Cardiac Diseases Causing Congestive Heart Failure in Geriatric Dogs and their Diagnostic Approaches

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ABSTRACT

In India, congestive heart failure is a prevalent yet frequently unnoticed cause of canine fatalities. The leading contributors to CHF include conditions such as dilated cardiomyopathy, mitral valve disease, hypertrophic cardiomyopathy, and pericardial effusion. Detecting CHF in its early stages is crucial, as the majority of cases occur in senior dogs, making early diagnosis essential for improving outcomes. The present study confirmed 24 canines affected with CHF. Cases were confirmed by echocardiography, and six (n=6) healthy dogs were considered for the normal study. The data were statistically analysed and expressed as mean and SE. In the study, approximately 0.93% of the canine population were found to be affected with cardiac disorders. The prominent clinical signs recorded were ascites and exercise intolerance. Radiographs revealed frequent cases of cardiomegaly, ascites, and pericardial effusion. Echocardiographic assessments identified dilated cardiomyopathy as the leading cardiac disorder in dogs, underscoring the importance of early detection and treatment.

Keywords: Geriatric dogs, ECG, Dilated cardiomyopathy, HCM

INTRODUCTION

In recent years, the rising trend of dogs as companion animals in urban areas has been reflected in the increasing cases at Veterinary Teaching Hospitals, nearly doubling over the past 15 years. Alongside this growth, heart diseases in dogs have become more prevalent, with around 10-15% of dogs in North America now suspected to have cardiac issues (Atkins *et al.,* 2009). Cardiac diseases in dogs can be either congenital or acquired, often culminating in congestive heart failure (CHF). CHF is a complex clinical syndrome resulting from impaired cardiac function, leading to hemodynamic changes, further triggering neuroendocrine compensatory mechanisms. The main causes of CHF include myxomatous valvular degeneration (MVD), dilated cardiomyopathy (DCM), and pericardial disorders. CHF can also impact various organs, including the liver, kidneys, and lungs, leading to multi-organ dysfunction. Myxomatous mitral valve disease (MMVD), also known as chronic valvular disease, is the leading cause of CHF in dogs, particularly affecting toy and small breeds (Boswood *et al.,* 2016). Early diagnosis and treatment of CHF are essential for improving both quality of life and survival. Tools such as patient history, clinical examination, haemato-biochemical assays, thoracic radiography, electrocardiography, and echocardiography are essential for diagnosing CHF. Cardiac biomarkers, such as cardiac troponin-I and NT-pro BNP, also provide valuable diagnostic insights. In short, with the rising trend of canine population in urban areas, the incidence of cardiac diseases in dogs has risen significantly, making early diagnosis and effective management more critical than ever.

MATERIALS AND METHODS

During the study period, the number of dogs brought to the Department of Veterinary

Medicine at DGCN College of Veterinary and Animal Sciences, Palampur was 2,574. Of these, 275 geriatric cases were screened, and 24 geriatric dogs were diagnosed with CHF based on ECG, radiography and echocardiography, and they were selected for the study. Six healthy geriatric dogs brought for routine check-ups and vaccinations were randomly selected as a control group to obtain normal reference values and compare the parameters under study. Cases showing normal rate, rhythm, and complexes were used to create normal baseline data. For haemato-biochemical analysis, 2 ml of blood was aseptically collected in vacutainers containing K2 EDTA (3.6 mg/2 ml), and an additional 5 ml was gathered in red-top clot-activator vacutainers for routine biochemical and electrolyte assessments. Serum samples were stored at -20°C for future testing. Complete blood counts were performed using the BC-5000 Vet auto-haematology analyzer (Mindray Medical International, China), and electrolyte analysis was done with a CB Lyte analyzer (Chariot's Biotechnology, Mumbai). Biochemical analysis was carried out using the Agappe Mispa CXL Pro Plus system (Agappe Diagnostics Ltd.). Electrocardiographic evaluations followed the procedure established by Tilley and Smith (1997). The RMS Vesta 301i, a 12-lead ECG machine (Recorders and Medicare System, Panchkula, Haryana), was used alongside thermosensitive recording paper (Arrow Medical Recording, Chennai). Conductive gel and modified crocodile clips ensured accurate electrode placement on the dog's skin. ECGs were taken at speeds of 50 mm/sec and 25 mm/sec at a gain of 10mV and lead II was used for the study. Dogs suspected of heart disease underwent radiography in both right and left lateral recumbency to detect cardiac enlargement, lung abnormalities, and anatomical displacements. Ventrodorsal (VD) views in dorsal recumbency were also captured for enhanced accuracy. The vertebral heart scale (VHS) was calculated using right lateral radiographs, following the method by Baisan *et al.* (2017). Echocardiography confirmed diagnoses, using the Siemens Acuson X 300 ultrasound system with a 3.5-7 MHz P-8 phased array probe. Systolic blood pressure was measured non-invasively with a Doppler ultrasound technique, utilizing the JNR DS-100 Doppler Blood Pressure Meter (Hefei Golden Brains Optical Instrument Co. Ltd., China). Cardiac troponin I levels were quantitatively measured with the iChroma II scanning instrument and iChromacTnI immunoassay kits.

RESULTS AND DISCUSSION

In the study, 275 geriatric dogs were screened using ECG, of which 24 were diagnosed with CHF. The overall prevalence of cardiac disorders was 0.93%, closely aligning with previous reports of Haritha *et al.* (2017), who reported a CHF prevalence of 1-1.77%. In our study, among the 24 CHF cases, dilated cardiomyopathy (DCM) emerged as the leading cause, affecting 9 dogs (37%). Haematological parameters such as haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), total leukocyte count (TLC), and platelet levels revealed no significant difference in CHF cases. This supports the notion that these parameters often provide limited diagnostic value in heart diseases.

Biochemical analyses across all disease groups showed no significant differences in diseased dogs when compared to the control group. A key finding in this study was the significant elevation in systolic arterial pressure (SAP) in dogs with dilated cardiomyopathy (DCM) ($p<0.001$) and tachycardia. In our current study, we observed tachycardia in dogs with DCM, averaging 147.67 ± 11.65 beats per minute. Similarly, in cases of pleural effusion, we recorded an average heart rate of 150.4 ± 26.81 beats per minute (bpm). Overall, we noted a significant increase in heart rate, echoing Patowary *et al.* (2022) observations.

These findings are summarized in Table I. In CHF-affected dogs, tachycardia was often recorded as baroreceptors (rich in Na+/K+-ATPase) became less responsive, which decreases the feedback to the medulla oblongata. This reduction leads to less vagal output, causing reduced heart rate variability in affected dogs. As a result, dogs with congestive heart failure (CHF) often exhibit sinus tachycardia as an underlying condition (Aiello *et al.,* 2016). Additionally, activation of the neurohumoral system, resulting in elevated levels of catecholamines and activation of the renin-angiotensin-aldosterone system (RAAS), further contributes to an increased heart rate in CHF.

Table I: Heart rate in CHF-affected geriatric dogs (n=24)

Parameter	Control (n=25)	DCM (n=9)	MVD (n=7)	HCM (n=3)	PE (n=24)
Heart Rate (beats/minute)	98.5 ± 1.20^{a}	147.67 ± 11.65^{b}	120.57 ± 2.62^{ab}	114.96 ± 2.88^{ab}	150.4 ± 26.81^{b}

Means bearing different superscripts within the same rows differ significantly (p<0.05)

The mean ± SE systolic arterial pressure (SAP) in geriatric dogs from the healthy control group was 130 ± 3.50 mmHg, as depicted in Table II. Among the dogs affected by congestive heart failure (CHF), SAP was significantly elevated at day 0 in those with dilated cardiomyopathy (DCM) (p<0.0001), while in hypertrophic cardiomyopathy (HCM), mitral valve disease (MVD), and pericardial effusion (PE), the increase in SAP was not statistically significant, but still towards the higher side. The elevated SAP may be attributed to increased pressure and volume load on the heart, resulting in reduced cardiac output and impaired myocardial contractility (Martin *et al.,* 2009). While Gradman and Alfayoumi (2006) have asserted that hypertension can lead to CHF, the relationship between the two remains an area of ongoing study. Whether CHF triggers hypertension or vice versa is still a subject that warrants further research.

Table II: Arterial Pressure (SAP) in CHF-affected geriatric dogs

Parameter	Control (n=17)	DCM (n=9)	MVD (n=7)	HCM (n=3)	PE (n=5)
SAP (mmHg)	130 ± 3.50^{a}	188.88 ± 15.85^{b}	155.29 ± 7.35^{a}	151 ± 4.58^{a}	151.4 ± 12.13^{a}

Means bearing different superscripts within the same rows differ significantly (p<0.0001)

The clinical signs associated with congestive heart failure in dogs displayed a wide range of variations in both nature and severity. Exercise intolerance was the most common symptom, observed in 20 dogs (83.34%), which aligns with the findings of Patowary *et al.* (2022). This was followed by inappetence and ascites, each affecting 13 dogs (54.17%). Dyspnoea and pallor CMM were noted in 12 dogs (50.00%), while nocturnal coughing occurred in 11 dogs (45.83%). Pericardial thrill and jugular pulsation were detected in 9 dogs (37.50% each), and cachexia was present in 7 dogs (29.17%). Additionally, peripheral limb oedema, syncope, orthopnoea, and pulse deficit were each documented in 5 dogs (20.83%). A comprehensive analysis of clinical signs in various cardiac ailments leading to CHF was detailed in Table III. Jeyaraja *et al.* (2008) and Satish *et al.* (2011) reported similar symptoms that included exercise intolerance, dyspnoea at rest, fatigue, ascites,

inappetence, paleness to cyanotic mucous membranes, episodes of syncope, and swelling in the extremities.

Auscultatory abnormalities recorded in dogs with congestive heart failure (CHF) were presented in Table IV. The most common abnormality was tachycardia, observed in 13 dogs (54.16%). An enlarged area of auscultation could be associated with elevated vertebral heart scores. Crackles, suggesting pulmonary oedema, were recorded in 5 dogs (20.80%). Both muffled and normal heart sounds were detected in 4 dogs (16.67%) each, while a gallop rhythm was found in 3 dogs (12.50%). Bradycardia was the least common and was present only in 2 dogs (8.34%).

Satish *et al.* (2011) highlighted the presence of murmurs, gallop sounds, and arrhythmias in cardiac disorders. Murmurs are a common finding in CHF caused by MVD (4 cases, 57.1%), as documented by Smith (2006), remarking on their prevalence in dogs diagnosed with chronic valve disease. Muffled heart sounds and tachycardia were common findings in pericardial effusion recorded during this study (3 cases, 60%), with effusion resulting in muffled heart sounds. In our study, in DCM, the most notable auscultation findings were tachycardia and an enlarged area of auscultation, both present in 77.78% of cases. Similarly, in HCM, an increased area of auscultation stood out, observed in 66.67% of cases. The dogs diagnosed with congestive heart failure were classified according to the consensus guidelines from the American College of Veterinary Internal Medicine (ACVIM) (Keene *et al*., 2019) (Table V). Most of the dogs, *i.e.*, 19 out of 24 (79.17%), were categorized as Stage C, indicating they exhibited clinical signs of heart failure related to structural heart disease. Within this group, 4 dogs were affected by mitral valve disease (MVD), 7 by dilated cardiomyopathy, 3 by hypertrophic cardiomyopathy, and 5 by pericardial effusion. Additionally, two cases were classified in Stage B2 and Stage D, with one dog in each stage affected by MVD and DCM, respectively. Only one dog was found in Stage B1, affected by MVD, and no cases were identified in Stage A. Various ECG findings in dogs with CHF due to DCM, MVD, HCM, and PE were found. And the overall highest incidence was of atrial fibrillation (AF) in dogs affected with CHF, as shown in Figure 1.

Table III: Clinical signs manifested in CHF-affected dogs (n=24)

Clinical signs	Number of Dogs (%)				Total (n=24)
	DCM (n=9)	MVD (n=7)	HCM (n=3)	Pericardial Effusion (n=5)	
Nocturnal coughing	5 (55.56%)	3 (42.85%)	1 (33.34%)	2 (40%)	11 (45.83%)
Ascites	7 (77.78%)	2 (28.57%)	1 (33.34%)	3 (60%)	13 (54.17%)
Peripheral oedema of limbs	2(22.23%)	1 (14.28%)	--	2 (40%)	5 (20.83%)
Syncope	2 (22.23%)	1 (14.28%)	--	2 (40%)	5 (20.83%)
Pericardial thrill	5 (55.56%)	3 (42.85%)	--	1 (20%)	9 (37.50%)
Jugular pulsation	5 (55.56%)	3 (42.85%)	--	1 (20%)	9 (37.50%)
Cachexia	2 (22.23%)	2 (28.57%)	--	3 (60%)	7 (29.17%)
Exercise intolerance / lethargy	8 (88.89%)	4 (57.14%)	3 (100%)	5 (100%)	20(83.34%)
Dyspnoea	5 (55.56%)	3 (42.85%)	2 (66.67%)	2 (40%)	12 (50.00%)
Orthopnoea	2 (22.23%)	1 (14.28%)	--	2 (40%)	5 (20.83%)
Pulse deficit	2 (22.23%)	1 (14.28%)	--	2 (40%)	5 (20.83%)
Inappetence	5 (55.56%)	2 (28.57%)	2 (66.67%)	4 (80%)	13 (54.17%)
Pallor	2 (22.23%)	5 (71.42%)	2 (66.67%)	3 (60%)	12 (50.00%)

Table IV: Rhythm and sounds heard on auscultation of thorax in CHF dogs (n=24)

Auscultation findings	DCM	MVD	HCM	PE	No. of Cases	Percent
Tachycardia	7	2	1	3	13	54.16
Bradycardia	0	2	0	0	2	8.34
Murmurs	2	4	0	0	6	25.00
Gallop rhythm	2	1	0	0	3	12.50
Crackles due to pulmonary oedema	2	1	0	2	5	20.80
Muffled	1	0	0	3	4	16.67
Increased area of Auscultation	7	2	2	1	12	50.00

Table V: Classification of CHF dogs by ACVIM system (n=24)

Class	Number of Dogs				Total (n=24)
	DCM	MVD	HCM	Pericardial Effusion	
A	0	0	0	0	0 (0%)
B1	0	1	0	0	1 (4.17%)
B2	1	1	0	0	2 (8.34%)
C	7	4	3	5	19 (79.17%)
D	1	1	0	0	2 (8.34%)
Total	9	7	3	5	24 (100%)

Fig. 1: Atrial fibrillation (AF) in a dog affected with DCM (50 mm/s paper speed; 10 mm/mV gain)

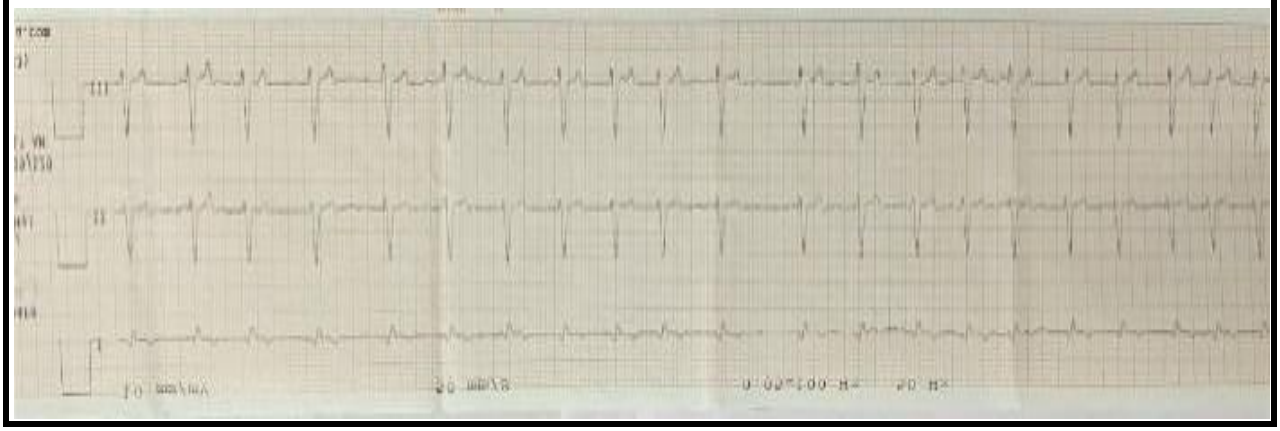

Table VI: Radiographic findings in CHF due to DCM, MVD, HCM and PE in geriatric dogs

Abnormal Findings	Number of Canines				Total (n=24)
	DCM (n=9)	MVD (n=7)	HCM (n=3)	Pericardial Effusion (n=5)	
Cardiomegaly	9 (100%)	1 (14.29%)	3 (100%)	0	13 (54.17%)
Pericardial fluid	3 (33.34%)	3 (42.85%)	0	5 (100%)	11 (45.84%)
Elevated trachea	7 (77.78%)	1 (14.28%)	2 (66.67%)	0	10 (41.67%)
Pleural effusion	2 (22.23%)	3 (42.85%)	0	5 (100%)	10 (41.67%)
Ascites	6 (66.67%)	3 (42.85%)	0	4 (80%)	13 (54.17%)
Pulmonary vessels dilation	5 (55.56%)	3 (42.85%)	1 (33.34%)	0	9 (37.50%)
Congestion of the lung lobe	4 (44.45%)	4 (57.14%)	2 (66.67%)	0	10 (41.67%)

The radiographic findings in affected dogs are detailed in Table VI and Figures 2a-2f. Among these dogs, ascites (Fig. 2d) and cardiomegaly (Fig. 2e and 2g) were the most common findings, occurring in 13 dogs (54.17%) each. Pericardial effusion (Fig. 2b) was observed in 11 dogs (45.84%), while lung lobe congestion, tracheal elevation and pleural effusion (Fig. 2b) were present in 10 dogs (41.67%). These findings are consistent with those reported in radiographic studies by Baisan *et al.* (2017) and Martin *et al.* (2009). In CHF affected dog's pulmonary oedema was attributed to left-sided heart failure (Martin *et al., 2009*). The CHF-affected dogs had a significant elevation of VHS (Fig. 2e), which indicates cardiomegaly and radiographic signs that confirmed the presence of structural heart disease. This might be due to dilatation of all chambers in DCM and HCM, whereas ascites is typically noticed in right-sided heart failure. This leads to increased venous pressure, which causes fluid to accumulate in the abdomen (Aiello *et al.,* 2016).

In cases of DCM, the most frequent finding was an increased vertebral heart score (VHS) or cardiomegaly, which was in accordance with the findings of Martin *et al.* (2009) and Jeyaraja *et al.* (2008). Tracheal elevation was consistent with the observations of Diana (2009), who reported that an increased vertebral heart score (VHS) or cardiomegaly is frequently associated with nocturnal coughing in dogs affected by congestive heart failure (CHF). In cases of MVD, cardiomegaly and tracheal elevation were less common, each appearing in 1 case (14.29%). Pulmonary vessel dilation was more frequently seen in dogs with DCM and MVD. Echocardiography played a key role in confirming the diagnosis of CHF by highlighting characteristic features of the disease, as noted by Smith (*loc cit.*) and depicted in Table VII. Cardiomegaly was the most prevalent echocardiographic finding, seen in 13 dogs (54.17%). Mitral valve regurgitation, followed closely, affected 12 dogs (50%), while pericardial effusion was observed in 11 dogs (45.84%). Dilated cardiomyopathy (DCM) was identified in 9 dogs (37.50%). Other significant findings included tricuspid valve regurgitation, left atrial enlargement (LAE), and compensatory hypertrophy, each seen in 8 dogs (33.34%), with right atrial enlargement detected in 6 dogs (25%); all these findings are depicted in Table VII. These echocardiographic results are consistent with those reported by Patowary *et al.* (2022).

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Cardiac biomarkers like cardiac troponin-I (cTnI) and N-terminal pro-brain natriuretic peptide (NT-pro BNP) were also estimated. The cTnI levels were significantly elevated across all cardiac disease groups. On day 0, group I had a mean ± SEcTnI value of 1.08 ± 0.29 ng/mL, showing a significant increase ($P < 0.01$). While group II had the mean ± SE of 1.12 ± 0.3 ng/mL, which was also significantly elevated ($P < 0.01$), group III exhibited a mean ± SE of 1.35 ± 0.3 ng/mL, which was highly significant ($P < 0.001$) compared to the Control group. On day 0, group I had a mean± SE, cTnI of 1.08 ± 0.29 ng/mL, while in group II it was recorded as 1.12 ± 0.3 ng/mL and 1.35 ± 0.3 ng/mL ingroup III. All three groups were found to show significantly elevated ($P < 0.001$) cTnI levels

compared to the control group, similar to that reported by Ando et al. (2023). Elevated cTnI levels occur due to sarcomere injury, which leads to the detachment of cTnI from actin. This, along with membrane disruption, allows cTnI to leak into the bloodstream. NT-pro BNP levels were significantly elevated ($p<0.01$) in all cardiac disease groups compared to the control group. Specifically, the values were 168.81 ± 10.854 pg/mL for DCM, 82.89 ± 1.86 g/mL for MVD, and 37.13 ± 2.143 pg/mL for HCM, whereas the control group had a value of 10.37 ± 1.35 pg/mL. These results are consistent with the findings of Sultana *et al.* (2019), NT-proBNP can serve as a reliable diagnostic marker for cardiac disease, especially when advanced imaging techniques are unavailable in veterinary practice

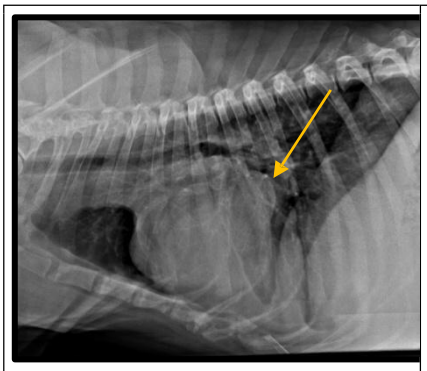

Fig. 2a: Left Atrial Enlargement

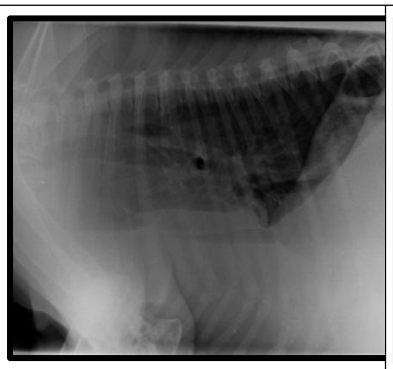

Fig. 2b: Pleural and pericardial effusion

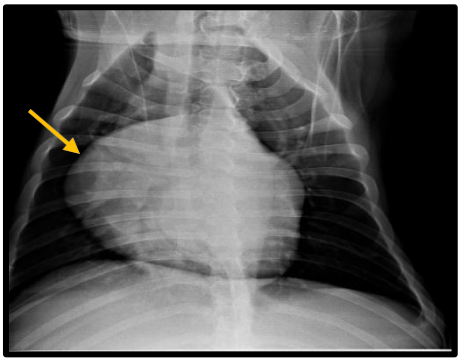

Fig. 2c: Right ventricular enlargement

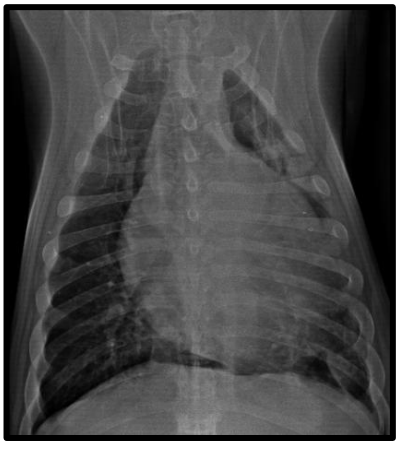

Fig. 2d: Left-sided cardiomegaly

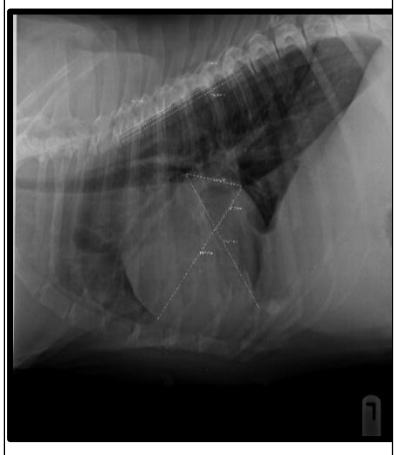

Fig. 2e: Cardiomegaly (increased VHS=14.5)

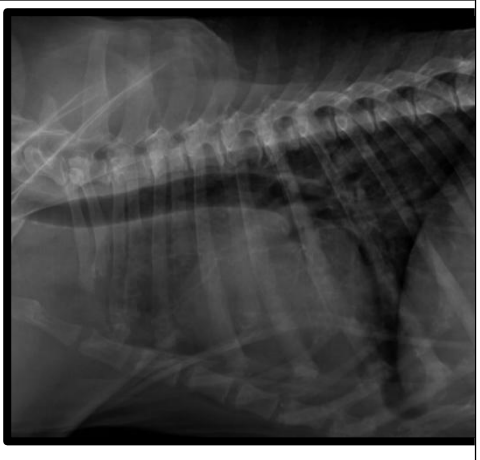

Fig. 2f: Effusion and DCM

Table VII: Echocardiographic observations in geriatric dogs with CHF (n=24)

Echocardiographic findings	No. of dogs	Percentage
Dilated cardiomyopathy	9	37.50
Cardiomegaly	13	54.17
Tricuspid valve regurgitation	8	33.34
Mitral valve regurgitation	12	50.00
Pericardial effusions	11	45.84
Left atrial enlargement (LAE)	8	33.34
Hypertrophy/Compensatory hypertrophy	8	33.34
Right atrial enlargement (RAE)	6	25.00

CONCLUSION

In conclusion, this study provides a comprehensive understanding of congestive heart failure in geriatric dogs, revealing significant insights into its diagnostic complexities. Clinical symptoms such as exercise intolerance, inappetence, ascites, and dyspnoea were common, with tachycardia being the most frequent auscultatory abnormality. The elevated systolic arterial pressure, especially in DCM cases, stood out as a critical indicator of cardiac dysfunction. Echocardiographic findings like mitral valve regurgitation and left atrial enlargement played pivotal roles in confirming CHF. The significant elevation of cardiac biomarkers highlighted their importance in identifying CHF. This work highlights the need for a multi-modal diagnostic approach, combining clinical, biochemical, and imaging data to accurately diagnose and manage congestive heart failure in geriatric dogs.

REFERENCES

Aiello, S.E., D.G.Moses, P.D.Allen, A.Constable, P.R.Dart, K.E.Davies, P.T.Quesenberry, D.Reeves and J.M.Sharma (2016), Traumatic reticuloperitonitis, *The Merck Veterinary Manual*, 11th ed., Merck & Co., Inc., Kenilworth, NJ, USA, pp. 230–233.

Ando, T., T.Izawa, H.Nishida and H.Akiyoshi (2023), Clinical findings using echocardiography and plasma cardiac troponin I and pathological findings in dogs with hypertrophic cardiomyopathy: A retrospective study, *Open Vet. J.,* **13**(6): 742–752.

Atkins, C., J.Bonagura, S.Ettinger, P.Fox, S.Gordon, J.Häggström, R.Hamlin, B.Keene, F.V.Luis and R.Stepien (2009), Guidelines for the diagnosis and treatment of canine chronic valvular heart disease, *J. Vet. Intern. Med.,* **23**(6): 1142–1150.

Baisan, R.A., M.Ciocan, O.Birsan and V.Vulpe (2017), Objective assessment of the radiographic cardiac size in dogs: A review of the heart size measurements, *Lucr. Stiinţ. Ser. Med. Vet.,* **2**: 16–23.

Boswood, A., J.Häggström, S.G.Gordon, G.Wess, R.L.Stepien and M.A.Oyama (2016), Effect of pimobendan in dogs with preclinical myxomatous mitral valve disease and cardiomegaly: The EPIC study—a randomized clinical trial, *J. Vet. Intern. Med.,* **30**: 1765–1779.

Diana, A., C.Guglielmini, M.Pietra, M.Di Tommaso and M.Cipone (2009), Use of the vertebral heart score in coughing dogs with chronic degenerative mitral valve disease, *J. Vet. Med. Sci.,* **71**(1): 9–13.

Gradman, A.H. and F.Alfayoumi (2006), From left ventricular hypertrophy to congestive heart failure: Management of hypertensive heart disease, *Prog. Cardiovasc. Dis.,* **48**(5): 326–341.

Haritha, G.S., K.S.Kumar, S.Ayodhya and V.V.Kumar (2017), Prevalence of cardiac disorders in canines – a clinical study, *Intas Polivet,* **18**(1): 148–152.

Jeyaraja, K., B.Gowri, A.P.Nambi and K.Vasu (2008), Echocardiographic evaluation of dilated cardiomyopathy in dogs, *Indian Vet. J.,* **85**: 983–984.

Keene, B.W., C.E.Atkins, J.D.Bonagura, P.R.Fox, J.Häggström, V.L.Fuentes, M.A.Oyama, J.E.Rush, R.Stepien and M.Uechi (2019), ACVIM consensus guidelines for the diagnosis and treatment of myxomatous mitral valve disease in dogs, *J. Vet. Intern. Med.,* **33**(3): 1127– 1140.

Lord, P., C.Carlsson, J.Haggstrom, A.Eriksson and

C.Kvart (2009), Size and shape of right heart chambers in mitral valve regurgitation in small-breed dogs, *J. Vet. Intern. Med.,* **23**(5): 1007–1013.

Martin, M.W., M.J.Johnson and B.J.Celona (2009), Canine dilated cardiomyopathy: A retrospective study of signalment, presentation and clinical findings in 369 cases, *J. Small Anim. Pract.,* **50**: 23–29.

Patowary, P., A.Phukan, B.C.Baishya, U.Barman, A.Das and S.Tamuly (2022), Evaluation of haematological and serum biochemical alterations in dogs affected with congestive heart failure, *Indian J. Anim. Res.,* **56**(8): 941–944.

Satish, K.K., K.V.Amruth, P.Nagaraj and R.D.S.Thirumala (2011), Diagnosis of pericardial effusion in dogs, *Indian Vet. J.,* **88**: 82–84.

Smith, P. (2006), Management of chronic degenerative mitral valve disease in dogs, *In Pract.,* **28**: 376–383.

Sultana, F., B.Changkija, D.Kalita, B.Baishya, A.Das and P.Deka (2019), Evaluation of NT- proBNP as a cardiac biomarker for the early diagnosis of cardiac disease in dogs, *Int. J. Lives. Res.,* **9**(10): 86–96.