

Electrocardiographic Abnormalities in Canine Dilated Cardiomyopathy and their Management

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ABSTRACT

Dilated cardiomyopathy (DCM) is one of the commonly acquired myocardial disease of dogs which most often is accompanied by electrocardiographic abnormalities. The present study was aimed to identify the electrocardiographic (ECG) abnormalities that were present in DCM affected dogs as well as their management. A total of 52 dogs with DCM were evaluated electrocardiographically using RMS Vesta 301i as per standard procedure. Pre-therapeutic electrocardiographic evaluation revealed normal sinus rhythm in 15 cases (28.84%), sinus tachycardia in 18 cases (34.61%), atrial fibrillation in 8 cases (15.38%), ST coving in 6 cases (11.53%), reduced 'R' amplitude in 5 cases (9.6%), junctional premature complexes in 2 cases (3.84%), ventricular premature complex in 2 (3.84%), atrial flutter in 1 case (1.92%) and isorhythmic atrioventricular disassociation in 1 case (1.92%). All the cases were treated for DCM using standard protocol. Atrial fibrillation and flutter were treated with Diltiazem @ 1-1.5 mg/kg three times a day and Digoxin @ 0.003 mg/kg twice a day orally and ventricular premature complex was treated with Sotalol @ 1-2 mg/kg two times a day orally. Six cases of atrial fibrillation was presented for follow-up and all achieved effective control of heart rate and two of them reverted to normal sinus rhythm *i.e.*, rhythm control, one to atrial flutter and three persisted with atrial fibrillation. VPC's in both the dogs were successfully controlled by 15th day of therapy.

Keywords: Antiarrhythmics, Arrhythmias, Atrial fibrillation, Dilated cardiomyopathy, Ventricular premature complex.

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INTRODUCTION

Dilated cardiomyopathy (DCM) is an important myocardial disorder and is the second most commonly acquired cardiac disease of dogs (Dutton and Lopez Alvarez, 2018) characterised by morphological and electrical abnormalities. Electrocardiographic (ECG) abnormalities in DCM was often reported with an incidence ranging from 55 per cent (Freid *et al.*, 2021) to 91 per cent (Morales, *et al.*, 2001), which include atrial premature complexes, atrial fibrillation, VPC's and ventricular tachyarrhythmias (Wess and Torti, 2018), of which atrial fibrillation was the most common (Pedro *et al.*, 2020a). Electrocardiographic evaluation in these cases is vital to identify these abnormalities and also for monitoring the therapy. Detailed studies on various electrocardiographic abnormalities and their management protocols in canine DCM were scarce. The present study was aimed at identifying the electrocardiographic changes in canine dilated cardiomyopathy and also to assess the therapeutic efficacy of antiarrhythmics in managing them.

MATERIALS AND METHODS

Client owned dogs presented to referral cardiology unit, Madras Veterinary College with ascites, limb oedema, dyspnoea, cough and arrhythmias, murmurs/gallop on cardiac auscultation were taken up for the study. A total of 52 dogs (35 males and 17 females) with an age from 2.5 years upto 11.5 years were noticed. The breeds recorded were Labrador retrievers (41), Rottweiler (2), Non-descript (3), Doberman (2), Beagle (1), German Shepard (1), Golden retriever (1) and

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Pug (1). All the cases were subjected to thorough clinical, radiographic, echocardiographic and electrocardiographic evaluation. Echocardiographic evaluation was done using Aerscan CD 25 ultrasound system under standard positions as suggested by Boon (2011).

Dogs with left ventricular dilation indicated by an increased left ventricular internal diameter diastole (LVIDd) along with reduced ejection fraction and fraction shortening were the parameters considered for diagnosing the case as dilated cardiomyopathy (DCM) (Vatnikov *et al.*, 2019; Bonagura and Visser, 2022). Dogs that were diagnosed of

having DCM were further subjected to electrocardiography (ECG). ECG was performed with patient on right lateral position on a wooden table with the four limbs stretched out. Care was taken to prevent the environmental stress on the patient by allowing it to adapt to room environment before starting the procedure. Limb leads were connected as per the lead indications and electrocardiograph was recorded for about five min to check for the presence of arrhythmias. Recording was done on thermosensitive paper at paper speed of 25 mm/s and 50 mm/s with voltage of 10 mm/mv as standard setting. In cases with tall R wave in lead II beyond lead II area, voltage was reduced to 5 mm/mv to clearly interpret the amplitude. Individual wave amplitude, durations were measured and arrhythmias recorded were analysed and treated. Therapeutic protocols adapted varied with the underlying arrhythmia. Cases with atrial fibrillation/flutter were treated with Diltiazem @ 1.0-1.5 mg/kg three times a day and Digoxin @ 0.003 mg/kg two times a day orally. In cases of ventricular premature complexes, Tab. Sotalol @ 1-2 mg/kg was given BID PO. These antiarrhythmic medications were given along with the medication for dilated cardiomyopathy. Post-therapeutic ECG evaluation was done at weekly interval.

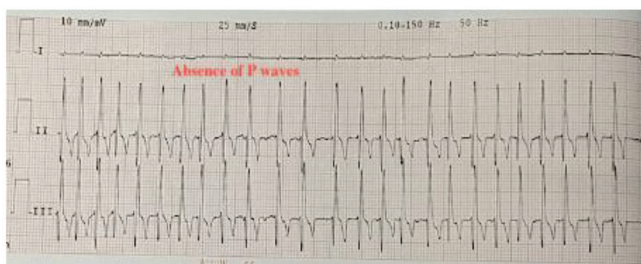
RESULTS AND DISCUSSION

In the present study, a total of 52 dogs with dilated cardiomyopathy were studied. Pre-therapeutic electrocardiographic evaluation revealed normal sinus rhythm in 15 cases (28.84%), sinus tachycardia in 18 cases (34.61%), atrial fibrillation in 8 cases (15.38%), ST coving in 6 cases (11.53%), reduced 'R' amplitude in 5 cases (9.6%), junctional premature complexes in 2 cases (3.84%),

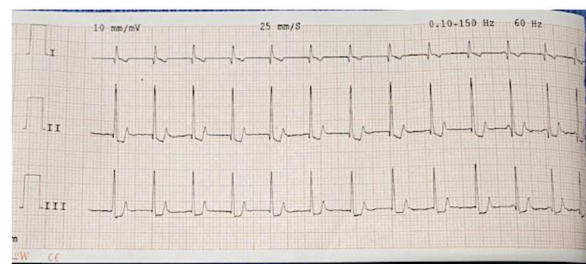
ventricular premature complex in 2 dogs (3.84%), atrial flutter in 1 dog (1.92%) and isorhythmic atrioventricular disassociation in 1 (1.92%).

Out of the 8 cases treated for atrial fibrillation, 6 dogs were available for regular follow-up while 2 dogs were not presented and hence excluded from the study. Effective control of heart rate (i.e., rate control) was achieved in all six cases, of which two reverted to normal sinus rhythm, one to atrial flutter and three persisted as atrial fibrillation with normal heart rate. Ventricular premature complexes were treated with Tab Sotalol @ 2 mg/kg BID P.O and effective control was achieved within one month of treatment with no VPC's evident on ECG monitoring.

In the present study, overall incidence of electrocardiographic abnormalities was 71.15 % (37/52) in which arrhythmias constituted 26.92% (14/52). Among the arrhythmias, atrial fibrillation (Figure 1 & 2) was seen in 57.14 % (8/14) dogs, followed by junctional premature complexes 14.28% (2/14) and ventricular premature complexes 14.28% (2/14) (Figure 3 and Figure 4), isorhythmic atrioventricular disassociation 7.14% (1/14) (Figure 6) and atrial flutter 7.14% (1/14) (Figure 8). These findings were in accordance with Fried *et al.* (2021) who reported that supraventricular arrhythmias are more common in dilated cardiomyopathy with atrial fibrillation being the most common among them. Sinus tachycardia was noticed in majority of the cases under study and is commonly reported in dogs with dilated cardiomyopathy (Martin *et al.*, 2009). In dogs with DCM due to reduced cardiac output, sympathetic stimulation (a compensatory response) will be activated by increasing norepinephrine levels (Santos *et al.*, 2006) to maintain cardiac output through chronotropic and ionotropic support (McEwan, 2000).

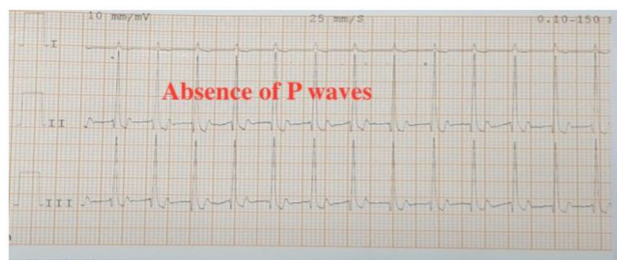


Pre-treatment (Heart rate: 220/min)

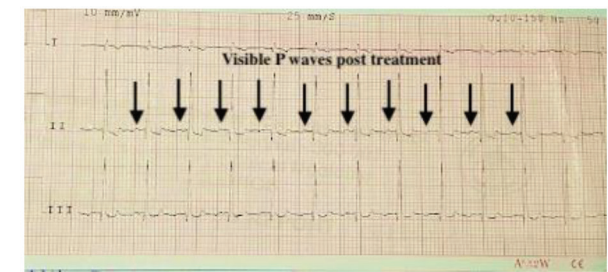


Post treatment (Heart rate: 140/min)

Fig. 1: Atrial fibrillation (rate control)



Pre-treatment



Post treatment (rhythm control)

Fig. 2: Atrial fibrillation



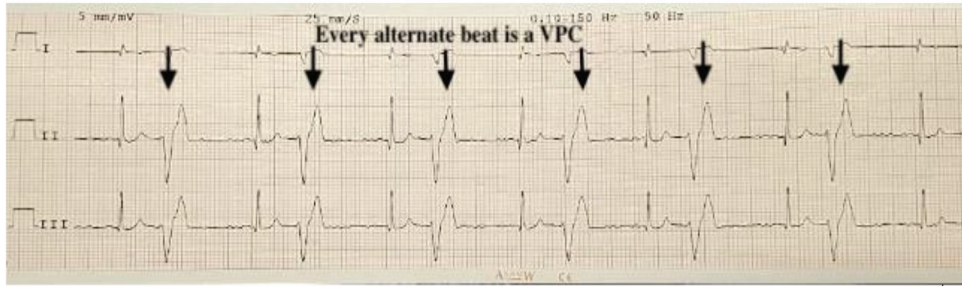
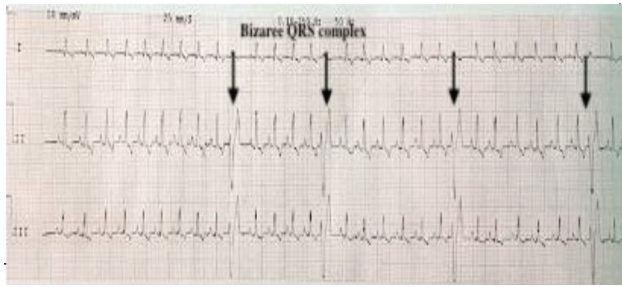
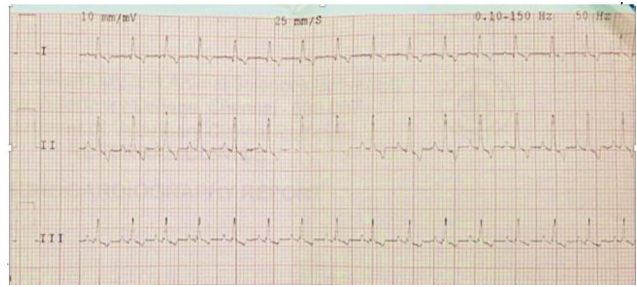


Fig. 3: Ventricular bigeminy

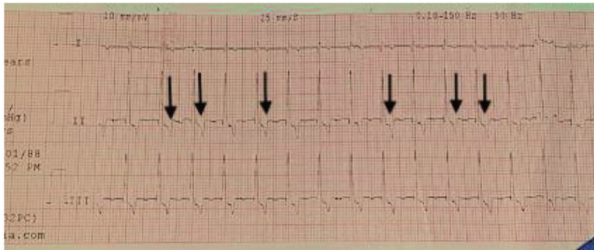


Pretherapy

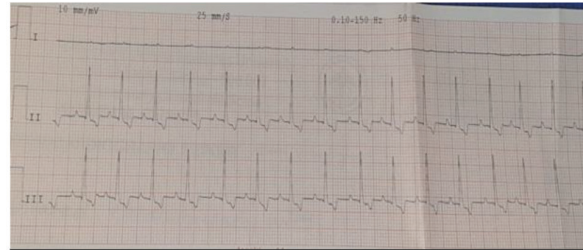


Post therapy with sotalol (absence of bizarre complexes)

Fig. 4: Ventricular premature complex



Pretherapy (concaving of ST segment)



Post therapy

Fig. 5: ST coving

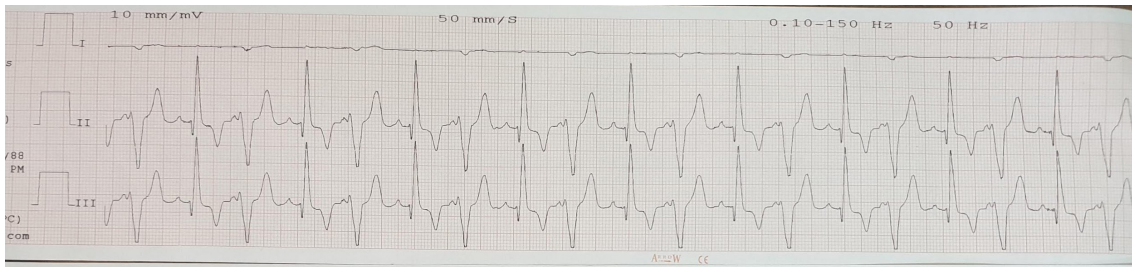


Fig.6: Isorhythmic Atrioventricular disassociation (Bizzare QRS complex and P wave are of independent origin, their occurrence is happening in a Isorhythmic fashion)

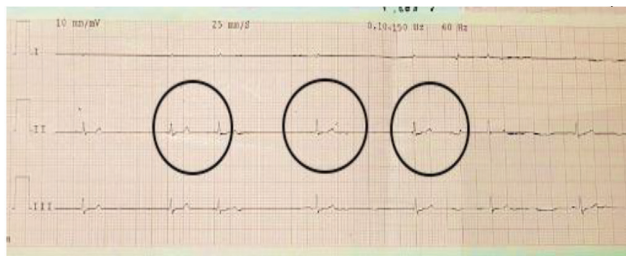


Fig. 7: Low amplitude QRS complex

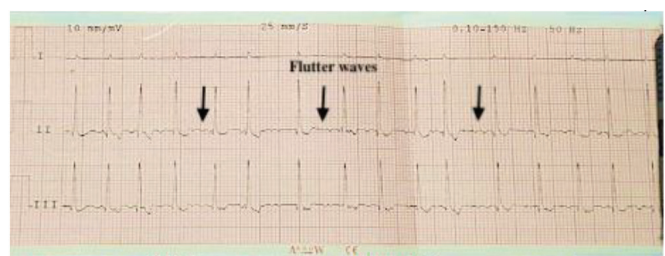


Fig. 8: Atrial flutter

Atrial fibrillation is a supraventricular arrhythmia that is characterized by rapid and disorganized atrial activity resulting in loss of atrial contraction and compromised ventricular filling (Pedro *et al.*, 2020a). Clinically it is characterized by rapid and irregular heart beat associated with varying pulse strengths and remarkable pulse deficits. Management is often targeted to achieve rate and rhythm control in these cases. Beta-blockers or calcium channel blockers are recommended to reduce and gain control of heart rate (Jung *et al.*, 2016). Calcium channel blockers are well tolerated, whereas beta-blockers have limitations in cases with decompensated congestive heart failure. Diltiazem is a calcium channel blocker as well as class IV antiarrhythmic agent that slows AV conduction, whereas digoxin exhibits its antiarrhythmic effect through sympathetic inhibition and parasympathomimetic effects (Wess and Torti, 2018). Combination of these two drugs will have a prominent negative chronotropic effect and rate control when compared with either of them individually (Gelzer *et al.*, 2009) and are very effective in controlling atrial fibrillation. Rhythm control is indicated to establish a sinus rhythm which can be performed through electrical cardioversion or pharmacological cardioversion such as Amiodarone (Pedro *et al.*, 2020b). In the present study effective rate control was achieved in all the six dogs, of which two also had rhythm control.

Ventricular premature complexes are the ectopic beats produced due to spontaneous depolarisation of an ectopic pacemaker in ventricular myocardium (Wess and Torti, 2018), which can be seen in some healthy dogs with a rate less than 50 ventricular premature complexes over 24 h. In DCM the cut-off value recommended for diagnosis based on VPC varies with the breeds. Normal breeds were considered positive with cut-off value greater than 100 ventricular premature complexes over 24 h, while in Boxers and Dobermans it is greater than 300 ventricular premature complexes over 24 h (Wess *et al.*, 2017; Wess, 2022). In the present study ventricular bigeminy was also noticed in one case, which is a repetitive sequence of one normal beat and one ectopic beat (Wess and Torti, 2018). Several oral drugs were reportedly effective in the management of ventricular arrhythmias which include sotalol, mexiletine, lidocaine etc. (Moise *et al.*, 2009). In the present study, sotalol was taken as the first line of management for ventricular premature complexes. Both the cases showed significant improvement with no recurrence of ventricular premature complex in the later period. Sotalol is a selective beta-blocker as well as class III antiarrhythmic agent with potassium channel blockade effect. The finding was in accordance with Meurs *et al.* (2002), who evaluated various antiarrhythmics for management of ventricular arrhythmias and reported that sotalol has very minimal proarrhythmic effect and is very effective in controlling ventricular premature complexes.

Another prominent finding noticed in the present study was 'ST coving'(Figure 5) which is also called 'concaving'

downward that indicates myocardial hypoxia or sub-endocardial myocardial infarction (Tilley, 2008). Poor cardiac output along with tachycardia in DCM could have resulted in ST coving.

Low amplitude QRS complexes (Figure 7) were seen in 5 cases due to the presence of mild to moderate pleural effusion and pericardial effusion that develop as a sequel of congestive heart failure. Various differentials to be ruled out for presence of short QRS complexes are pericardial effusion, pleural effusion, edema or obesity (Tilley, 2008). Presence of arrhythmias especially atrial fibrillation is reported to be one of the negative prognostic indicator (Friederich *et al.*, 2020) and effective management of tachycardia, fibrillation or flutter are vital in determining the outcome of dilated cardiomyopathy.

CONCLUSIONS

In dogs affected with DCM, sinus tachycardia was the most common electrocardiographic abnormality and atrial fibrillation was the common arrhythmia. Combination of diltiazem and digoxin was found to be highly effective in achieving rate and rhythm control in atrial fibrillation, while in cases with ventricular premature complexes sotalol was effective. Early identification of underlying arrhythmia and their appropriate management results in improved life span of the dogs with DCM.

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