

Integrated Assessment of Pulmonary Hypertension in the Dog Using Clinical and Paraclinical Methods

Florin SIMIZ¹., Doru MORAR¹., Cristina VĂDUVA¹., Simina VELESCU¹., Bogdan FLOREA¹., Daniela Elena BRĂSLAȘU^{2*}., Corina Marina KRACUNOVIC¹

¹University of Life Sciences "King Mihai I" from Timișoara, Faculty of Veterinary Medicine, 300645, Calea Aradului No. 119, Timișoara, Romania

²University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Veterinary Medicine, 050097, Splaiul Independenței nr.105, sector 5, Bucharest, Romania

*Correspondence: danabraslasu@gmail.com

Abstract Pulmonary hypertension in dogs is a multifactorial cardiovascular disorder associated with progressive pulmonary vascular impairment and adaptive changes of the right cardiac chambers. The objective of this study was to perform an integrated evaluation of clinical, radiographic, electrocardiographic, and ultrasonographic findings in 39 dogs diagnosed with this condition, and to compare echocardiographically estimated pressure values according to sex and acoustic window. The study group included 20 males and 19 females, with body weights ranging from 5 to 34 kg, belonging to several breeds. Each patient underwent physical examination, thoracic radiography, 12-lead electrocardiography, and two-dimensional, M-mode, and Doppler cardiac imaging. The predominant clinical manifestations were exercise intolerance, respiratory distress, irritative cough, and orthopnea. Thoracic radiographs frequently demonstrated enlargement of the right cardiac silhouette and vascular modifications compatible with circulatory overload. Electrocardiographic assessment revealed rhythm disturbances, reduced QRS amplitude, and ST-segment deviations, suggesting myocardial involvement.

Cardiac imaging confirmed enlargement of the right atrium and right ventricle, structural remodeling, and altered pulmonary flow patterns. Estimated pressure values were significantly higher when obtained from the left parasternal approach compared with the right-sided approach in both sexes. Females also showed higher mean values than males. These results underline the relevance of a multimodal diagnostic approach for accurate recognition and staging of this syndrome in dogs. Doppler-based evaluation remains the most useful noninvasive technique for pressure estimation, assessment of right-sided adaptation, and severity stratification. The correlation of clinical signs with imaging and hemodynamic data provides important diagnostic and prognostic information

Keywords: hemodynamics, cardiopulmonary syndrome, ventricular adaptation, canine cardiology, vascular overload, prognosis

Introduction

Pulmonary hypertension (PH) in dogs is a complex hemodynamic disorder characterized by increased pulmonary vascular pressure secondary to cardiovascular, respiratory, parasitic, thromboembolic, or multifactorial diseases. Persistent pulmonary pressure overload induces right heart remodeling, right atrial and ventricular enlargement, systolic dysfunction, and may progress to right-sided heart failure. Clinically, canine pulmonary hypertension is frequently associated with nonspecific signs such as dyspnea and exercise intolerance, which can delay diagnosis. Doppler echocardiography is currently considered the main noninvasive method for assessing pulmonary hypertension, while complementary indices such as the pulmonary vein-to-pulmonary artery ratio (PV/PA) and the right pulmonary artery distensibility index (RPAD) provide additional information regarding disease severity and cardiovascular remodeling.

Material and method

The study included 39 dogs (20 males and 19 females), weighing between 5 and 34 kg, with clinical and echocardiographic suspicion of pulmonary hypertension. Diagnosis was established based on the integration of clinical, cardiovascular, and imaging findings, according to the recommendations of the American College of Veterinary Internal Medicine consensus statement.

All dogs underwent complete clinical and cardiovascular examination, thoracic radiography, 12-lead electrocardiography, and Doppler echocardiography. Electrocardiographic evaluation included heart rate, rhythm, cardiac axis, P wave, PQ interval, QRS complex, QT interval, and ST segment analysis.

Echocardiographic examination was performed from right and left parasternal views using B-mode, M-mode, and Doppler techniques, with assessment of parameters associated with pulmonary hypertension. All findings were interpreted in correlation with clinical signs and examination conditions.

Results and discussions

Pulmonary hypertension represents an important stage of chronic cor pulmonale and is associated with right heart remodeling and hemodynamic disturbances. In the investigated dogs, clinical examination revealed dyspnea, mild cyanosis during effort, cardiac arrhythmia, and systolic murmurs over the tricuspid area.

Thoracic radiography showed right-sided cardiomegaly, vascular overload, and tracheal displacement on right lateral projections (Fig.1), while ventrodorsal views revealed a rounded cardiac silhouette associated with right ventricular hypertrophy characteristic of chronic cor pulmonale (Fig. 2). Further assessment included electrocardiographic evaluation.

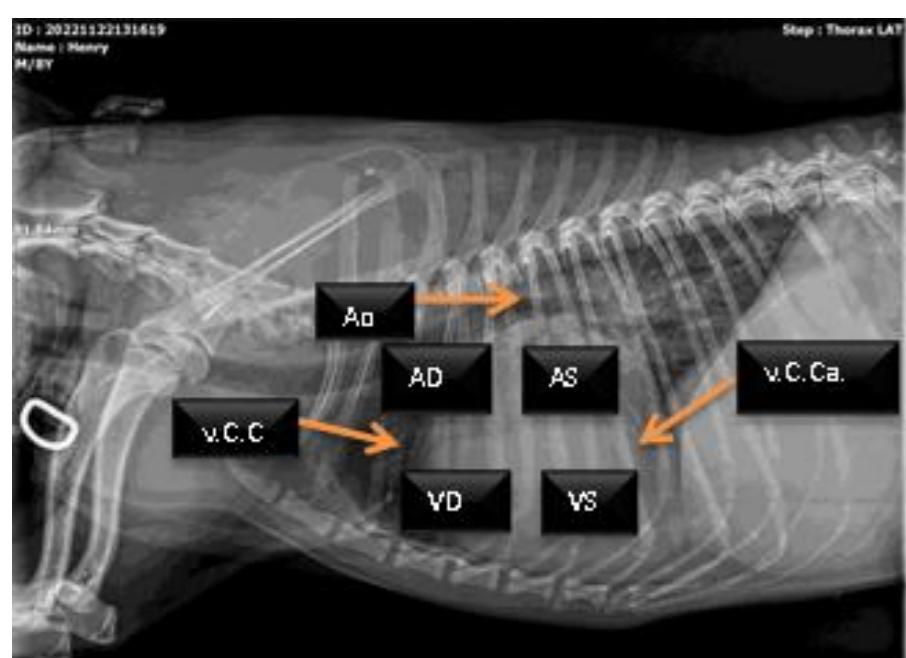
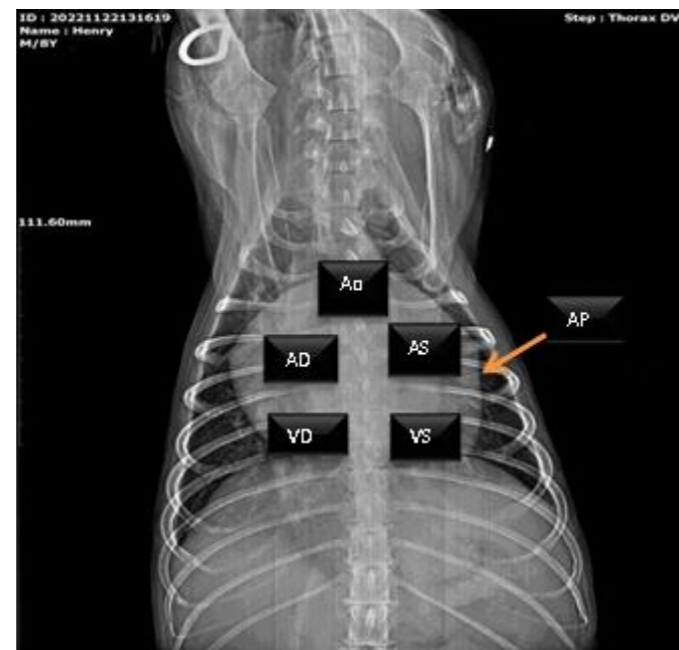


Fig. 1. Right lateral thoracic radiographic image

Fig. 2. Dorsoventral thoracic radiographic projection in a dog with pulmonary hypertension at the level of the pulmonary artery



Electrocardiographic examination revealed sinus bradycardia with sinoatrial conduction disturbances, persistent arrhythmia with prolonged R-R intervals suggestive of sinoatrial block, and mild ST-segment changes indicative of subendocardial ischemia secondary to right ventricular hypertrophy associated with pulmonary hypertension. Additional findings included mild dysrhythmia and positive ventricular complexes in lead aVL, suggestive of right fascicular block (Figs. 3-4).



Fig. 3. Canine electrocardiogram showing bipolar and unipolar leads

Fig. 4. Canine electrocardiogram showing bipolar and unipolar leads.

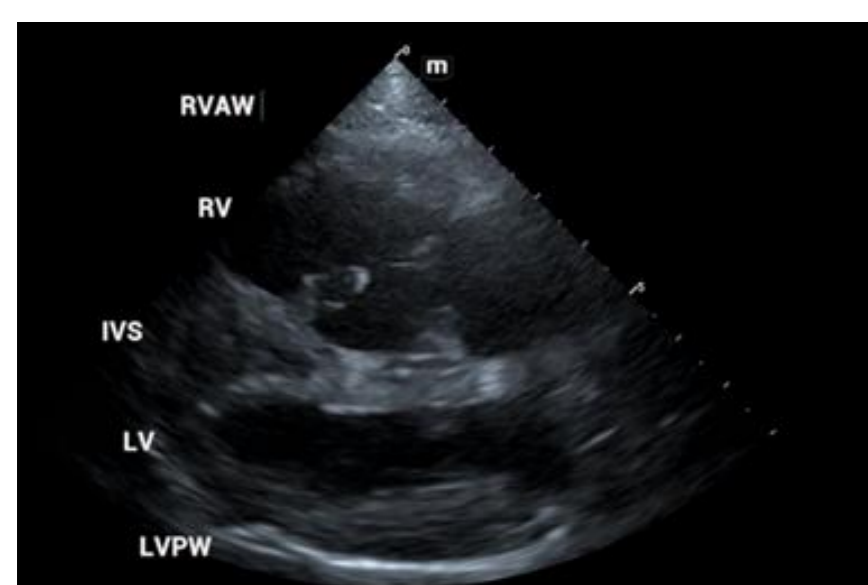
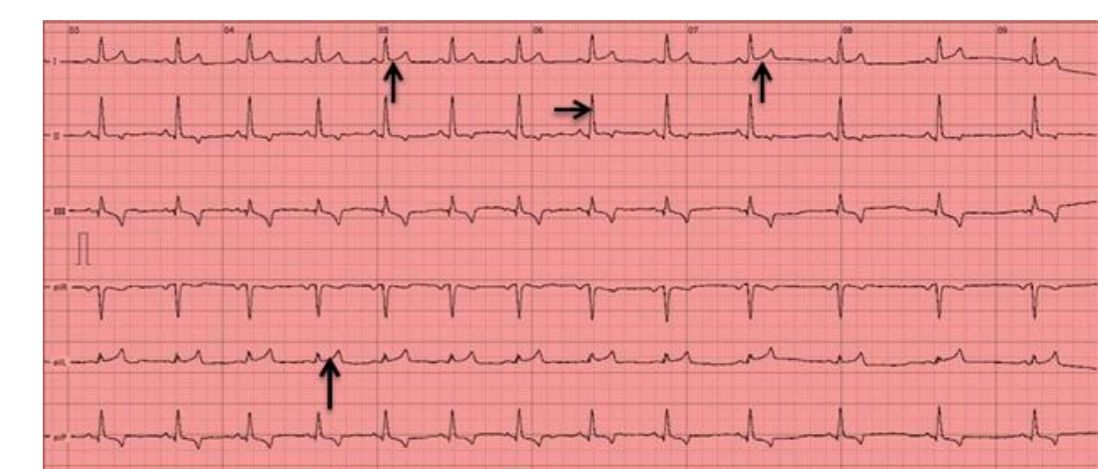
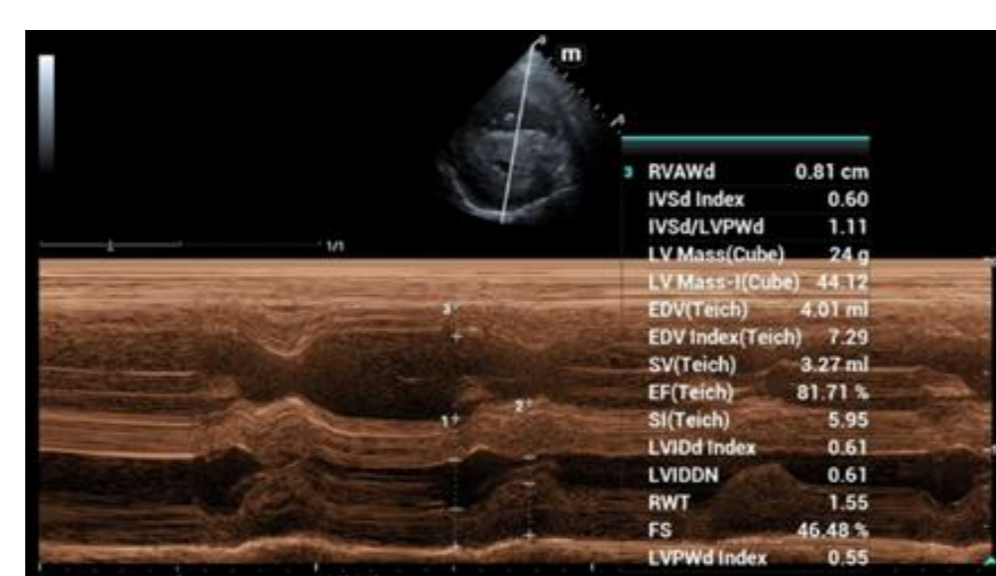


Fig. 5. B-mode echocardiography from the right parasternal view in a dog with right-sided cardiomegaly.

Fig. 6. Right parasternal B+M-mode echocardiography in a dog with right-sided cardiomegaly.



B-mode echocardiography revealed right heart chamber enlargement and tricuspid valve thickening, suggestive of degenerative changes affecting right atrioventricular hemodynamics and pulmonary flow. B+M-mode examination demonstrated preserved ventricular systolic and diastolic function associated with right ventricular dilation, with FS and EF values remaining within physiological limits (46.48% and 81.71%, respectively) (Figs. 5-6).

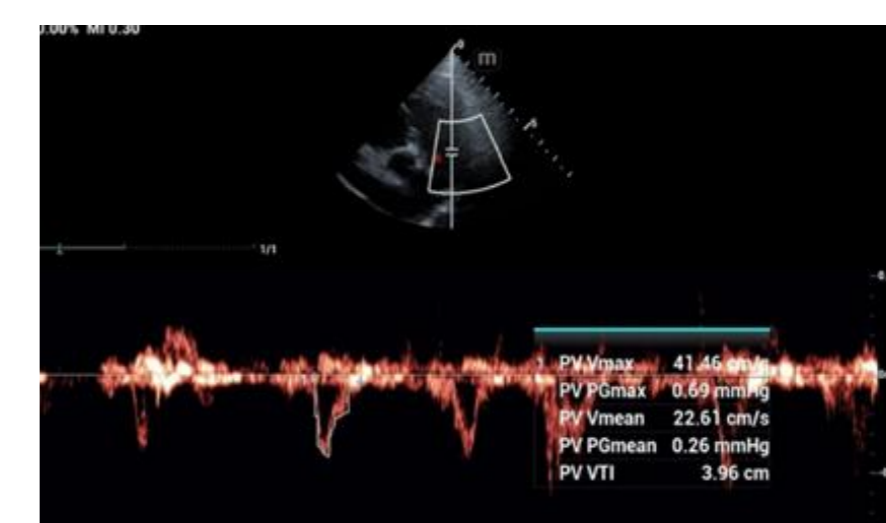


Fig. 7. Pulsed-wave Doppler echocardiography of the right heart at the level of the pulmonary valve in a dog.

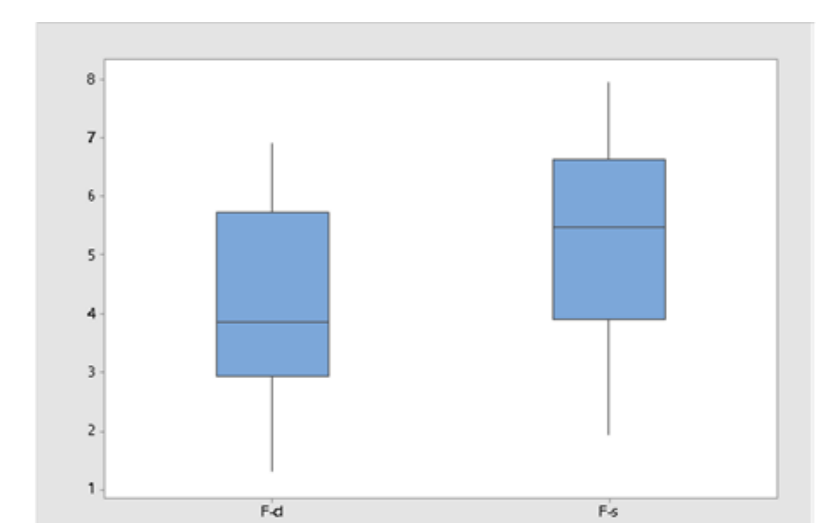


Fig. 8. Graphical representation of pulmonary artery pressure values measured from the left and right sides in dogs

Pulsed-wave Doppler echocardiography revealed a negative pulmonary flow with increased peak velocity (41.46 cm/s) and no evidence of pulmonary regurgitation, as indicated by the clear spectral envelope without regurgitant signals (Fig.7).

Spectral Doppler evaluation revealed significantly higher pulmonary artery pressure values from the left parasternal window compared with the right side in both male and female dogs ($p < 0.001$). In males, mean pulmonary pressure values were 4.329 mmHg on the left side and 3.464 mmHg on the right, while in females the values reached 5.311 mmHg and 4.078 mmHg, respectively (Fig. 8).

Conclusions

Cardiorespiratory signs in dogs with pulmonary hypertension require comprehensive paraclinical investigation in order to establish the underlying etiology. Thoracic radiography proved useful for identifying pulmonary vascular and cardiac abnormalities, while electrocardiography allowed the assessment of rhythm disturbances and cardiac morphological changes.

Echocardiography, particularly B-mode, B+M-mode, and Doppler techniques, represented an essential diagnostic tool for evaluating cardiac remodeling, pulmonary trunk pressure, and intracardiac blood flow velocities. Comparative assessment using both right and left parasternal windows improved the evaluation of pulmonary arterial pressure and highlighted significant pressure differences between the two hemithoraces.