Himachal Journal of Agricultural Research 49(2): 238-243 (2023)

Electrocardiographic evaluation of Canine Parvovirus infection

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Manuscript Received: 11.07.2023; Accepted: 01.08.2023

Abstract

The study was conducted in the Department of Veterinary Medicine, DGCN, COVAS, CSKHPKV, Palampur to find out electrocardiographic changes in canine parvovirus infected dogs. Snap antigen specific parvovirus kits were used for the diagnosis of canine parvovirus. Electrocardiography was used to find different ECG changes in affected dogs. A total of twenty-one dogs (n = 15: canine parvovirus positive and n = 6: healthy) were selected for the present study. The significant ECG changes observed in affected dogs included - increased Q amplitude (0.56 ± 0.05mV), tachycardia (167.38±10.04 bpm), decreased R amplitude (0.56 ± 0.07mV), increased prevalence of notched QRS complex (40%) and sinus arrhythmia (53.33%). The clinical findings indicated a high prevalence of cardiac issues in young puppies (<8 weeks) affected by canine parvovirus infection. Further studies incorporating ECG along with detailed cardiac examination should be done on more canine parvovirus cases to support these findings.

Key words: Cardiac arrythmias, Myocarditis, Notched QRS, Sinus arrhythmia

Canine parvovirus (CPV) infection poses a significant threat to the health and well-being of dogs worldwide. While the gastrointestinal manifestations of CPV are well-documented, its impact on the canine cardiac system is often overlooked. Additionally, the viremia exhibits two distinctive clinical forms: (i) Entero-gastritis (hemorrhagic) in all age dogs (ii) myocarditis, cardiac arrhythmias and subsequent heart failure usually in pups less than 3 months of age.

Electrocardiography (ECG) serves as a valuable diagnostic tool for detecting and monitoring cardiac changes in various diseases, including viral infections. Electrocardiography, a non-invasive and cost-effective method, is currently considered as a crucial diagnostic tool for detecting cardiac issues in dogs (Tilley *et al*. 2008). Using the waves, complexes, and segments of an ECG, any case of myocardial abnormalities, cardiac enlargement, pericardial diseases, or even electrolyte imbalances might be suspected. Study conducted by Sravanthi *et al*. (2019) observed lower QRS complex amplitudes in CPV affected dogs compared to healthy dogs.

By exploring the ECG alterations associated with CPV infection, this article highlights the importance of ECG monitoring in managing canine parvovirus associated cardiac complications and making informed treatment decisions. To the best of authors knowledge limited studies have been done on electrocardiographic alterations and their detection in CPV infected dogs of Himachal Pradesh. However, CPV virus has been shown to have adverse impacts on the myocardial integrity in affected dogs and their timely diagnosis is crucial. Keeping in view these facts, the present study was conducted for evaluation of the electrocardiographic findings in CPV affected dogs presented at Department of Veterinary Medicine, Dr. G.C. Negi College of Veterinary and Animal Sciences of CSKHPKV Palampur.

Materials and Methods

The study was conducted at the Department of Veterinary Medicine, DGCN COVAS, CSKHPKV,

Palampur (H.P.). Six apparently healthy dogs with normal vital signs were selected as the control group. Fifteen dogs showing clinical signs and symptoms of parvoviral enteritis (CPV) which were presented for treatment in the department were chosen and diagnosed by using following tools and methods:

Snap Antigen Specific Parvo Kit: The Snap Antigen Specific Parvovirus Kit is a diagnostic tool used for the detection of parvovirus antigens in dogs. "UbioQuickVET® Canine Parvovirus Antigen Rapid Test Kit" was used to perform the rapid test for the confirmation of CPV infection in dogs using their rectal swab sample.

Electrocardiography: ECG recordings were made using the RMS Vesta 301i® ECG machine and a standard electrocardiographic lead system, following the guidelines of Tilley (1992). ECG were recorded at speeds of 50mm/s and 25mm/s in all six leads, with measurements taken using lead II. The waveforms, complexes, and intervals were recorded and compared with the standard measurements obtained from the healthy control group dogs.

Fifteen dogs presented with clinical signs and symptoms of parvoviral enteritis were evaluated and diagnosed positive with Snap Ag specific Ubio Quick-VET CPV Kit®. The dogs under control group were all male with an average age between 3 months to 1 year. There were not any apparent clinical signs and symptoms in the healthy dogs. Rectal swabs were taken from the affected dogs and were run on the test kits, which showed positive test line appearance in no time (Fig. 1). All the fifteen dogs under study were male, with age between 40 days to five months. ECGs were taken in all the fifteen cases irrespective of their age.

Results and Discussion

Clinical Signs and Symptoms:

In puppies, the onset of parvoviral infection was characterized by several cardinal signs, including anorexia (loss of appetite), lethargy (lack of energy), bloody watery diarrhea, vomiting, and dehydration, with a dehydration rate typically ranging from 6% to 8%. Initial clinical symptoms include anorexia, dullness, fever and weakness and are non-specific in order (Gerlach *et al*. 2020). Later, common symptoms including vomiting and watery bloody diarrhoea were also reported.

Electrocardiographic Findings:

The dogs that were younger than three months showed significant arrhythmias on ECG as well as on auscultation. The electrocardiographic (ECG) alterations observed in the subjects of this investigation revealed noteworthy findings (Table 1). The ECG changes recorded in the study population encompassed the following:

♦ An increased Q amplitude (>0.4mV) was observed in eleven cases (Fig. 5), indicating increased electrical activity during ventricular depolarization. The prevalence rate for this abnormality was 73.33%. A deepening of the Q wave in dogs infected with canine parvovirus may be an indication of right ventricular hypertrophy. Areshkumar *et al*. (2018) reported similar findings in his studies on electrical conductivity of the heart in CPV. This finding also

Table 1. Prevalence of various electrocardiographic abnormalities in canine parvovirus affected dogs

ECG abnormalities	No. of Dogs affected	Prevalence Rate (%)
Sinus Arrhythmia	8	53.33
Wandering Pacemaker	3	20.00
QRS notching	6	40.00
Increased Q - amplitude (>0.4mV)	11	73.33
Decreased R- amplitude (<0.5mV)	8	53.33
Reduced QT duration (<0.16s)	3	20.00
Presence of U wave	1	06.66
ST elevation (>0.2mV)	2	13.33

aligns with Bolton (1975) report stating that a Q wave deeper than 0.5mV (5 boxes) in lead II suggests the presence of right ventricular hypertrophy.

- QRS wave notching in multiple leads was observed in six cases (Fig. 2), representing a prevalence of 40.00% (Table 1). This finding suggests abnormalities in ventricular depolarization. According to Winter and Bates (2018) myocardial fibrosis in dogs has been linked to notched QRS complexes. According to Ford *et al*. (2017) myocarditis and myocardial fibrosis were an associated feature in the pups suffering from myocardial form of parvoviral enteritis.
- Decreased R amplitude (<0.5mV) as observed in eight cases (Fig. 3) with prevalence rate of 53.33%. According to Sravanthi *et al*. (2019), although the infected group's QRS complexes had normal width, they had low R wave amplitudes (0.5mv), which means that they had low voltage, which is a sign of pericardial effusion brought on by sepsis. According to reports, parvovirus infections resulted in modifications to R waves, an elevation of the S-T segment, a notch in the QRS, and a bad prognosis for small R waves (Wood 1983).
- Irregular sinus arrhythmia was detected in eight cases (Fig. 4), corresponding to a prevalence rate of 53.33%. This abnormality denotes an irregular rhythm originating from the sinus node. Sinus arrhythmias exists in almost all dogs whether healthy, quiet, or sleeping and is associated with respiration and thus is a physiological arrhythmia (Hamlin *et al*. 1966).
- Wandering pacemaker, characterized by a shifting pacemaker site, was identified in three cases, accounting for an occurrence rate of 20.00%. P wave fluctuation was interpreted as abnormal P wave configuration. This can be the result of the pacemaker in the SA node. A common feature of canine ECGs known as wandering pacemaker is high vagal tone, which enables the precise location of the pace making site inside the SA node (Sahoo *et al*. 2022).
- Additionally, a U wave appearance (Fig. 9), indicative of hypokalemia, was noted in one case, corresponding to a prevalence of 6.66%. Suggestive reason for the appearance of U wave is the loss of potassium ions due to vomiting and diarrhea which is very common in CPV-2 affected dogs. This can be correlated to reduced QT duration which too indicates hypokalemia. Common ECG changes in hypokalemic patients include the development of U-waves (El-Said *et al*. 2021).
- Reduced QT segment duration (<0.16s) was observed in three cases (Fig. 10) with a prevalence rate of 20% and ST segment elevation (>0.2mV) was observed in two cases (Fig. 6) with a prevalence rate 13.33%. There was a decrease in the QT interval (0.16 sec), which implies a loss of chloride and potassium ions because of continuous vomiting and diarrhoea. The presence of an increased S-T segment indicates myocardial hypoxia and pericarditis, according to Sravanthi *et al*. (2019). According to Robinson *et al*. (1979), puppies suspected with viral myocarditis exhibited paroxysmal ventricular tachycardia, short R waves, S-T segment elevation, and notched QRS waves. The only cardiac muscle fiber that was discovered to be fatally vulnerable was very young (in puppies under 8 weeks old) dogs. Canines with parvoviral infection had lower R wave, ST segment elevation, and QRS notching (Carpenter *et al*. 1980). Moreover, alterations in the QRS complexes of the infected animals implied heterogenous depolarization of the ventricles. Notably, the presence of R wave notching in multiple leads underscored the necessity for a comprehensive diagnostic examination to accurately evaluate the extent of cardiac involvement. The likelihood of a dog having cardiac disease that has QRS notching in multiple ECG leads, is significant, and this should warrant diagnostic evaluation as stated by Winter and Bates (2018). It is important to note that myocardial dysfunction represents a frequent consequence of sepsis in dogs, as evidenced by previous research conducted by Otto *et al*. (2000).

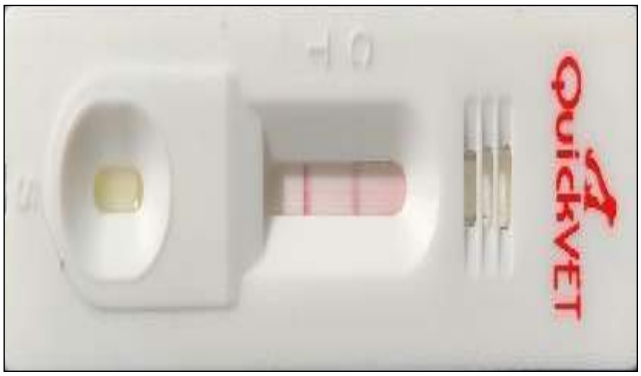

Fig. 1. Canine Parvo Virus-2 infection diagnostic kit

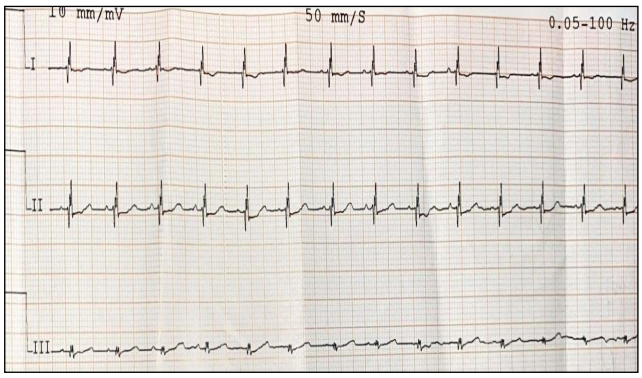

Fig. 2. ECG showing QRS complex notching in multiple leads (Speed: 50mm/sec)

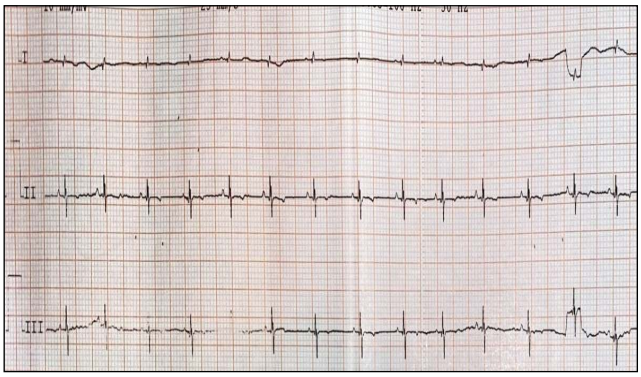

Fig. 3. ECG showing low voltage QRS complexes (Speed: 25mm/sec)

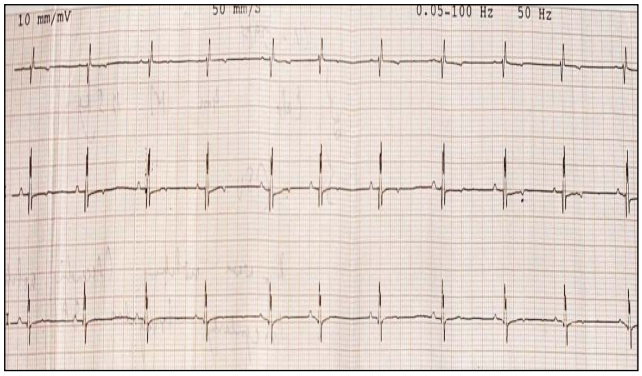

Fig. 4. ECG showing irregular Sinus arrhythmia (Speed: 50mm/sec)

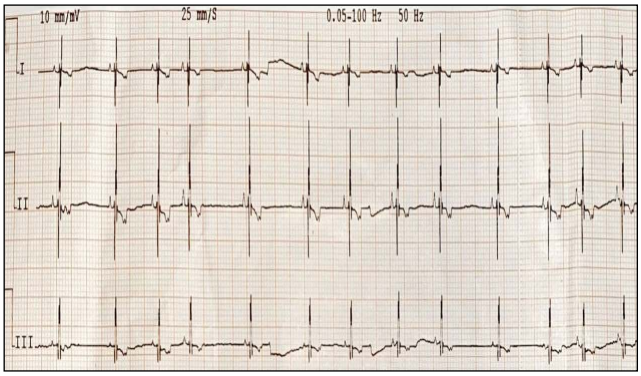

Fig. 5. ECG showing elevated Q amplitude along with sinus arrhythmia and notched QRS complex (Speed: 25mm/sec)

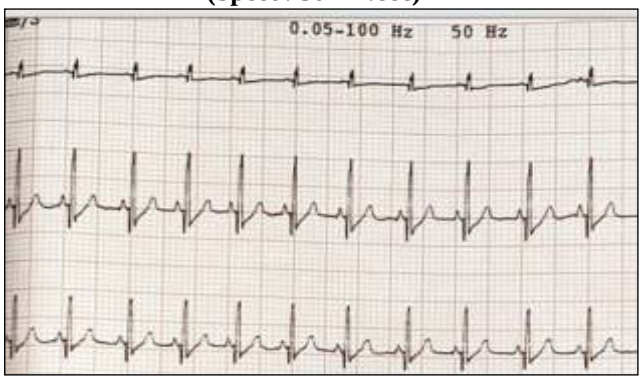

Fig. 6. ECG showing ST segment elevation visible in multiple complexes (Speed: 25mm/sec)

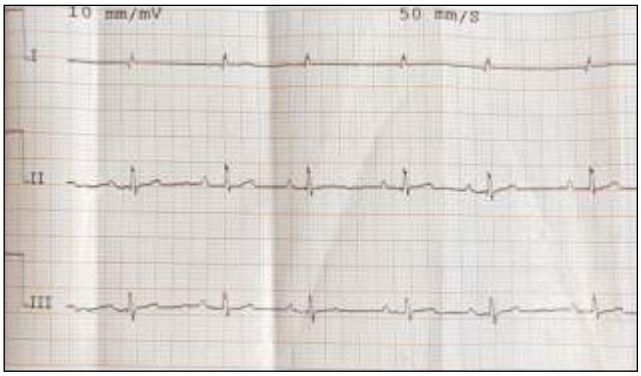

Fig. 7. ECG showing low amplitude QRS complexes with notching (Speed: 50mm/sec)

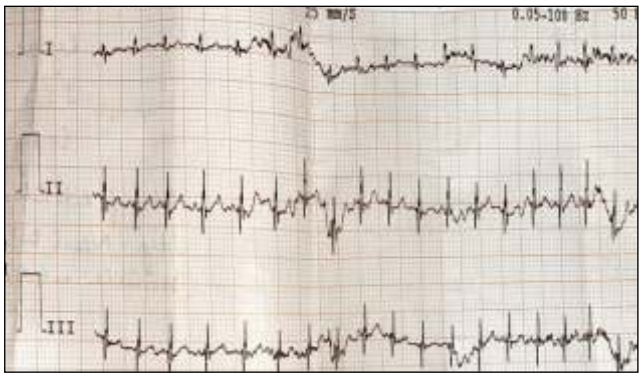

Fig. 8. ECG showing tachyarrhythmia with deep Q wave and QRS notching (Speed: 25mm/sec)

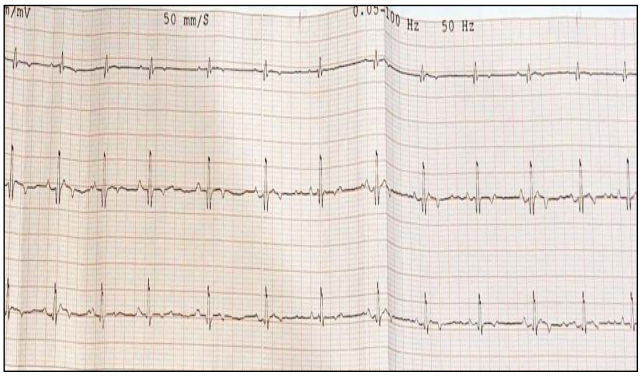

Fig. 9. ECG showing U-wave after T wave in multiple complexes (Speed: 50mm/sec)

Fig. 10. ECG showing short QT interval (Speed: 25mm/sec)

A highly significant (P<0.0001) increase in the Q-wave amplitude was observed in the CPV infected group than those in the control group dogs (Table 2). According to Atwell and Kelly (1980) a similar finding was observed with deep Q waves and the suggestive reason was myocardial fibrosis caused by canine parvovirus in younger dogs. Also, there was a significant difference in the values of R amplitude and QRS duration between the control and affected groups (P<0.05). According to Robinson *et al*. (1979) and Carpenter *et al*. (1980) short voltage R waves were found in dogs of younger age affected with CPV-2. Decreased R amplitudes (<0.5mV) were observed in 8 out of 15 cases with prevalence rate of 53.33%. No significant change in P wave amplitude and P wave duration was observed in the control group dogs and the CPV infected group dogs. No significant difference was observed in the PR interval between the control and affected dogs. There was a nonsignificant reduction in the duration of the QT segment. The QT segment duration (<0.16s) were observed in 3 out of 15 cases. Similar findings were reported by Sravanthi *et al*. (2019) in which they suggested to be due to electrolytic imbalance and reduced potassium because of severe gastroenteritis in CPV.

Significant increase in the heart rate among the dogs of the affected group in comparison to the control group was observed (Table 2). Tachyarrhythmias (abnormal rapid heart rhythms) were also be observed and was similar to the findings of Yilmaz and Senturk (2007) study in CPV-2 affected dogs, where they suggested tachycardia and tachypnoea are one of the most observed clinical findings in dogs suffering from parvoviral enteritis. However, in young puppies, the myocardial form can lead to sudden and severe cardiac failure, resulting in per-acute to acute death. The

Table 2. Parameters showing control and CPV affected dogs

Variables	Control (n=6)	CPV (n=15)	P-value
P amp (mV)	0.11± 0.03	0.14 ± 0.02	0.39
P duration (sec)	0.03 ± 0.01	0.03 ± 0.002	0.60
R amp (mV)	1.19± 0.35	0.56± 0.07*	0.03
QRS duration (sec)	0.05± 0.01	0.042± 0.004	0.78
PR interval (sec)	0.09 ± 0.03	0.08 ± 0.003	0.73
QT interval	0.16 ± 0.05	0.18 ± 0.01	0.61
Q amp (mV)	0.18 ± 0.005	0.56 ± 0.05**	<0.0001
T amp (mV)	0.14± 0.05	0.15± 0.02	0.83
Heart Rate (bpm)	132± 10.68	167.38±10.04*	0.03

* Significant at 5% (P< 0.05); ** Significant at 1% (P< 0.01)

myocardial form of parvoviral infection in puppies is particularly devastating, as it directly affects the heart muscle. This can lead to a rapid deterioration of cardiac function, ultimately resulting in fatal outcomes. The combination of myocardial involvement and the vulnerability of young puppies makes the myocardial form of the disease highly lethal (Hoskins 1997). Understanding different clinical presentations and outcomes of parvoviral infection in different age groups is essential for early detection, appropriate management, and prevention of fatalities associated with this severe viral infection in dogs.

Conclusion

Electrocardiographic parameters in canine parvo virus infected young dogs showed increased Q wave amplitude, decreased R wave amplitude and tachycardia, increased prevalence of notched QRS complexes and irregular sinus arrhythmias were also seen on comparison to healthy control. Further studies incorporating ECG along with detailed cardiac examination should be done on a greater number of canine parvovirus cases to support these findings.

Conflict of interest: The authors have no conflict of interest in this research paper.

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