



SHORT COMMUNICATION

Radiographic Assessment of Dogs with Pulmonary Arterial Hypertension

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Received: 27 Sept., 2021

Revised: 02 Nov., 2021

Accepted: 08 Nov., 2021

ABSTRACT

Pulmonary arterial hypertension (PAH) is most commonly diagnosed by Doppler echocardiography, which may not be easily accessible. Thus, in this study, radiography was performed as a means of diagnosis of PAH in canines. In this study, nine clinical cases with presenting complaint of cough, exercise intolerance, dyspnea, ascites were evaluated by lateral, dorso-ventral and ventro-dorsal chest radiography. PAH was diagnosed secondary to dilated cardiomyopathy (DCM) in eight dogs. However, one dog was diagnosed with PAH secondary to chronic degenerative mitral valve disease. The most common radiographic changes in dogs affected with PAH were found to be cardiomegaly, right ventricular enlargement of heart, tracheal elevation, enlargement of cranial and caudal lobar pulmonary arteries and pleural effusions.

HIGHLIGHTS

- Study was conducted to find out the pulmonary arterial hypertension abnormalities.
- Radiographic changes were found to be cardiomegaly, right ventricular enlargement of heart, tracheal elevation, enlargement of cranial and caudal lobar pulmonary arteries.

Keywords: Pulmonary artery hypertension, Thoracic radiographs, dogs

Radiographs are an invaluable aid in diagnosis of cardiac affections. Thoracic radiographs are used to assess severity of cardiomegaly, patterns of lung changes, pulmonary vasculature and presence of effusions or masses in thoracic cavity. Pulmonary artery hypertension in canines is defined as a systolic pulmonary artery pressure ≥ 25 mm Hg (Bach *et al.*, 2006). Pulmonary hypertension being a complication of several cardiac diseases but is not diagnosed frequently. Primary pulmonary hypertension is rare in canines, with most recorded cases being secondary to cardiac, respiratory and parasitic affections. Right heart catheterization, the gold standard for diagnosis of PAH is not accessible and is a risky procedure in compromised patients (Kelliham and Stepien, 2012). Echocardiography is thus the most commonly used method to diagnose PAH in canines. Echocardiographic changes associated with PAH are peak tricuspid regurgitation, right atrial

enlargement, flattening of interventricular septum, right ventricular hypertrophy and paradoxical septal motion (Soydan *et al.*, 2015). Thoracic radiographic changes evaluated in patients with pulmonary artery hypertension include cardiac silhouette changes, pulmonary vasculature changes, right sided cardiac enlargement, lobar pulmonary artery enlargement (Adams *et al.*, 2017). Objective of the present article was to determine the radiographic changes associated with pulmonary artery hypertension in dogs.

This study was conducted on 9 clinical cases presented to Teaching Veterinary Clinical Complex, GADVASU,

How to cite this article: Kumar, T.M., Saini, N. and Anand, A. (2021). Radiographic Assessment of Dogs with Pulmonary Arterial Hypertension. *J. Anim. Res.*, 11(06): 1117-1121.

Source of Support: None; **Conflict of Interest:** None 

Ludhiana. Patients showing signs of cough, ascites, exercise intolerance, dyspnea were selected and further evaluated by lateral, ventro-dorsal and dorso-ventral chest radiography.

Lateral and Ventro-dorsal (VD) radiographs were taken for all patients. For lateral radiographs, the patient was placed on right lateral recumbency, with the forelimbs pulled as far cranially as possible, to prevent superimposition of brachial muscles on cranial part of thorax (Thrall, 2013). For VD/DV view, the positioning was done such that sternum is superimposed on spine.

Presence of cardiomegaly was determined on lateral radiograph by the vertebral heart score (VHS), as done by Buchanan and Bucheler (1995). The long axis (L) was taken from carina to apex of the heart, while short axis (S) was taken perpendicular to long axis at widest part of heart (Fig. 1a). The long and short axis dimensions were measured at vertebrae, starting at level of fourth thoracic vertebra (T4). The total length of vertebrae was taken as VHS.

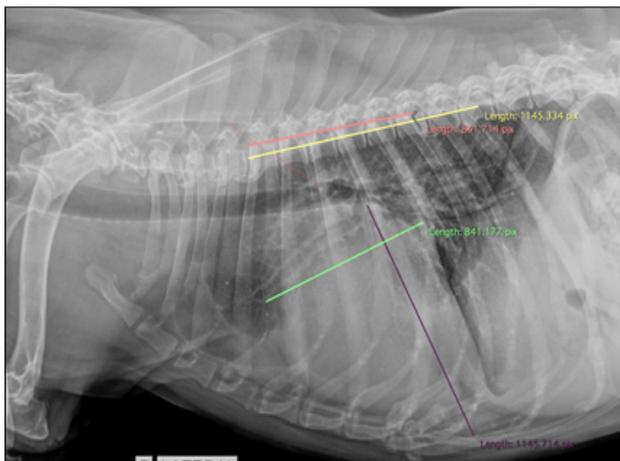


Fig. 1a: Lateral chest radiograph showing calculation of vertebral heart score, by measuring long and short axis and positioning it over the fourth rib

The lateral radiograph was assessed for sternal contact, lifting of apex of heart, enlargement of pulmonary vessels and chambers of heart. Sternal contact was classified as mild (+), moderate (++) or severe (+++) based on contact aligned with the number of sternebrae. Sternal contact was classified as mild if in contact with 3 sternebrae, moderate with 4 sternebrae and severe with 5 sternebrae.

The various chambers of the heart were checked for enlargement on lateral and VD views. In lateral view, lifting of apex of heart and in VD view, inverted or reverse D appearance of heart was considered as evidence of right sided enlargement (Suter, 1984). Also, a subjective estimation of right to left side of heart was done, as described by Adams *et al.* (2017). They stated that when a line was drawn from carina to apex, if the right side of heart occupies more than 3/5 of heart then right sided cardiac enlargement is suspected. The trachea was assessed for elevation at the level of carina, signifying enlargement of left atrium. The lung pattern was assessed for severity of alveolar/bronchial/interstitial pattern if present. Any lung pattern seen in lateral views must be substantiated in DV or VD views to be considered significant (Thrall, 2013). Presence of pleural effusions were determined by presence of inter-lobar fissures and retraction of lung lobes away from chest wall. Cardiogenic pulmonary edema may be seen as alveolar pattern, but also as bronchial pattern in large breed dogs with DCM.

Pulmonary artery was evaluated in lateral and ventro-dorsal or dorso-ventral chest radiographs. In lateral view, cranial lobar pulmonary artery should be of similar size as the proximal fourth of the fourth rib (Thrall and Losonsky, 1976). In VD or DV view, the caudal lobar artery was compared to size of the ninth rib at level of intersection between rib and artery (Thrall, 2013) and to size of third rib (Adams *et al.*, 2017). The caudal lobar artery must be similar in size to dorsal aspect of third rib and ninth rib at level of their intersection. The pulmonary veins should be similar in size to artery. Pulmonary vein is located ventral to pulmonary artery in lateral view and medial to pulmonary artery in VD and DV views (Thrall, 2013). The lobar arteries were also evaluated for tortuosity.

Diagnosis of the primary cardiac disease was done by echocardiography. 8 cases studied were affected with dilated cardiomyopathy (DCM) based on thin interventricular septum, left ventricular wall and decreased systolic motion (Boon, 2011). One case was diagnosed with degenerative mitral valve disease (DMVD), based on significantly thickened mitral valve leaflets and enlarged left atrium.

In radiographs of dogs with PAH secondary to DCM, lateral views showed sternal contact to be mildly increased in 1 patient, moderately increased in 6 patients and severely

increased in 1 patient. Right heart enlargement indicated by lifting of apex of heart was seen in 7 patients. Cranial lobar artery, when compared to proximal aspect of fourth rib was enlarged in 3 patients (Fig. 1b and Fig. 1c).

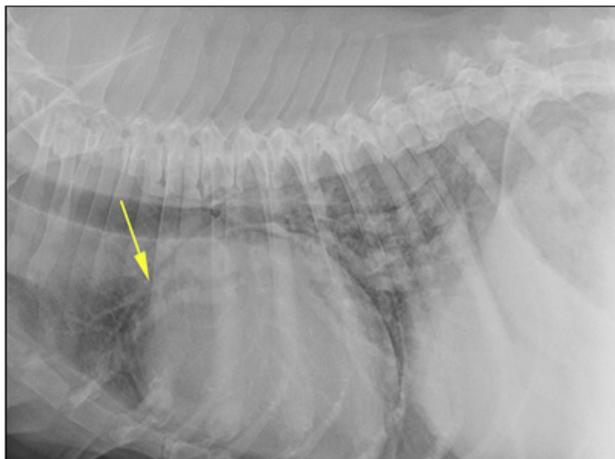


Fig. 1b: Lateral chest radiograph showing enlarged and tortuous cranial lobar artery (arrow)

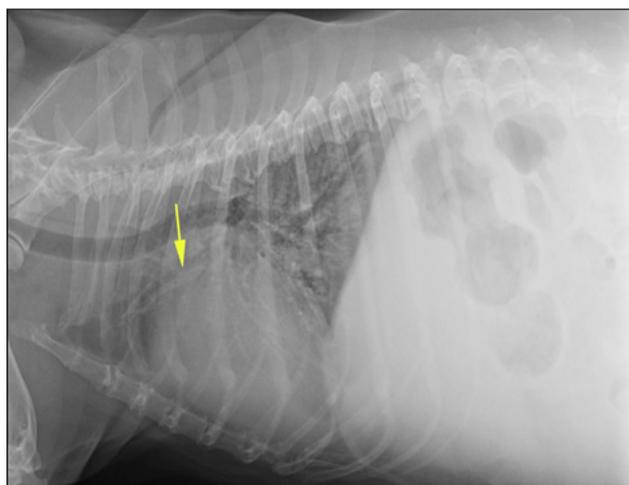


Fig. 1c: Lateral chest radiograph showing enlargement of cranial lobar artery (arrow) in comparison to fourth rib

Tortuous lobar arteries were seen in one patient (Fig. 1b). This being a subjective evaluation, was found not to be significantly associated with PAH in older studies (Adams *et al.*, 2017). The VHS was calculated (Table 1) and was found to be in the range of 11.2-13.3, indicating cardiomegaly in all the dogs studied.

Table 1: Calculated VHS of all the dogs evaluated in the study

Case no	Long axis (L)	Short axis (S)	Vertebral heart score (VHS)
1	6.2	5	11.2
2	7	6.2	13.2
3	6.8	5.2	12
4	6.8	5	11.8
5	7.6	5.1	12.7
6	7.8	5.3	13.1
7	6.2	6	12.2
8	7.5	5.8	13.3
9	6.5	5.8	12.3

Tracheal elevation was present in all 8 cases, with J shaped trachea in 3 cases (Fig. 1d).

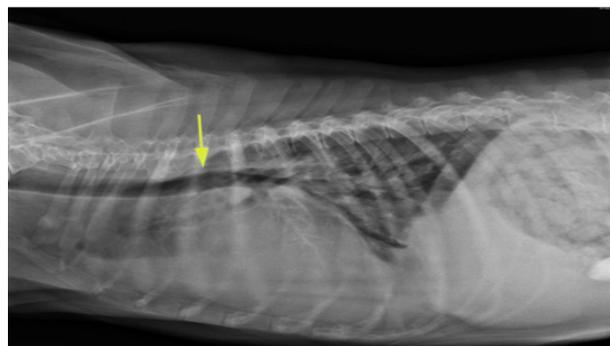


Fig. 1d: Lateral chest radiograph showing J shaped trachea

As per 3/5 rule as described above, the right heart was found to occupy more than 3/5 of heart in all 8 cases (Fig. 1e).

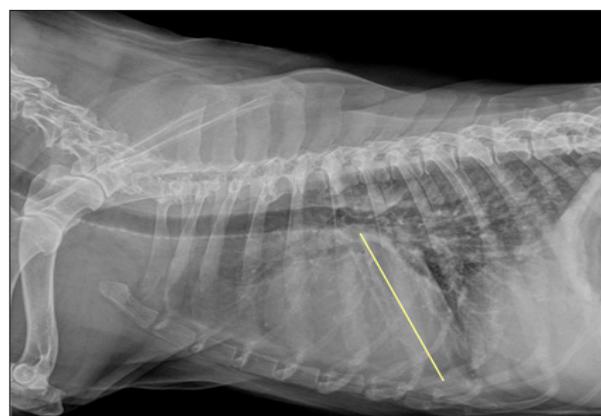


Fig. 1e: Lateral chest radiograph showing enlargement of right side, as shown by 3/5 rule



Pleural effusions were seen in 4 cases, being mild (Fig. 2). Perihilar edema was seen in 4 cases. Interstitial lung pattern was seen in 7 cases.

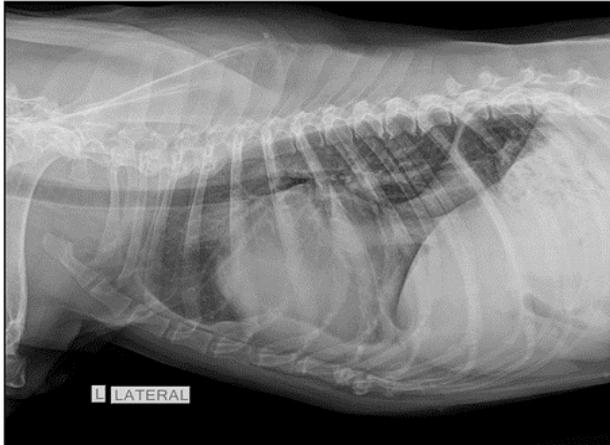


Fig. 2: Pleural effusions seen on lateral chest radiograph

In VD/DV view, left atrial enlargement was observed in one case (Fig. 3). The cardiac apex was shifted away from the midline (towards left), indicating right heart enlargement in all 8 cases. The caudal lobar artery was found to be larger than ninth rib in 6 cases (Fig. 4), and equal in size or lesser than size of third rib in all 8 cases. However, according to few workers, enlargement of pulmonary artery when compared to third rib was found to be a better indicator than enlargement as compared to ninth or fourth rib to determine pulmonary hypertension (Adams *et al.*, 2017).



Fig. 3: Left atrial enlargement seen as a circular radio-dense area in the center of heart on VD view

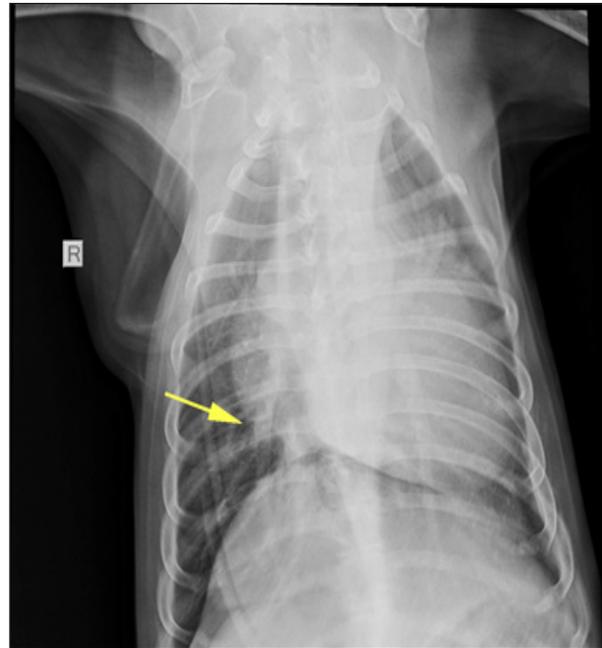


Fig. 4: Enlarged caudal lobar artery in comparison to ninth rib in VD view

In lateral chest radiograph of one dog with PAH secondary to degenerative mitral valve disease (DMVD), moderately increased sternal contact was observed, along with lifting of apex. Cranial lobar pulmonary artery was enlarged in comparison to fourth rib. Trachea was significantly lifted, being parallel to spine (Fig. 5). The VHS was calculated to be 13.1, indicating cardiomegaly.

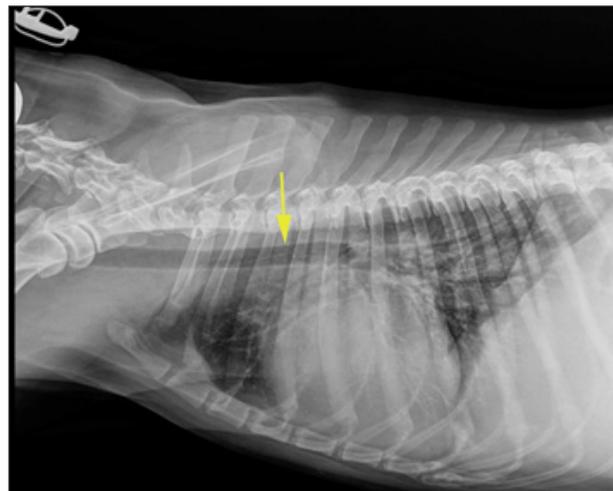


Fig. 5: Lateral chest radiograph showing trachea parallel to the spine

The right side of heart occupied more than 3/5 of heart. In VD view, reverse D shape of heart indicating right sided enlargement was seen (Fig. 6). Presence of reverse D appearance of heart has been found to be correlated with the severity of PAH, although this finding being present in only 60% of clinical cases of PAH (Adams *et al.*, 2017). This finding also occurs in pulmonic stenosis, heartworm disease, ventricular septal defects and is thus non-specific for PAH. A bulge was also seen at 1-2 o'clock position, indicating enlargement of the main pulmonary artery (Fig. 6) (Adams *et al.*, 2017).

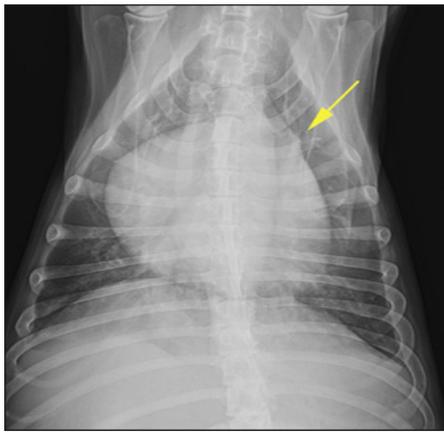


Fig. 6: Reverse D appearance of heart seen on VD view along with a bulge at 1-2 o'clock position

CONCLUSION

Radiography of thorax can be used to evaluate patients with cardiac diseases known to be associated with pulmonary arterial hypertension. Although, lack of any specific radiographic changes does not allow it be used as the sole diagnostic tool to determine PAH. Echocardiography remains the best method for diagnosis of PAH, although thoracic radiography provides additional information rather than final diagnosis.

REFERENCES

- Adams, D.S., Marolf, A.J., Valdés-Martínez, A., Randall, E.K. and Bachand, A.M. 2017. Associations between thoracic radiographic changes and severity of pulmonary arterial hypertension diagnosed in 60 dogs via Doppler echocardiography: A retrospective study. *Vet. Radiol. Ultrasound.*, **58**(4): 454–462.
- Bach, J.F., Rozanski, E.A., MacGregor, J., Betkowski, J.M. and Rush, J.E. 2006. Retrospective evaluation of sildenafil citrate as a therapy for pulmonary hypertension in dogs. *J. Vet. Intern. Med.*, **20**(5):1132-1135.
- Boon, J. 2011. *Veterinary Echocardiography* (2nd ed.). West Sussex: Wiley-Blackwell, pp. 494-499.
- Buchanan, J.W. and Bucheler J. 1995. Vertebral scale system to measure canine heart size in radiographs. *J. Am. Vet. Med. Assoc.*, **206**(2): 194-99.
- Kelliham, H.B. and Stepien, R.L. 2012. Pulmonary hypertension in canine degenerative mitral valve disease. *J. Vet. Cardiol.*, **14**:149–164.
- Soydan, L.C., Kelliham, H.B., Bates, M.L., Stepien, R.L., Consigny, D.W., Bellofiore, A., Francois, C.J. and Chesler, N. C. 2015. Accuracy of Doppler echocardiographic estimates of pulmonary artery pressures in a canine model of pulmonary hypertension. *J. Vet. Cardiol.*, **17**(1): 13–24.
- Suter, P.F. 1984. *Thoracic Radiography: A Text Atlas of Thoracic Diseases of the Dog and Cat*. 1st ed. Switzerland: Wettswil; 430– 480.
- Thrall, D.E. and Losonsky, J.M. 1976. A method for evaluating canine pulmonary circulatory dynamics from survey radiographs. *J. Am. Anim. Hosp. Assoc.*, **12**: 457–462.
- Thrall, D.E. 2013. *Textbook of veterinary diagnostic radiology*. 6th ed. Philadelphia: Saunders Elsevier, pp. 585-607.

