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Electrocardiographic changes in babesiosis and ehrlichiosis affected dogs

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Abstract
The present study was aimed to know the hematobiochemical changes in the dogs affected with Babesiosis and Ehrlichiosis in Dogs. Dogs presented to small animal OPD, Department of Veterinary Medicine were selected for the study. 15 dogs which were positive by PCR technique for either of the infections or mixed infection were subjected to electrocardiographic examination. Commonly observed electrocardiographic abnormalities were low QRS complex (40%, 6/15 dogs), tall T wave (40%, 6/15 dogs), increased width of T wave (33.33%, 5/15 dogs), ST coving (26.66%, 4/15 dogs), absent P wave (20%, 3/15 dogs) and Q dip (20%, 3/15 dogs), Increased width of the P wave (13.33%, 2/15 dogs), Tall QRS complex (13.33%, 2/15 dogs) and Absent T wave (13.33%, 2/15 dogs).

Keywords: Babesiosis, ehrlichiosis, electrocardiography

Introduction
Dogs has been domesticated and been a part of a families for various purposes since ancient times, One community used dogs for the purpose of hunting and some used them as guards to protect them and the livestock they are raring in olden days. Now the times has changed and dogs are been using for different purposes, among those dogs as a companion animal has gained lot of scope from the start of this century, dogs are considered as a part of their family and has cared equally as a family member in terms of everything. Healthcare is also an integral part of companion animal care and with the increasing number of diseases day by day, among the diseases, haemoprotozoan diseases have gained greater importance in the recent days due to repeated tick infestations due to travelling or due to boarding them in the kennels.
Vector-borne infections pose significant threat to the health of domestic dogs and also have public health implication. Dogs are affected by several haemopathogens, resulting in diseases such as babesiosis, hepatozoonosis, ehrlichiosis, anaplasmosis and leishmaniasis (Otranto *et al*. 2009) [28]. These infections usually has non-specific signs (pale mucous mem branes, fever, lethargy, anemia, lymphadenomegaly and petechial hemorrhages) which may vary according to the immune status, age of the dog, pathogen involved; parasitemia level thus represent a diagnostic challenge (Baneth *et al*. 2012) [3]. Most of the dogs remain infected sub-clinically thus hinder the control programs and therapeutic intervention against the diseases (Otranto & Dantas - Torres, 2010) [27]. These animal acts as reservoirs for the scattering of infection.
The present study is aimed at recording the effect of these hemoprotozoan infections on heart is also studied by conducting the electrocardiography examination for the PCR positive dogs.

Review of Literature
Among tick-borne diseases, canine ehrlichiosis and babesiosis infect both wild and domestic Canidae (Hibler & Greene, 1986) [14]. *Ehrlichia canis*, an intracellular rickettsial organism that infects canine leukocytes, primarily monocytes, is the causal agent of canine ehrlichiosis (Greene & Harvey, 1984) [13]. *Babesia canis*, *B. gibsoni*, and *B. vogeli* are intracellular protozoan parasites of canine erythrocytes that cause canine babesiosis.

Ehrlichia is an alpha-proteobacterium of the Anaplasmataceae family. *Ehrlichia canis* (tropical canine pancytopenia), *Ehrlichia ewing*ii (canine granulocytic ehrlichiosis), and *Ehrlichia chaffeensis* (human monocytic ehrlichiosis) are all capable of infecting dogs (Anderson *et al*., 1991; Irwin and Jefferies, 2004) [1, 15]. The few studies that examined the prevalence of canine ehrlichiosis in India using conventional examination of stained blood smears found prevalences of 0.35% (n = 752) in Punjab (Juyal., *et al*., 1994) [17], 18.9% (n = 238) in Nagpur (Samardani., *et al*., 2003) [29], and 55% in stray dogs in Maharashtra (Mallapur, 2002) [23]. According to one study that used an *E. canis*-specific nested PCR, 46/98 (46.9%) of owned dogs in Chennai were positive for *Ehrlichia* spp., compared to 19% by microscopy (Lakshmanan *et al*., 2007) [19].

Babesia spp. are classified as members of the order Piroplasmida, which is part of the phylum Apicomplexa. Early studies identified two morphologically distinct forms of the erythrocytic stage in the canine host, leading to the designation of the larger form (3-5 m) as *B. canis* and the smaller (1-3 m) as *B. gibsoni*. *B. canis* was reclassified into three subspecies based on cross-immunity, serological testing, vector specificity, and molecular phylogeny (*B. canis*, *B. rossi*, and *B. vogeli*). They are currently all recognized as distinct species (Zahler *et al*. 1998, Carret *et al*. 1999, Costa-Junior *et al*. 2009) [32, 6, 9].

It is typical for dogs to have both ehrlichiosis and babesiosis at the same time. The occurrence of concurrent infections varies and is most likely related to the geographic distribution of the agents. Multiple organ dysfunction syndrome (MODS) develops from systemic inflammatory response syndrome (SIRS), which is a hallmark of babesiosis (Matijatko *et al*., 2010) [24].

Babesia spp. was discovered in a blood smear by Victor Babes in 1888 while searching for the source of frequent cattle infections (Babes, 1888) [2]. The blood smear was thus the first approach for detecting *Babesia* spp. in clinical samples, and it is still used in clinical practice and laboratory diagnostics today.

In babesiosis a number of extracardiac conditions that could induce ECG abnormalities include anaemia, hypoxia, hypokalaemia, metabolic acidosis, hyperkalaemia, and uraemia (Keim, 1995; Lobetti, 1998; Maegraith, *et al*., 1957) [18, 20, 22].

Ischaemia can cause changes in the T wave. Myocardial damage can also generate ST segment changes (elevation or, less usually, depression), and myocardial necrosis can cause QRS wave changes (widening, high voltage Q-amplitude, slurring, and notching). Myocarditis can result in sluggish conduction and/or total atrioventricular (AV) block. Ventricular premature complexes (VPC) and paroxysmal ventricular tachycardia have been recorded in dogs with myocarditis (Patterson *et al*., 1961) [26].

A study conducted by Dvir *et al*., (2004) [10], the following ECG changes were recorded, sinoatrial (7%) and atrioventricular blocks (4%), ventricular premature complexes (7%), low R-amplitude (23%), prominent Q (33%), axis deviations (40%), prolonged QRS (32%), ST depression and coving (28%), large T (42%), and notched R (28%).sinoatrial blocks or sinus arrest (7%), ventricular premature complexes (7%), low R-amplitude (23%), prominent Q (13%), axis deviations (40%), prolonged QRS (32%), ST depression and coving (28%), large T (42%), and notched R (28%).

Lobetti *et al*., (2012) [21] opined that it should also be noted that in the course of babesiosis there are many factors which affect the change of the electrocardiogram, e.g. anaemia, hypoxia or uraemia, and the heart muscle damage cannot be determined solely based on ECG result.

In the current investigation, ECGs were performed on 23 dogs with hemolytic anaemia (12 with *Ehrlichia canis* and 11 with *Babesia spp*.). Sinus arrhythmia was the most common of the heart rhythms detected by electrocardiography (82.61%). In the current investigation, 20 (86.96%) of the dogs had sinus tachycardia. ST-segment abnormalities (ST depression and elevation) were identified in 5 (21.74%) anemic dogs, while ST slurring was found in 3 dogs (Bhat *et al*., 2016) [5].

The ECG revealed the following abnormalities in babesiosis-infected dogs, which were verified by haematological and molecular tests: Increased sinus rhythm in 7 animals, heart-axis deviation in 5 dogs, change in appearance and/or amplitude of T wave in 17 dogs, widened QRS complex in 3 dogs, atrioventricular block I (AV block I o) in 2 dogs, ventricular tachycardia in one dog, and additional ventricular beats in 3 dogs (Bartnicki *et al*., 2017) [4].

Pandey *et al*., (2022) [25] reported that in a Labrador positive for *Babesia gibsoni* through Blood smear examination showed normal Electrocardiography with normal heart rate, P wave duration and amplitude, R wave amplitude, QRS duration and T wave amplitude.

Materials and Methods

Dogs with clinical signs suggestive of Haemoprotozoan diseases, such as inappetence/ anorexia, high temperature, lymphadenopathy, dullness, pale mucous membranes, icterus, emaciation, diarrhoea, haemoglobinuria, and a history of tick infestation, were selected for the study.

Electrocardiography was performed using a MAC 400 (Wipro GE Health care Pvt. Ltd, Bengaluru) 3 channel, 12 lead electrocardiograph recorder. Electrocardiography recordings of the animals were taken as described by Tilley (1992) [31].

Results and Discussion

ECG of dogs which were positive for either Babesia or Ehrlichia infection or mixed infection were having abnormalities such as low QRS complex (40%, 6/15 dogs), tall T wave (40%, 6/15 dogs), increased width of T wave (33.33%, 5/15 dogs), ST coving (26.66%, 4/15 dogs), absent P wave (20%, 3/15 dogs) and Q dip (20%, 3/15 dogs), Increased width of the P wave (13.33%, 2/15 dogs), Tall QRS complex (13.33%, 2/15 dogs) and Absent T wave (13.33%, 2/15 dogs).

Table 1: Electrocardiographic findings recorded in the present study in Group 2 (N=15)

Electrocardiographic findings	Group 2	Percentage
Absent P wave	3	20
Increased duration of P wave	2	13.33
Low QRS complex	6	40
Tall QRS complex	2	13.33
Q dip	3	20
ST coving	4	26.66
Absent T wave	2	13.33
Increased amplitude of T wave	6	40
Increased duration of the T wave	5	33.33

Dvir *et al*., (2004) [10] reported low R amplitude, high QRS duration, high ST deviation (depressed or elevated) and high T amplitude are the commonest findings in the dogs affected with *Babesiosis*. These results are in agreement with the present study.

Champion *et al*., (2013) [7] reported Increase in P-wave amplitude was seen most (42.86%) in milder cases of Anemia due to blood parasites followed by Increase in P-wave duration was seen mostly (42.86%) in severe cases of anemia, 42.86 precent of Increase in QRS duration was seen in very severe cases of Anemia, 85.71 percent of dogs with moderate anemia were having Increase in R-wave amplitude, ST segment depression was seen mostly (42.86%) in dogs having moderate anemia and Increase in T wave amplitude was seen equally (14.29%) in all the groups having Mild to Very severe anemia. Some of the changes in the Electrocardiography in the present study are in agreement with the recordings of the above said author.

Sarma *et al*., (2014) [30] reported increase in the R wave amplitude in the dogs affected concomitantly with *Babesiosis* and *Ehrlichiosis* which are in agreement with the present study.

Chaudari *et al*., (2017) [8] reported single changes in the ECG such as Sinus arrhythmia 12 (13.48%) Tachycardia 32 (35.96%) Tachyarrhythmia 06 (6.74%) Bradycardia 02 (2.25%) Bradyarrhythmia 01 (1.12%) Atrial fibrillation 05 (5.62%) Atrial paroxysmal tachycardia 01 (1.12%) Sinus arrest 04 (4.49%) Low voltage complexes (LVC) 16 (17.98%) ST depression 03 (3.37%) ST elevation 01 (1.12%) ST coving 01 (1.12%). Gowtham *et al*., (2022) [12] reported ST coving in an ECG in a dog affected with *Babesiosis* indicating Myocardial hypoxia. Pandey *et al*., (2022) [25] reported there was no changes in the Electrocardiography in a dog confirmed with Babesiosis which is in contrast to the present study findings.

Overwhelming inflammatory response was suggested as one of the mechanism for tissue damage in canine babesiosis and may be responsible for cardiopathy. Dog with babesiosis and ehrlichiosis have pathological changes within the myocardium that are usually in the left ventricle (Dvir *et al*., 2002) [11].

Lobetti *et al*., (2012) [21] opines it should also be noted that in the course of babesiosis there are many factors which affect the change of the electrocardiogram, e.g. anaemia, hypoxia or uraemia and electrolyte imbalance, the heart muscle damage cannot be determined solely based on ECG result.

So the variations in the blood volume, hypoxia and electrolyte imbalance and structural damage to the heart muscle are the contributing factors for change in the Electrocardiographic rhythm.

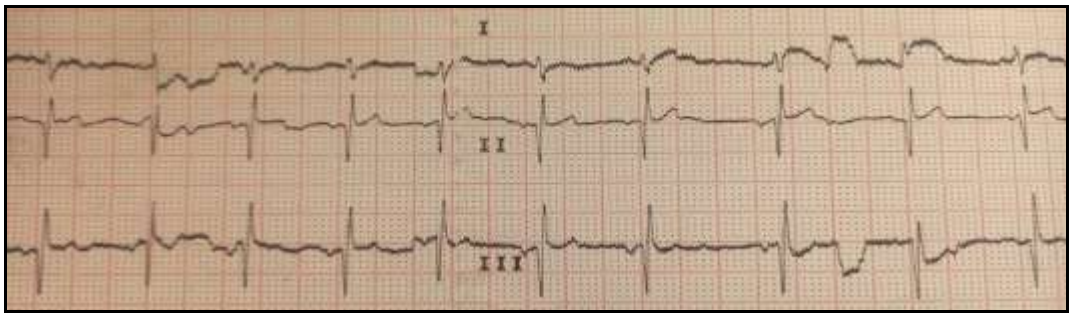

Fig 1: ECG image showing Negative deflection of P wave, Q dip and increase in the amplitude of T wave

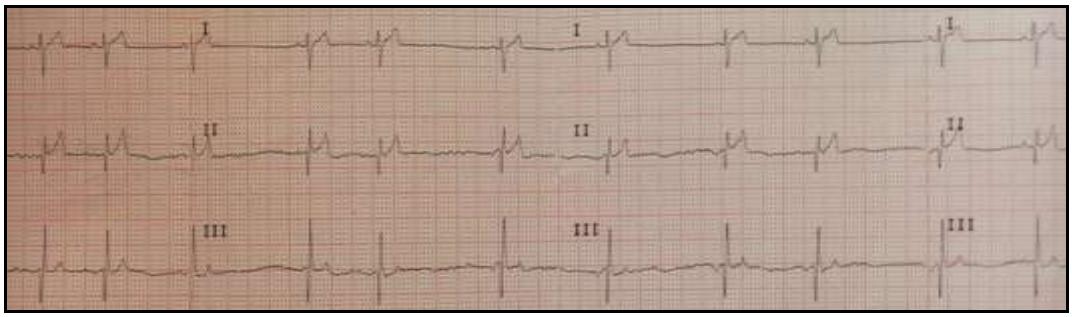

Fig 2: ECG image showing Tachycardia and Absent P wave

Fig 3: ECG image showing Tall QRS complex and ST segment coving

Conclusion

In conclusion, the electrocardiographic abnormalities observed in dogs infected with Babesia or Ehrlichia, or mixed infections, underscore the potential cardiac impact of these diseases. Our findings align with previous studies, noting commonalities such as low QRS complex, tall T wave, and ST segment deviations. However, discrepancies exist, reflecting the complexity of canine babesiosis and ehrlichiosis. Notably, the inflammatory response and myocardial pathology, particularly in the left ventricle,

suggest a multifaceted mechanism for cardiopathy. While electrocardiography serves as a valuable diagnostic tool, it should be interpreted cautiously, considering concurrent factors like anaemia, hypoxia, and electrolyte imbalances. Ultimately, a comprehensive understanding of these diseases requires integration of clinical, pathological, and electrocardiographic data, illuminating the intricate interplay between infection, inflammation, and cardiac dysfunction in affected dogs.

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