



ISSN: 2456-2912

VET 2024; 9(6): 415-418

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www.veterinarypaper.com

Received: 02-08-2024

Accepted: 10-09-2024

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Evidence of initiation of cardio renal syndrome in occult stage of dilated cardiomyopathy in dogs

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Abstract

Cardiomyopathies results in cardiac dysfunction affecting myocardium of heart especially dilated cardiomyopathy (DCM) being second common cause of mortality in cardiovascular disorders. This study was undertaken to diagnose and rule out hematological and serum biochemical values in dogs with occult stage of DCM in comparison to healthy dogs. The disease was diagnosed with the aid of electrocardiography and echocardiography. The hematological values revealed a significant anemia, erythrocytopenia, thrombocytopenia and neutrophilia. Whereas, renal function tests revealed presence of significant levels of elevated blood urea nitrogen and creatinine. Electrocardiography revealed abnormalities such as Electrical alterans, arrhythmia and ST coving. Echocardiographic abnormalities such as reduced contractility and volume indices with left atrial enlargement was noticed. Based upon all these parameters, the cases were diagnosed with an addition condition called cardio renal syndrome. All the animals were given standard treatment and clinical improvement was noticed after one month of treatment.

Keywords: Dilated cardiomyopathy, electrocardiography, echocardiography, anemia, blood urea nitrogen, creatinine and cardio renal syndrome.

Introduction

Dilated cardiomyopathy (DCM) is one of the myocardial disorders defined as Left Ventricular (LV) systolic dysfunction characterized by progressive increase in ventricular dimensions, normal or reduced LV wall thickness, and atrial dilatation. The symptomatic phase/ overt phase follows the asymptomatic/ occult phase wherein to maintain the optimum cardiac output, several compensatory mechanisms act synergistically to prevent congestive heart failure (CHF) (Sisson *et al.*, 2000) [9]. Whereas, the interaction between cardiovascular disease, renal insufficiency and anemia, form a deleterious effect, termed as the cardio-renal anemia syndrome (CRA) due to erythropoietin insufficiency (Silverberg *et al.*, 2006 and Efstratiadis *et al.*, 2008) [8, 1]. This study was taken up with an aim to diagnose occult stage of DCM along with to find out the changes in hematology and serum biochemistry in DCM dogs compared to apparently healthy dogs.

Materials and Methods

The present study was conducted at Small Animal Medicine unit, Dept of Veterinary Medicine, Teaching Veterinary Clinical Complex (TVCC), RIVER, Puducherry. Ten apparently healthy dogs of small to giant sized breeds aged from 1-3 years with normal vital signs were selected randomly for the study with apparently no history, clinical signs, hematological, renal function tests, electrocardiographic, echocardiographic or radiographic abnormalities for any diseases were considered in this group. Whereas, 20 dogs of age group 4-15 years presented without any history or clinical manifestation were diagnosed to be suffering with Occult stage Dilated Cardiomyopathy (DCM) by clinical examination, hematology, serum biochemistry, electrocardiography and echocardiography.

Electrocardiographic examination was conducted as procedure described by Smith *et al.* 2015 [10]. Animal was restrained on a wooden table with stretching of limbs perpendicular to body. The bipolar lead system was placed as per indications in which electrodes were placed either proximal to the elbow joint for forelimbs and over the stifle joint for hindlimbs. ECG readings

were recorded at 10mm/mv voltage and 25 mm/sec speed on standard ECG paper.

Echocardiographic examination was conducted as procedure described by Smith *et al.* 2015 [10]. Animal was restrained in right lateral recumbency on a table with stretching out the four limbs or in standing position to expose right parasternal window. Standard thoracic echocardiography was performed using a micro-concave probe frequency of 3-8 MHz with improving the contact surface using acoustic gel. Cardiac imaging was performed in two dimensional (2D) and M-mode as per the standard protocol and respective parameters were assessed as interpreted by Smith *et al.* 2015 [10].

Results

The Mean \pm SE values of hematology of control and DCM occult stage dogs were presented in table 1. The animals of diseased group revealed presence of anemia with significantly decreased hemoglobin and packed cell volume ($p < 0.01$) in DCM stage II group compared to healthy control dogs. Similarly, total erythrocyte count (TEC) significantly decreased ($p < 0.05$) in occult group compared to healthy control dogs. The mean values of platelet count and neutrophils were also significantly decreased ($p < 0.05$) in DCM stage dogs compared to control dogs.

The Mean \pm SE values of serum biochemistry of control and DCM occult stage dogs were presented in table 2. The blood urea nitrogen (BUN) and creatinine values were significantly increased ($p < 0.05$) in occult stage than the control group.

Electrocardiographic examination revealed abnormalities such

as Electrical alterans (2/20 dogs) (Fig 1), arrhythmia (4/20 dogs) and ST coving (2/20 dogs) (Fig 2). Whereas, in all the 20 dogs, echocardiography revealed reduced contractility indices and elevated left atrium to aorta ratio indicative of left ventricular dilatation and left atrial enlargement (Fig 3 and 4).

Table 1: The mean \pm SE values of hematological parameters of control and occult stage DCM dogs along with their p values (value of significance)

Parameters	Control	Occult stage DCM	p value
Hb (g/dl)	12.57 \pm 0.36	8.25 \pm 0.66	0.001
PCV (%)	42.85 \pm 1.11	24.02 \pm 2.01	0.000
TEC (millions/ mm ³)	6.41 \pm 0.21	4.62 \pm 0.22	0.011
WBC (thousands/ mm ³)	13.23 \pm 1.36	11.14 \pm 1.37	0.886
PLATELET COUNT (laks/ mm ³)	225.90 \pm 10.41	138.81 \pm 22.96	0.137
NEUTROPHIL (%)	81.50 \pm 1.05	71.95 \pm 1.15	0.017
LYMPHOCYTE (%)	15.10 \pm 0.87	20.23 \pm 1.16	0.167
MONOCYTE (%)	3.0 \pm 0.39	6.2 \pm 0.76	0.027
EOSINOPHIL (%)	0.40 \pm 0.16	0.52 \pm 0.17	0.980
MCV	69.15 \pm 2.60	64.76 \pm 1.16	0.789
MCH	22.92 \pm 0.85	21.70 \pm 1.15	0.791
MCHC	33.55 \pm 0.11	32.43 \pm 0.27	0.905

Table 2: The mean \pm SE values of serum biochemical parameters of control and occult stage DCM dogs along with their p values

Parameters	Control	DCM Stage II	p value
BUN	16.94 \pm 1.51	35.95 \pm 3.16	0.035
Creatinine	0.52 \pm 0.08	1.42 \pm 0.24	0.000

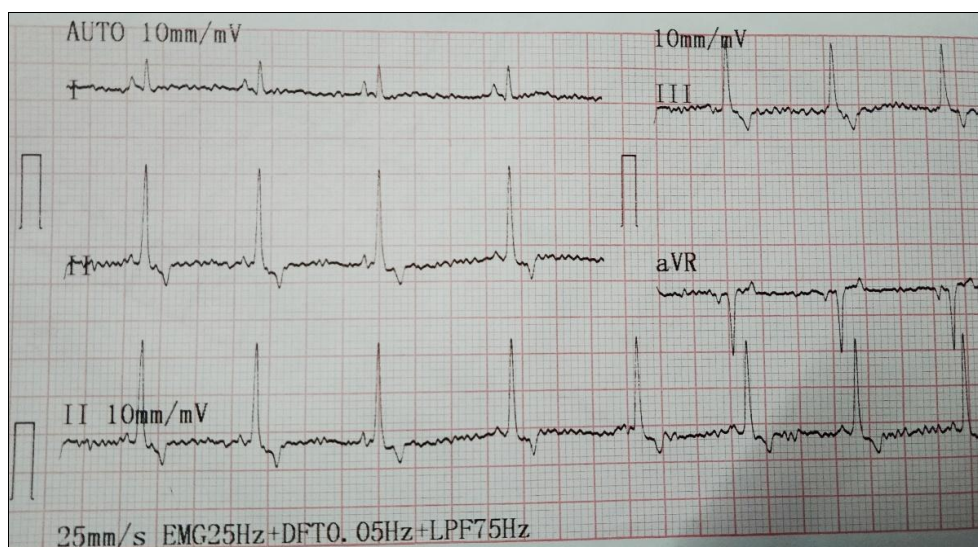


Fig 1: ECG showing electrical alterans (10mm/sec)

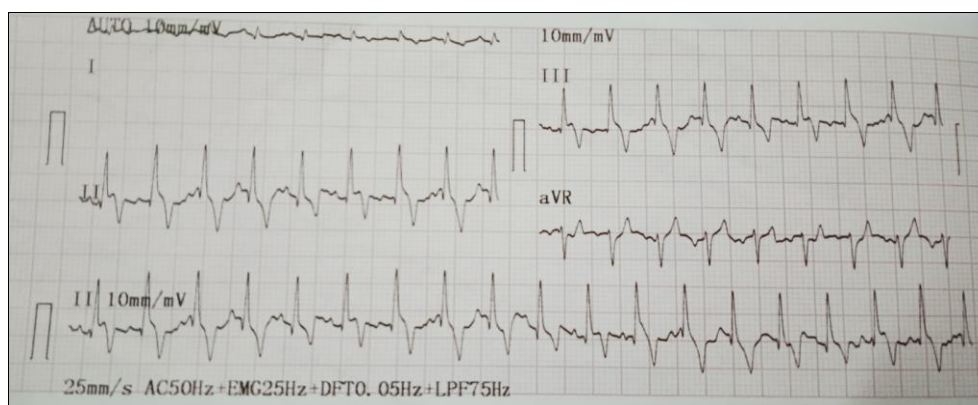


Fig 2: ECG showing tachycardia with ST Coving (10mm/sec)



Fig 3: Left ventricular parameters with contractility indices



Fig 4: Left atrium to aorta dimensions

Discussion

The present study revealed significant changes in hematological and biochemical changes in occult stages of dogs. This study revealed anemia which is consistent with the results obtained by Martin *et al.* (2009) in 248 dogs with DCM. Similarly, thrombocytopenia was noticed which was similar to findings of Sesh *et al.* (2013). The significant neutropenia observed was inconsistent with the findings of Sesh *et al.* (2013) in which neutrophilia was noticed. Additionally, elevated BUN and creatinine levels were noticed which is in consistent with the findings Jeyaraja *et al.* (2015)^[3] and Matli *et al.* (2021).

The presence of a complex interactions between cardiac and renal system to regulate hemostasis of circulatory fluid, vascular tone and blood pressure. Chronic insult to heart leads to renal insufficiency leading to the deficiency of erythropoiesis which further intensifies the anemic condition (Shamseddin and Parfrey, 2009). This study reveals the presence of elevated BUN and creatinine mean levels which were indicative of IRIS stage 2 chronic renal failure with no symptoms were noticed (IRIS Staging of CKD (Modified 2023)). The constant and chronic reduced blood supply to the renal tissue leads to reduced glomerular filtration rate, erythropoietin deficiency and anemia which further

aggravates the vascular tone and hemostasis. This reduced vascular tone in turn leads to insufficient circulatory return to heart and reduced stroke volume affecting the tissue perfusion rate and worsening and progression of cardiac and renal diseases to advanced stages.

Conclusion

The complex bidirectional relationship of cardiac and renal system reveals the need to rule out concurrent renal insufficiency in cardiac diseases associated with anemia. Even though the clinical signs were absent for both cardiac and renal insufficiencies in this study, the vicious cycle of insult to both the systems were still evident. This highlights the need of screening of dogs with anemia for both cardiac and renal tests. Moreover, the early therapeutic interventions led to return of the elevated parameters to normal, by which possibility of providing quality life to animal was evidenced.

Conflict of Interest

Authors declare no conflict of interest with respect to the clinical work, authorship, and/or publication of this article.

Author's Contribution

GJ: Carried out the data collection, analysis and drafted the manuscript; ND: Supervised, analyzed the work and revised the manuscript; KR, AA, DS and PV were read, corrected and approved the final manuscript

Acknowledgment

The authors thank the Dean and Department of Veterinary Medicine, Veterinary Clinical Complex, Rajiv Gandhi Institute of Veterinary Education and Research, Puducherry for providing the necessary facilities.

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article

Jyothsna GSS, Devadevi N, Rajkumar K, Lakshmi PV. Evidence of initiation of cardio renal syndrome in occult stage of dilated cardiomyopathy in dogs. *International Journal of Veterinary Sciences and Animal Husbandry.* 2024;9(6):415-418.

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