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Characterization of Cardiac Diseases in Dogs Prevalent in Indian Conditions

A. Yadav[1], T. Kumar[1], N. Sindhu[1], D. Agnihotri[1], C. Jajoria[1], M. Sharma[1]

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ABSTRACT

Background: Cardiac diseases defined as structural, functional, mechanical and electrical abnormality of heart. Characterization of different cardiac diseases in dogs prevalent in North Indian conditions is least studied.

Methods: Out of total 2582 registered dogs, 41 were suspected for cardiac diseases based on clinical signs. Further confirmation and characterization was done by electrocardiography, radiography, echocardiography and cardiac biomarkers. Statistical analysis was done through SPSS 23.

Result: Present study inferred, Dilated cardiomyopathy (DCM) as the most prevalent cardiac affection. Left ventricular dilation, interventricular septum thinning, increased E point septal separation and left atrial enlargement were characteristic echocardiographic indices in DCM. Echocardiographic indices in hypertrophic cardiomyopathy were increased interventricular septum, left ventricular posterior wall and reduced left ventricular lumen. Labrador retriever found to be most predisposed breed for DCM while Rottweiler reported to be most affected with pericardial effusion. Cardiac Troponin-I (cTnI) was statistically ($p<0.05$) increased in all cardiac categories with cut off value above 92 ng/l indicating cardiac affection, while Lactate dehydrogenase serve as screening biochemical marker with significant increase in all the cardiac cases ranging from 291 IU/l to 586.4 IU/l.

Key words: Echocardiography, Labrador retriever, LDH, Troponin-I.

INTRODUCTION

Cardiac diseases are commonly encountered in general veterinary practice and it is estimated that approximately 10% of all dogs presented for primary care to veterinary hospitals have cardiac diseases in North America (Atkins *et al*., 2009). Whereas Haritha *et al.* (2018) conducted a study in India on dogs brought to PVNRUVAFS, Rajendranagar, Hyderabad and found overall prevalence of cardiac disorders to be 1.77%. Another researcher Thirunavukkarasu, (2019) conducted study in Chennai during study period 2018-2019 and reported incidence of acquired heart diseases (AHD) to be 0.37 per cent. AHD occurs most often secondary to degenerative mitral valve disease, dilated cardiomyopathy (DCM) and pericardial diseases. Hypertrophic cardiomyopathy (HCM) is another acquired heart disease which is a rare form of heart muscle disease in dogs (Thirunavukkarasu, 2019). Auscultation, radiography, electrocardiography, echocardiography and biochemical tests are most useful diagnostic procedures employed in recognizing the cardiac diseases in dogs (Hoque *et al*., 2019).

Thoracic radiography is the most commonly applied method for the diagnosis of congestive heart failure and considered as clinical gold standard (Balbarini *et al.,* 1991). Electrocardiography is another non-invasive diagnostic tool for monitoring heart rate, cardiac rhythm, conduction integrity and electrical axis (Mukherjee *et al*., 2015). Echocardiography has emerged as the most versatile imaging technique for the study of cardiac diseases (Bodh *et al*., 2016). Circulating cardiac biomarkers also continue to generate lot of interest in research (Schober *et al.,* 2010) and need to be studied in detail.

[1]Department of Veterinary Medicine, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 004, Haryana, India.

Corresponding Author: A. Yadav, Department of Veterinary Medicine, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 004, Haryana, India.
Email: yadavannu1726@gmail.com

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Canine cardiac diseases are being studied around the globe but research in this part of country is lacking. Therefore, present study was planned with the objective to diagnose and characterize different canine cardiac affections reported in referral hospital setups of northern part of India and also to identify sensitivity of biochemical and cardiac bio-markers for these cardiac diseases. Assessment of different echocardiographic indices was undertaken for further characterization of cardiac affections.

MATERIALS AND METHODS

Approval from Institutional Animal Ethics Committee was taken. Present study was carried out on dogs presented to Veterinary Clinical Complex, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar for a period of 8 months *i.e*. from August' 2019 to March' 2020. Out of total 2582 screened dogs, 41 dogs were suspected for

cardiac affections based on preliminary screening and were included in the study. Six healthy dogs were included as control group.

Haemato-biochemical examination

Haematological estimation was done using Automated hematology cell counter MS4s, MeletSchlosing Lab and for biochemical and electrolytes estimation (EM Destiny 180), Erba Diagnostics Mannheim GmbH and EasyLyte EXPAND analyzer was used.

Radiographic measurements

Thoracic radiography was performed with an X-ray unit (Siemens X- Ray machine) and images processed through Computed radiography system (Konica Minolta PVT, LTD). Heart size in the lateral view was evaluated using vertebral heart scale (Buchanan and Bucheler, 1995).

Electrocardiography

Electrocardiogram was recorded using ECG 300G- VET CONTEC Electrocardiograph machine and Bailey's hexaxial limb lead as described by Tilley and Smith, (2008).

Echocardiography

Siemens Acuson S2000 ultrasound machine (Siemens Healthcare Pvt. Ltd.) with multifrequency (2-4MHz) cardiac phased array probe was used. All the dogs were clipped on the right and left thoracic wall from 2nd to 7th intercostal spaces as described by (Boon, 2011) and placed in lateral recumbency on a specially designed table having "V"-shaped cut on the table top.

Cardiac biomarker estimation

Serum samples collected on first day was stored at -20°C for Cardiac Troponin I estimation using commercially available Canine Cardiac Troponin 1 ELISA kit (Bioassay Technology Laboratory).

Statistical analysis

Statistical analysis performed using SPSS 23. Duncan test and two-way ANOVA with repeated measures was applied on the data obtained. The results were presented as Mean±S.E. at 5 per cent level of significance (p=0.05).

RESULTS AND DISCUSSION

Trends of cardiac diseases in dogs of this northern part of country revealed that 0.77% of the reported patients were having cardiac diseases. Almost similar prevalence was reported by Thirunavukkarasu, (2019) in Chennai. Out of 41 suspected dogs, 11 dogs were ruled out on the basis of electrocardiographic and radiographic findings. These ruled out 11 dogs were later confirmed to be affected with respiratory affections. Remaining thirty dogs were screened with echocardiography and 20 cases turned out to have confirmed cardiac diseases. Echocardiographic findings categorised these affected dogs into five categories. Most common cardiac disease diagnosed was DCM (8 dogs; 40%) followed by PE (4 dogs; 20%), HCM (3 dogs; 15%), R- CHF (3 dogs; 15%) and systolic dysfunction (2 dogs; 10%). Similar reports on the predominance of DCM among acquired cardiac diseases were reported by Satish Kumar *et al*. (2016) and Jan *et al.* (2018) in different parts of India in different breeds. DCM predominance seems to be because it has long been suspected to have a genetic basis and autosomal dominant mode of transmission had been reported in Newfoundland (McEwan, 1998). Predominance of Labrador retriever in this part of country makes DCM to be predominantly occurred cardiac diseases. Maximum occurrence of cardiac diseases was observed in 4-9 years age group *i.e*. adult dogs (60%) followed by 0-4 year age group (25%) and 9-14 years age group (15%). Male dogs dominated females in overall occurrence of cardiac diseases with 60% (12/20) and 40% (8/20) respectively. Higher occurrence in male dogs may be because of preference of pet owners for keeping male dogs in comparison to female dogs. Although with this amount of sample size true sex predisposition cannot be predicted.

Breed wise distribution revealed Labrador retriever to be most predisposed (45%) followed by Pug (20%), Rottweiler (15%), German shepherd (10%), Golden Retriever (5%) and Mongrel (5%). Labrador retriever predominance suggesting higher ownership of this breed in our locality as well as because of inbreeding of poor breed lines (Vishnurahav *et al.,* 2018).

Haematological parameters revealed significant increase in neutrophil count in affected dogs as compared to control. This increase attributed to inflammatory reaction associated with increased level of TNF and IL-1 (Singh *et al.,* 2014) or due to concurrent secondary bacterial infection of respiratory tract (Venkatesakumar *et al.,* 2018). Significant increment in Lactate dehydrogenase (LDH) with mean value (291.65-586.47 IU/l) was recorded (except systolic dysfunction), in contrast to control group animals as shown in Fig 1. Elevated LDH may be due to limited skeletal muscle blood flow in patients with cardiac diseases leading to low cardiac output and increased peripheral resistance and muscle degeneration (Indhu *et al.,* 2018). So, elevated serum-LDH might be considered as a risk factor for cardiac diseases in dogs and can be a routine biochemical indicator for cardiac affections.

Electrocardiographic and radiographic findings of affected dogs are presented in Table 1 and 2 respectively. Radiographic findings like globoid cardiac silhouette, increased sternal contact, cardiomegaly, tracheal elevation, left atrial, left ventricular and right ventricular enlargement are suggestive of cardiac diseases. Left ventricular enlargement (72.7%) gave indication about myocardial diseases *i.e.* DCM and HCM. Globoid cardiac silhouette (75%) found to be characteristic for PE. In the present study VHS (11.8-13.5) was found to be sensitive in diagnosing cardiac cases but lack further characterization. Moreover, VHS had unspecified sensitivity and can suffer from considerable observer variation (Ferasin *et al*., 2013).

Severe left atrial dilatation in DCM affected dogs causes atrial fibrillation (Jeyaraja *et al*., 2015). Electrocardiographic findings for DCM and HCM recorded in present study were

Table 1: Electrocardiographic finding in dogs suffering from cardiac affections.

Electrocardiographic findings	Diseases											
	Dilated cardiomyopathy (n=8)		Pericardial effusion (n=4)		Hypertrophic cardiomyopathy (n=3)		Right sided CHF (n=3)		Systolic dysfunction (n=2)		Total no. of cases cardiac (n=20)	
	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)
Normal sinus rhythm	1	12.5	-	-	-	-	-	-	-	-	1	5
Left atrial enlargement	5	62.5	-	-	1	33.33	-	-	1	50	7	35
Left ventricular enlargement	4	50	-	-	1	33.33	-	-	-	-	5	25
Sinus tachycardia	-	-	1	25	2	66.67	-	-	-	-	3	15
Right atrial enlargement	-	-	1	25	-	-	2	66.67	-	-	3	15
Sinus arrest	-	-	-	-	-	-	-	-	1	50	1	5
Atrial fibrillation	2	25	-	-	-	-	1	33.33	-	-	3	15
ST depression	2	25	-	-	1	33.33	-	-	-	-	3	15
Low voltage QRS complex	-	-	3	75	-	-	1	33.33	-	-	4	20
Electrical alterans	-	-	3	75	-	-	1	33.33	-	-	4	20

Table 2: Radiographic findings in dogs suffering from cardiac affections.

Radiographic findings	Diseases											
	Dilated cardiomyopathy (n=8)		Pericardial effusion (n=4)		Hypertrophic cardiomyopathy (n=3)		Right sided CHF (n=3)		Systolic dysfunction (n=2)		Total no. of cardiac cases (n=20)	
	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)	No. of cases	(%)
Enlargement of left atrium	5	62.5	-	-	1	33.33	-	-	-	-	6	30
Elevation of trachea	5	62.5	3	75	1	33.33	1	33.33	-	-	10	50
Pulmonary oedema	3	37.5	-	-	1	33.33	-	-	-	-	4	20
Cardiomegaly	7	87.5	4	100	2	66.67	2	66.67	2	100	17	85
Globoid cardiac silhouette	-	-	3	75	-	-	1	33.33	-		4	20
LV enlargement	6	75	-	-	2	66.67	-	-	-	-	8	40
Increased sternal contact	3	37.5	3	75	1	33.33	3	100	-	-	10	50
RV enlargement	-	-			-	-	3	100			3	15
Ascites	6	75	4	100	2	66.67	2	66.67	-	-	14	70
No change	1	12.5	-	-	1	33.33	-	-	-	-	2	10

left atrial (54.54%) and left ventricular enlargement (45.45%) respectively, low voltage QRS and electrical alterans (75% each) in Pericardial effusion (PE) and right atrial enlargement (66.67%) in R-CHF. Changes in electrical alterans may be because of alternating configuration of the ventricular action potential or alternating changes in intra ventricular conduction or due to exaggerated anatomical or swinging motion of the heart within distended pericardial sac (Bodh *et al.,* 2016). Low voltage QRS complex in PE might be because of internal short circuiting of the electrical currents by the accumulated fluid within the pericardial space (Wray, 2014).

Increased mean values (151.72 ng/l-586.47 ng/l) of canine cTnI were observed in cardiac affected dogs on day 0 before the start of therapy as compared to the control group (91.33ng/l), with HCM (586.47ng/l) having highest mean value (Fig 1). Similar findings were reported by Chun *et al*. (2010) in PE affected dogs and by Falk *et al*. (2013) in CHF affected dogs.

Mean±SE of M mode echocardiographic parameters are presented in Table 3. In DCM affected dogs, B-mode examination revealed left atrial enlargement, left ventricle enlargement and thinning of inter-ventricular septum. M-mode echocardiographic findings showed significant increase in mean values of LVIDs (53.49±2.97 mm), LVIDd (61.83±3.44 mm) with significant decrease in mean values of IVSd (7.18±0.64 mm), IVSs (7.16±0.89 mm), LVPWs (10.54±1.24) and LVPWd (7.58±0.78) in DCM affected dogs. There was reduced contractility of chambers manifested by low EF% (30.11±3.23%) and FS% (13.43±1.62%). Present findings were in agreement with earlier studies Karlapudi *et al.* (2012) and Sidhu *et al*. (2018). Right parasternal short axis view at the level of mitral valve showed increased EPSS ranging from 9-16 mm. LA/Ao was significantly increased indicating left atrial enlargement (Fig 2). Significant increase in mean values of end diastolic volume (EDV) (150.99±22.70 ml) and end systolic volume (ESV) (106.39±16.67 ml) was also

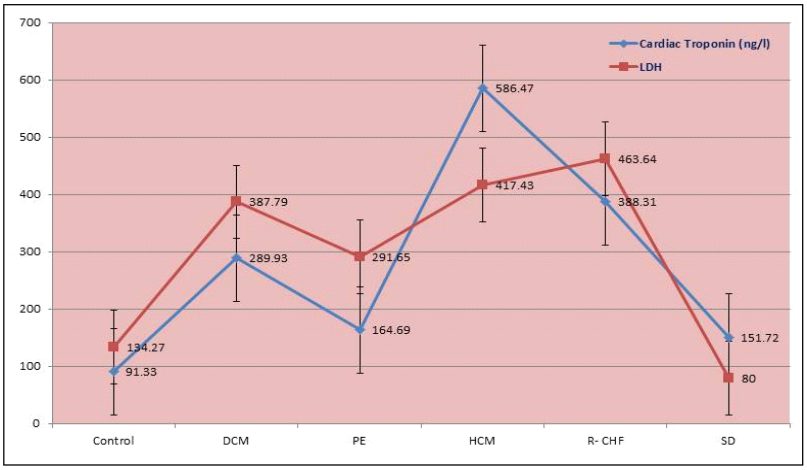


Fig 1: Graphical representation of Cardiac Troponin I and LDH mean values in different cardiac diseases. X axis depict different cardiac affections and y axis depicting mean values of LDH and Cardiac Troponin- I.

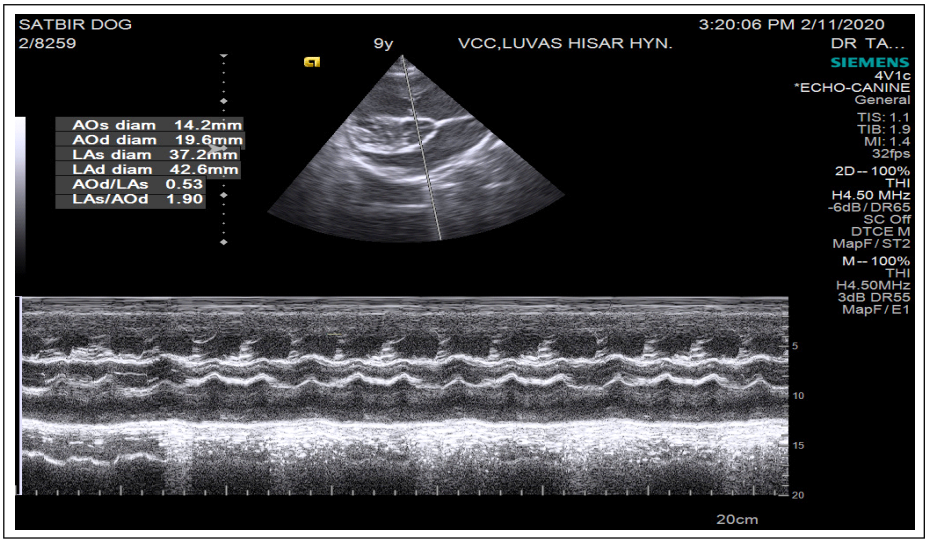


Fig 2: M-mode echocardiographic image of DCM affected dog at right parasternal short axis heart base: Aorta and Left atrium view showing left atrial enlargement. LA= left atrium, Ao= aorta, AOs diam= aorta diameter during systole, AOddiam= aorta diameter during diastole, LAs diam= left atrium diameter during systole, LAddiam= left atrium diameter during diastole.

Table 3: Mean±SE of M mode echocardiographic parameters in dogs suffered with cardiac affections.

Parameters	Diseases				
	Dilated cardiomyopathy (n=8)	Pericardial effusion (n=4)	Hypertrophic cardiomyopathy (n=3)	Right sided CHF (n=3)	Systolic dysfunction (n=2)
LVIDd (mm)	61.83±3.44^{b}	28.88±2.84^{a}	24.23±1.98^{a}	27.10±4.93^{a}	25.55±1.05^{a}
LVIDs (mm)	53.49±2.97^{b}	18.00±3.76^{a}	14.40±2.85^{a}	17.53±3.51^{a}	17.05±1.15^{a}
LVPWd (mm)	7.58±0.78^{a}	14.18±1.28^{b}	13.20±2.06^{b}	7.97±1.27^{a}	6.20±3.10^{a}
LVPWs (mm)	10.54±1.24^{ab}	18.63±2.04^{c}	16.33±0.75^{bc}	11.57±1.98^{ab}	11.05±0.75^{a}
IVSd (mm)	7.18±0.64^{a}	14.23±0.31^{b}	10.83±1.10^{b}	10.97±2.44^{b}	7.10±0.20^{a}
IVSs (mm)	7.16±0.89^{a}	24.50±2.50^{b}	12.13±2.62^{a}	12.93±2.49^{a}	10.6±1.3^{a}
LA/AO	1.89±0.15^{b}	1.00±0.08^{a}	0.92±0.16^{a}	0.71±0.07^{a}	0.93±0.06^{a}
EPSS (mm)	13.56±1.71^{b}	6.03±0.34^{a}	4.47±0.60^{a}	6.03±0.97^{a}	5.95±0.25^{a}
FS (%)	13.43±1.62^{a}	38.84±9.50^{b}	40.00±12.73^{b}	35.69±2.91^{b}	10.84±6.06^{a}
EF (%)	30.11±3.23^{a}	60.18±7.07^{b}	68.19±14.55^{b}	67.16±4.04^{b}	17.82±6.55^{a}
EDV (ml)	150.99±22.70^{b}	29.13±4.86^{a}	21.13±4.32^{a}	30.33±13.77^{a}	29.75±2.25^{a}
ESV (ml)	106.39±16.67^{b}	11.58±1.74^{a}	6.27±2.44^{a}	10.47±5.25^{a}	22.70±1.70^{a}

The means bearing different superscripts (a, b) differ significantly (P<0.05) between groups.

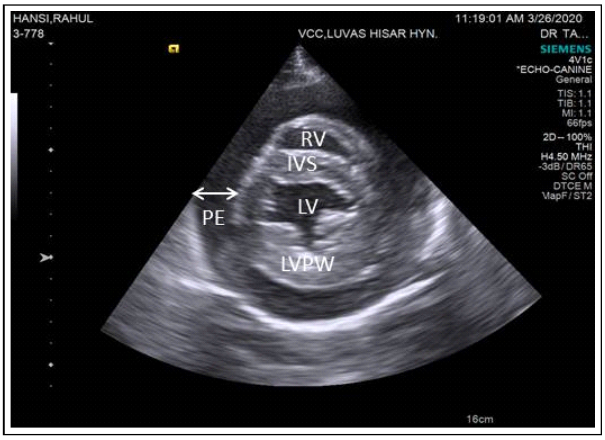


Fig 3: Echocardiographic image in dog affected with Pericardial effusion (2D B-mode right parasternal short axis left ventricle with papillary muscle view in PE affected dog showing pericardial effusion and swinging motion of heart. RV= Right ventricle, LV= Left ventricle, IVS= Interventricular septum, PE= Pericardial effusion, LVPW= Left ventricle posterior wall).

observed. Dogs having pericardial effusion showed presence of hypoechoic to anechoic free space between epicardium and pericardial sac and swinging motion of heart (Fig 3). In HCM concentric LV hypertrophy indicated by increased IVSd/ LVIDd was the most important echocardiographic finding as. There was significant decrease in mean values of LVIDs (14.40±2.85 mm), LVIDd (24.23±1.98 mm) with significant increase in mean values of LVPWd (13.20±2.06 mm), IVSd (10.83±1.10 mm). Papillary muscle hypertrophy with increased echogenicity of left ventricular posterior wall was also observed on B-mode image in HCM affected dogs. In R- CHF, prominent echocardiographic findings were right sided chambers enlargement *i.e.* right heart dilatation, bowing of interventricular septum towards left ventricle due to pressure or volume overload and increased right ventricle chamber size compared to left ventricle chamber size. Echocardiographic finding in systolic dysfunction revealed significant decrease in mean values of EF (17.82±6.55%) and FS (10.84±6.06%) and significant increase in ESVI (end systolic volume index).

CONCLUSION

Echocardiography serves as the most sensitive non-invasive diagnostic tool for cardiac diseases diagnosis and categorisation. Prevalence of cardiac disease was found to be 0.77% (20/2582) with dilated cardiomyopathy to be most prevalent cardiac disease. Labrador retriever reported to be most predisposed breed for DCM in this Northern part of India followed by Rottweiler as most affected with pericardial effusion. Adult dogs (4-9 years age group) were found to be more commonly affected and should be screened routinely for cardiac affections. Cardiac troponin-I with cut off value above 92 ng/ l detect all forms of cardiac affections and serve as reliable sensitive biomarker, while Lactate dehydrogenase serve as good screening biochemical marker with significant increase in all the cardiac cases ranging from 291 IU/l to 586.4 IU/l. Further work needs to be undertaken in different breeds of India and for longer duration to better understand cardiac diseases in relation to breed, area and lifestyle of pet parents.

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