is most prevalent in older small-sized dogs and has no sex predilection.
- The higher heart murmur grade is primarily attributed to the selection of dogs in LHF and associated advanced heart disease.
- Higher PV>PA and presence of PV>4th rib in right caudal lung lobe are consistent with the previously reported direct correlation between the direction of the mitral regurgitant jet and higher prevalence of right-sided pulmonary edema (Oui et al.).
- Absence of pulmonary vessel enlargement in control dogs with repeat LHF may be due to higher therapy dosage or more proactive owner response (alterations to the therapy at home and cardiologist oversight).
- LHF severity and drug dosage may have affected vessel ratios in chronic treatment groups.
- Normal vessel size in dogs who received furosemide pre-rads supports it as an effective rescue agent for correction of vascular congestion through diuresis.

Table 2: Mean +/- SD of vessel measures in dogs + or - furosemide pre-rads and associated p-values

	No Furosemide	Furosemide	P-value
LCr. PV/PA	1.33 +/- 0.33	1.19 +/- 0.23	0.0014
LCr. PA/4th rib	0.74 +/- 0.21	0.66 +/- 0.21	0.0123
LCr. PV/4th rib	0.95 +/- 0.25	0.77 +/- 0.26	0.0000
RCr. PV/PA	1.36 +/- 0.4	1.3 +/- 0.32	0.2332
RCr. PA/4th rib	0.76 +/- 0.23	0.63 +/- 0.21	0.0002
RCr. PV/4th rib	0.98 +/- 0.26	0.8 +/- 0.27	0.0000
LCa. PV/PA	1.31 +/- 0.37	1.2 +/- 0.28	0.0274
LCa. PA/4th rib	0.96 +/- 0.27	0.92 +/- 0.41	0.5889
LCa. PV/4th rib	1.2 +/- 0.33	1.07 +/- 0.42	0.0470
RCa. PV/PA	1.36 +/- 0.37	1.22 +/- 0.33	0.0113
RCa. PA/4th rib	1.04 +/- 0.32	0.94 +/- 0.32	0.0501
RCa. PV/4th rib	1.36 +/- 0.4	1.12 +/- 0.45	0.0010

Table 1: Categorization of vessel size according to ratio measurements in each lung lobe for all groups.

	Left cranial (LCr.)			Right cranial (RCr.)			Left caudal (LCa.)			Right caudal (RCa.)		
	PV/PA	PA/4th rib	PV/4th rib	PV/PA	PA/4th rib	PV/4th rib	PV/PA	PA/4th rib	PV/4th rib	PV/PA	PA/4th rib	PV/4th rib
CONTROL (Drug naïve)	PV>PA	Small	Normal	PV>PA	Small	Normal	PV>PA	Normal	Large	PV>PA	Normal	Large
Repeat LHF episodes	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Group 1	Normal	Small	Small	PV>PA	Small	Normal	PV>PA	Normal	Large	PV>PA	Normal	Normal
Group 2	PV>PA	Small	Normal	PV>PA	Small	Normal	Normal	Normal	Normal	PV>PA	Normal	Normal
Group 3	PV>PA	Normal	Normal	PV>PA	Small	Normal	PV>PA	Normal	Large	PV>PA	Normal	Large
Group 4	PV>PA	Small	Normal	PV>PA	Small	Normal	PV>PA	Normal	Normal	PV>PA	Normal	Normal
Group 5	Normal	Small	Normal	PV>PA	Small	Normal	PV>PA	Normal	Normal	PV>PA	Normal	Large
Group 6	PV>PA	Small	Normal	Normal	Small	Normal	PV>PA	Normal	Normal	PV>PA	Normal	Normal
Group 7	Normal	Small	Small	Normal	Small	Small	Normal	Normal	Normal	Normal	Normal	Normal
Group 8	Normal	Small	Normal	Normal	Small	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Group 9	Normal	Small	Small	PV>PA	Small	Normal	Normal	Normal	Normal	PV<PA	Normal	Normal
Group 10	Normal	Small	Small	Normal	Small	Small	Normal	Normal	Normal	Normal	Normal	Normal

LIMITATIONS

- Retrospective nature of study (provided therapy dependent on accuracy of medical record).
- Dosage of therapeutic agents not extrapolated from medical record (limited availability) and correlated to vessel size.
- No histopathological correlation.

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CONCLUSIONS

Dogs medically managed chronically for CMVI can decompensate into LHF without radiographic pulmonary venous enlargement. No clear association with a single or combination of chronic therapeutical agents could be identified. Normal vessel size is predominantly observed in dogs administered furosemide prior to radiographic evaluation.

References: Chetboul, Valérie, and Renaud Tissier. "Echocardiographic assessment of canine degenerative mitral valve disease." Journal of Veterinary Cardiology 14.1 (2012): 127-148.
Oui, Heejin, et al. "Measurements of the pulmonary vasculature on thoracic radiographs in healthy dogs compared to dogs with mitral regurgitation." Veterinary Radiology & Ultrasound 56.3 (2015): 251-256.