

Original Research Article

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Electrocardiographic Studies on Extra-Cardiac Affections in Dogs

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ABSTRACT

Keywords

ECG, Extra-Cardiac Diseases, Gastroenteritis, Urinary Tract Diseases, Dog.

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The present study was conducted to investigate characteristics of electrocardiography in gastroenteritis (GE) and urinary tract diseases (UTD) in dogs. The positive cases of GE (Group B) and UTD (Group C) affected dogs were screened for ECG and haemato-biochemical parameters as per the standard procedure and the outcome was compared and correlated statistically with healthy dogs (Group A). A decreased in amplitude of P wave, T wave and QRS complex were observed in both the affected groups (Gr. B & C) as compared to Group A. Additionally, a significant ($P < 0.05$) decreased in Hb, PCV, TEC, MCHC and TP and increased in AST and ALT were also noted in Group B whereas decreased Hb and TEC and increased in BUN, Creatinine and ALP were observed in Group C. There was significant ($P < 0.05$) positive and negative correlations between Electrocardiogram and haemato-biochemical parameters were observed in both the affected groups. The study revealed that ECG and haemato-biochemical parameters had a significant role in extra-cardiac diseases i.e. gastroenteritis as well as urinary tract diseases in dogs.

Introduction

Electrocardiography, a non-invasive and relatively inexpensive technique has now generally been accepted as an important diagnostic tool in detecting cardiac abnormalities in dogs (Tilley, 1985). It detects not only the disturbances of cardiac rate and rhythm but also cardiac enlargement, myocardial disease, ischemia, pericardial diseases, certain electrolyte imbalances and some drug toxicities. The electrocardiogram is

a basic and valuable diagnostic test in veterinary medicine and is relatively easy to acquire. The electrocardiogram is the initial test of choice in the diagnosis of cardiac arrhythmias and may also yield information regarding chamber dilation and hypertrophy. Electrocardiography (ECG) is an important diagnostic tool in the practice of veterinary medicine. It is not only evaluates the electrical function of the heart, but ECG is also able to give information regarding non-cardiac illness. When performing ECGs, it is

important to recognize the limitations as well as the benefits of their uses in clinical practice. Dehydration is seen in clinical condition like gastroenteritis, diarrhea, vomiting etc. (Chakrabarti, 1994). Severity of dehydration can be conveniently diagnosed by haemato-biochemical analysis but these are time consuming. Electrocardiography may be taken as a tool for the easy and quick diagnosis of the case of dehydration and electrolyte imbalance for their early treatment without losing valuable time to save the life of ailing animals (Hammer, 1978 and Dhanapalan *et al.*, 1993). An ECG should be evaluated to diagnose dysrhythmias associated with hyperkalemia requiring immediate treatment. There is no set potassium level that predicts a dysrhythmia. ECG changes associated with hyperkalemia include tall T-waves, prolonged P-R interval, bradycardia, sino-ventricular rhythm, sine wave and asystole (Ettinger *et al.*, 1974). In experimental settings, hyperkalemia has been associated with a defined series of ECG abnormalities, including shortening of QT interval, peaking of T waves, QRS prolongation, shortening of PR interval, reduction in amplitude of the P wave, loss of sinoatrial conduction with onset of a wide-complex 'sine-wave' ventricular rhythm, and ultimately asystole (Ettinger *et al.*, 1974). Although no uniform threshold has been documented in animal models, the most severe cardiac manifestations have been shown to occur with serum potassium concentrations >9 mEq/L. Hence the study was conducted to know the ECG pattern in extra-cardiac diseases and its correlation with haemato-biochemical alterations.

Materials and Methods

The present study was carried out at Teaching Veterinary Clinical Complex (TVCC) and Division of Veterinary Medicine, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology, R.S.Pura, Jammu

Selection of animals

The dogs were selected on the basis of having principal complain of diarrhea and vomiting for GE patients and having complained of polyuria, anuria, dysuria, anemia, halitosis and increase BUN and Creatinine level above 25mg/dl and 1.5 mg/dl, respectively were taken as UTD patients. The dogs brought to TVCC for routine checkup and having up to date vaccination and deworming status and normal clinico-physiological parameters were taken as healthy control. The animals were divided into three groups' viz. Gr.A(healthy dogs), Gr.B (GE affected dogs) and Gr.C (UTD affected dogs) comprising six dogs in each group.

Clinical Examination

Under clinical examination, the conjunctiva, oral mucosa, heart rate, pulse, respiration and temperature were recorded. A detailed auscultation of all the four quarters was done. The size and shape of chest and abdominal cavity were also determined.

Application of ECG

A 12 lead standard ECG recorder, BPL CARDIART-6208 machine under all standard prescribed conditions was used in present study. The electrocardiograph has been standardized 1cm = 1 mV so that each small box on the vertical axis equals 0.1 mV. The tracings were recorded at a paper speed of 50mm per second so each small box on horizontal axis equals 0.02 seconds. The details of lead- II were included in this study. Electrocardiogram was then analyzed for the presence of ECG abnormality, if any.

The ECG was recorded with dog in standard body position (Tilley, 1992) i.e. restrained in right lateral recumbency on a wooden table with legs positioned parallel to each other and

perpendicular to the long axis of body, and keeping the head and neck flat. The skin and electrodes were moistened with gel. The owner's presence at the end of the table was ensured in all cases to keep the dog calm and comfortable. No pharmacological preparation was used for restrain prior to ECG examination.

The front leg leads or electrodes (RA and LA) were attached to the appropriate forelegs just above the elbow. The rear leg leads (RL and LL) are likewise attached to the appropriate rear leg immediately proximal (above) to stifle (knee).

Analysis of ECG Parameters

The ECG parameters viz. P wave, QRS complex, T wave amplitude and duration, PR interval, QT interval and ST segment were recorded in each case.

Collection of blood samples

Eight ml of blood samples from each dog were collected from cephalic vein/saphenous vein. Two ml of blood was transferred to a EDTA vial for haematology estimation and 6ml blood was transferred to clot activator vial and serum was separated and kept in -20 c for future study.

Haematological parameters

Haematological parameters viz. Hb, PCV, TEC, MCV, MCH, MCHC, RDW, TLC and DLC (Neutrophil and lymphocyte) were determined as per the standard procedure (Jain *et al.*, (1986).

Biochemical parameters

The serum biochemical parameters viz. Total Protein, Albumin, Globulin, Albumin:Globulin (A:G ratio), Creatinine, Blood Urea Nitrogen (BUN), Aspartate

transaminase (AST), Alanine transaminase (ALT), Alkaline phosphatase (ALP), Total bilirubin, Indirect bilirubin, Calcium, Phosphorus, Sodium, Potassium and Chloride were analysed by automated biochemical analyzer (Chem-7, ERBA Company Ltd.) with the help of commercial kits (ERBA company Ltd).

Statistical Analysis

Data generated in the study was analyzed by IBM-SPSS 20 software. For comparison of different haemato-biochemical & ECG parameters of healthy, GE and UTD were analysed by Independent T-test. The ECG changes were correlated with haemato-biochemical alterations in the same dog using Pearson's correlation test.

Results and Discussion

Electrocardiography studies

The results of ECG of Gr.B and Gr.C affected dogs are shown in Table 1 and Figure 1, 2, 3, 4, 5 & 6. Present study revealed that Pa (0.15 ± 0.12 mv and 0.13 ± 0.10 mv), QRSa (1.68 ± 0.24 mv and 0.78 ± 0.11 mv) and Td (0.04 ± 0.02 sec and 0.04 ± 0.01 sec) in Gr.B and Gr.C respectively were significantly ($P < 0.05$) decreased as compared to Gr.A dogs (Table 1). The Ta value (0.18 ± 0.04 mv) of Gr. C was also significantly decreased as compared to Gr.A. The rest ECG parameters did not show any significant alteration in both the groups as compared to health dogs. These findings particularly are in agreement with previous workers (Della *et al.*, 1999; Mohan *et al.*, 1994; Dhanapalan *et al.*, 1993; Kline *et al.*, 1992) who studied the effect of acute haemorrhage and urinary tract diseases on QRS amplitude in the lead II canine electrocardiogram. The decreased level of ECG parameters in Gr. B might be due to dehydration haemodilution and anaemia which caused decreased myocardial oxygenation, as

a result myocardial hypoxia developed. In case of Gr. C, decreased in Pa, Ta and Td might be due to increase serum potassium causes reduction in resting membrane potential and quicken depolarization reported by Dhanapalan *et al.*, (1993), Kline *et al.*, (1992) and Bernard *et al.*, (1974).

Alteration of Haemogram

There was significant (P<0.05) decrease in Hb, PCV, TEC and MCHC in both Gr.B and Gr. C when compared to Gr. A (Table 2; Fig. 7 and 8). But there was significant (P<0.05) increase in MCV in both Gr.B and Gr.C dogs

as compared to healthy dogs in present study (Table 2). There was no significant difference of the other haematological parameters among the three groups (Table 2). Decreased levels of hemoglobin, total erythrocyte count and packed cell volume were also noticed by Dharmadheeran *et al.*, (2003), Biswas *et al.*, (2005), Lee *et al.*, (2012) and Ali *et al.*,(2014), Observed decrease HB, PCV, TEC and MCHC in Gr.B might be due to anaemia in haemorrhagic gastroenteritis (Mohan *et al.*, 1994), dehydration (Rai *et al.*, 1994) and mechanical obstruction and massive sloughing of intestinal epithelial cells (Mallela *et al.*, 2006).

Table.1 Electrocardiogram of Healthy, Gastroenteritis and Urinary Tract disease affected dogs
Mean± SE

ECG Parameters	Group		
	Gr. A (n=6)	Gr.B(n=6)	Gr. C(n=6)
Pa (mV)	0.31±0.09	0.15±0.12*	0.13±0.10*
Pd (sec.)	0.03 ± 0.13	0.03 ± 0.02	0.02 ± 0.01
QRSa (mV)	2.50 ± 0.21	1.68 ± 0.24*	0.78 ± 0.11*
QRSd (sec.)	0.05 ± 0.00	0.04 ± 0.02	0.05 ± 0.10
Ta (mV)	0.35 ± 0.15	0.24 ± 0.12	0.18 ± 0.04*
Td (sec.)	0.23 ± 0.81	0.04 ± 0.02*	0.04 ± 0.01*
STs (sec.)	0.15 ± 0.05	0.14 ± 0.02	0.13 ± 0.03
QTi (sec.)	0.17 ± 0.02	0.16 ± 0.02	0.17 ± 0.03
PRi (sec.)	0.07 ± 0.01	0.09 ± 0.05	0.07 ± 0.05

*P≤ 0.05 ,Gr.A=healthy, Gr.B=Gastroenteritis, Gr. C.=Urinary Tract Disease

Table.2 Haematological parameters of healthy, gastroenteritis disease and urinary tract diseases in dogs
Mean± SE

Parameters	Group		
	Gr.A (n=6)	Gr.B (n=6)	Gr.C (n=6)
Hb (g/dl)	15.28 ± 1.35	11.7 ± 1.71*	6.56 ± 1.24*
PCV (%)	44.53 ± 2.30	34.0 ± 6.94*	34.0 ± 2.44*
TEC (x106/µl)	6.96 ± 0.48	4.29 ± 0.34*	1.38 ± 0.80*
MCV (fL)	65.71 ± 6.83	78.71 ± 8.84*	93.86 ± 0.87*
MCH (pg)	22.07 ± 2.97	21.3 ± 1.99	25.44 ± 0.94
MCHC (g/dl)	33.58 ± 2.80	27.65 ± 2.20*	27.08 ± 0.34*
RDW (%)	12.69 ± 0.48	13.1 ± 1.47	12.69 ± 0.48
TLC (x103/µl)	11.88 ± 0.84	12.1 ± 1.55	10.51 ± 1.58
Neutrophils (%)	72.58 ± 2.73	74.27 ± 2.38	71.48 ± 2.30
Lymphocytes (%)	18.68 ± 3.33	18.68 ± 3.33	21.6 ± 1.00

*P≤ 0.05

Table.3 Serum biochemical profile of Healthy, gastroenteritis disease and urinary tract diseases affected dogs

Parameters	Mean± SE		
	Gr.A (n=6)	Gr.B (n=6)	Gr.C (n=6)
AST (IU/L)	58.28 ± 3.97	76.33 ± 5.46*	110.83± 4.91*
ALT (IU/L)	31.96 ± 6.07	23.22 ± 5.21	95.5 ± 3.87*
ALP (IU/L)	92.35 ± 6.85	114.44 ± 8.20*	133.83 ± 5.55*
TB (mg/dl)	0.30 ± 0.17	0.23 ± 0.13	1.52 ± 0.12
IB (mg/dl)	0.10 ± 0.08	0.18 ± 0.12	0.74 ± 0.50
TP (g/L)	6.73 ± 0.19	5.63 ± 0.70	6.34 ± 0.24
Albumin (g/L)	3.55 ± 0.40	2.18 ± 0.53*	4.89 ± 0.09
AG Ratio	1.13 ± 0.24	0.66 ± 0.22	0.29 ± 0.05
BUN (mg/dl)	14.26 ± 5.13	19.49 ± 5.02	188.5 ± 7.61*
Creatinine (mg/dl)	0.83 ± 0.36	1.06 ± 0.47	6.81 ± 1.92*
Ca (mg/dl)	8.76 ± 0.89	9.18 ± 1.31	9.34 ± 0.89
P (mg/dl)	4.38 ± 0.35	5.42 ± 2.38	8.62 ± 2.56*
Na (mEq/L)	143.66 ± 9.13	141.68 ± 8.60	127.16 ± 9.27
K (mEq/L)	4.53 ± 0.53	3.37 ± 1.20	6.08 ± 0.58
Cl (mEq/L)	117.5 ± 5.52	102.11 ± 6.35	109.66 ± 5.08

*P≤ 0.05

Table.4 Correlation between ECG and haemogram of gastroenteritis disease affected dogs

Parameters	Pa	Pd	QRSa	QRSd	Ta	Td	STs	QTi	PRi
Hb	-0.11	-0.06	0.34	0.12	0.52	0.10	0.50	0.14	0.34
PCV	0.15	0.46	0.75*	-0.11	0.39	0.05	0.22	0.48	0.44
TEC	0.30	0.22	0.41	0.03	0.21	-0.10	0.09	0.17	0.31
MCV	0.20	0.40	0.42	0.22	0.13	-0.16	0.39	0.16	0.16
MCH	0.57	0.70*	0.46	-0.11	-0.34	-0.55	0.07	0.09	0.45
MCHC	-0.00	-0.16	-0.18	-0.30	-0.20	-0.12	-0.52	0.04	-0.02
RDW	-0.00	-0.11	-0.28	-0.03	-0.11	-0.03	-0.13	0.23	-0.09
TLC	0.08	0.33	0.51	0.11	0.38	-0.04	0.53	0.25	0.25
Neutrophil	0.17	0.02	0.46	-0.03	-0.47	-0.33	-0.21	-0.46	-0.33
Lymphocyte	0.12	0.23	0.35	0.12	0.27	0.08	0.11	-0.67	0.49

*P≤ 0.05

Table.5 Correlation between ECG and biochemical of gastroenteritis disease affected dogs

Parameters	Pa	Pd	QRSa	QRSd	Ta	Td	STs	QTi	PRi
AST	0.38	0.63	0.68*	0.06	0.13	-0.20	0.31	0.56	0.57
ALT	0.30	0.57	0.63	0.07	0.20	-0.11	0.36	0.62	0.48
ALP	-0.22	-0.34	-0.56	0.04	-0.30	0.06	-0.21	-0.67*	-0.80**
TB	0.21	0.43	0.67	-0.08	0.42	-0.00	0.35	0.78	0.79
IB	0.33	0.60	0.67	-0.11	0.30	-0.10	0.41	0.82	0.79
Albumin	0.17	0.31	0.08	0.03	-0.25	-0.12	0.01	-0.05	-0.24
Globulin	0.37	0.51	0.69	0.01	0.21	-0.18	0.18	0.69*	0.82**
AG ratio	-0.10	-0.11	-0.37	0.02	-0.32	-0.10	-0.44	-0.67	-0.22
BUN	0.48	0.38	-0.19	0.41	-0.07	-0.07	0.48	0.49	0.87**
Creatinine	0.14	0.23	0.35	0.12	0.27	0.08	0.11	-0.67	0.49
Ca	0.28	0.39	-0.19	0.35	-0.10	-0.10	0.22	-0.00	0.21
P	0.21	0.40	0.13	-0.08	-0.16	-0.22	0.06	-0.04	0.69
Na	-0.42	-0.06	0.39	0.08	0.08	-0.08	-0.55	-0.53	0.65
K	-0.01	0.03	-0.41	-0.15	0.14	-0.14	0.07	-0.15	-0.41
Cl	-0.08	-0.43	0.08	-0.27	-0.02	-0.04	-0.26	-0.07	-0.70

*P≤ 0.05** P≤ 0.01

Table.6 Correlation between ECG and haemogram of urinary tract disease affected dogs

Parameters	Pa	Pd	QRSa	QRSd	Ta	Td	STs	QTi	PRi
Hb	0.01	0.45	-0.09	0.15	-0.32	-0.21	-0.44	-0.58	0.32
PCV	-0.31	0.40	-0.48	0.59	-0.31	-0.31	-0.32	-0.51	0.56
TEC	-0.08	0.45	-0.39	0.22	0.46	0.46	0.22	0.04	0.54
MCV	0.06	0.16	0.23	0.16	-0.31	-0.31	0.48	0.36	-0.29
MCH	-0.36	-0.25	0.49	0.34	-0.35	-0.35	0.86 *	0.77	-0.52
MCHC	-0.07	0.04	0.46	0.11	-0.49	-0.49	0.25	0.16	-0.33
RDW	0.27	0.13	0.21	-0.66	0.38	0.38	-0.69	-0.61	0.26
TLC	0.20	-0.47	0.53	-0.77	0.35	0.35	-0.25	-0.01	-0.32
Neutrophil	0.16	-0.10	0.41	-0.223	0.13	0.13	0.56	0.57	-0.422
Lymphocyte	-0.21	-0.73	0.86	-0.46	0.17	0.89	0.36	0.54	-0.60

*P≤ 0.05



Fig: 1. ECG of 3 year old, male GSD dogs suffering from GE. Decrease in Pa and QRSs clearly visible.

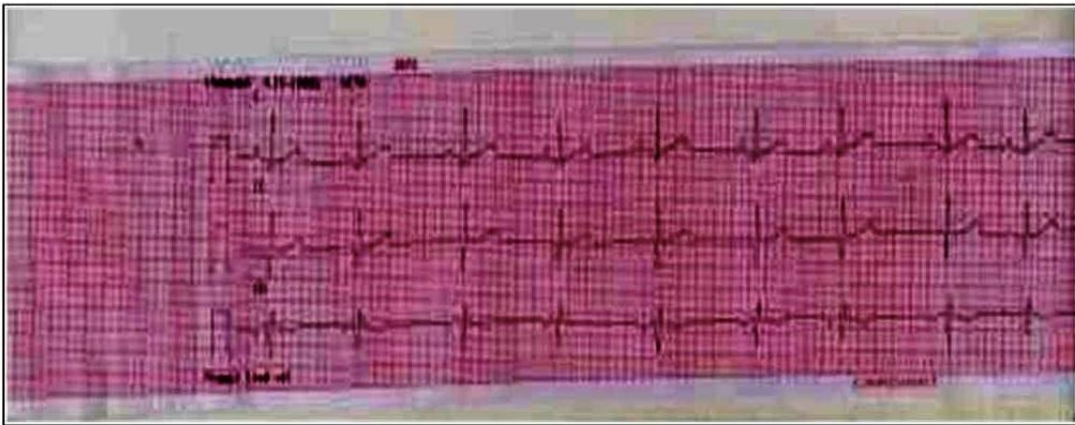


Fig. 2. ECG of 18 month old male Labrador dogs suffering from HGE, almost absence of P wave or significant decrease in Pa, QRSa and Ta is noticeable

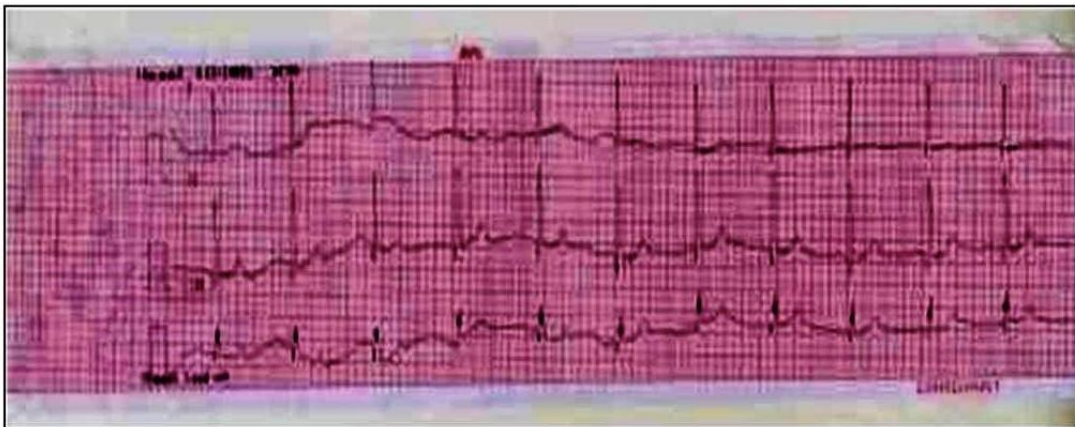


Fig.3.: ECG of 02 year old female GSD with CPV infection. Absences or decrease in Pa, R alternee and decrease in Ta is visible

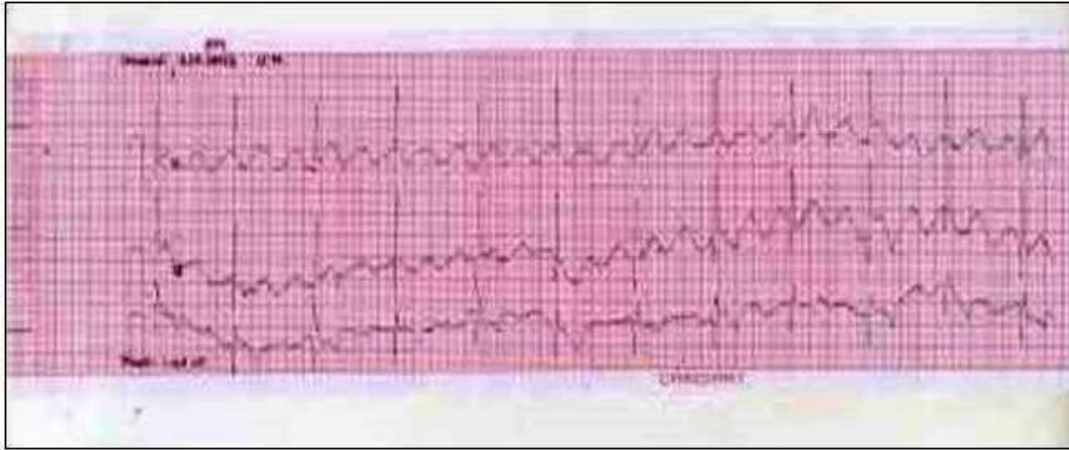


Fig.4. : ECG of 6 year old male GSD suffering from CKD. Decrease in Pa, QRSa and Ta along with increase in Td is noticeable

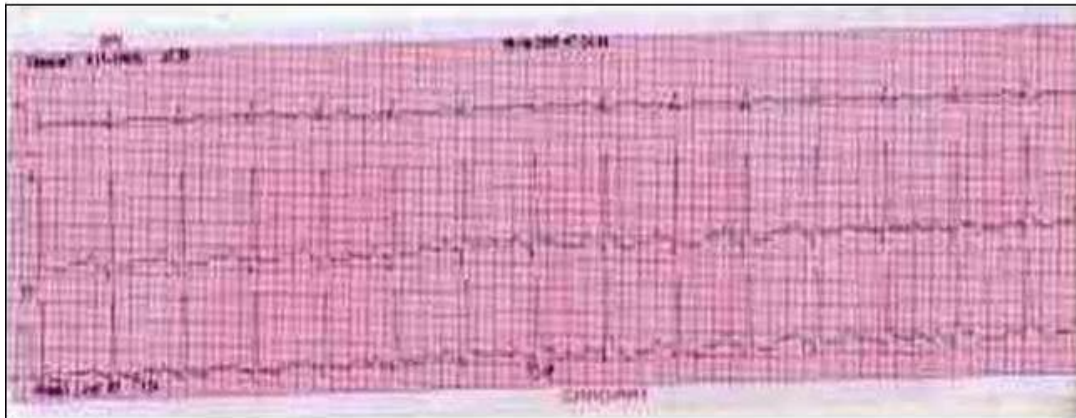


Fig.5. ECG of 4 year old male spitz suffering from ARI. Decrease in Pa, QRSa, Ta and Td is visible



Fig.6. : ECG of 6 year old female GSD suffering from CKD. Decrease in Pa, QRSa and Td along with increase in Ta is appreciable.

Fig.7 Haematological parameters of healthy, gastroenteritis disease and urinary tract diseases in dogs

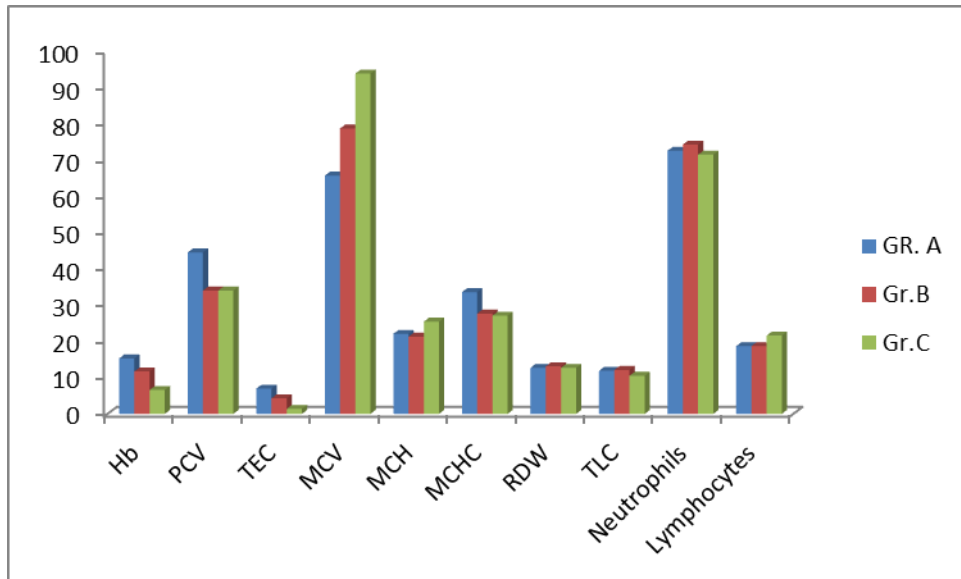


Fig.8 Serum biochemical profile of Healthy, gastroenteritis disease and urinary tract diseases affected dogs

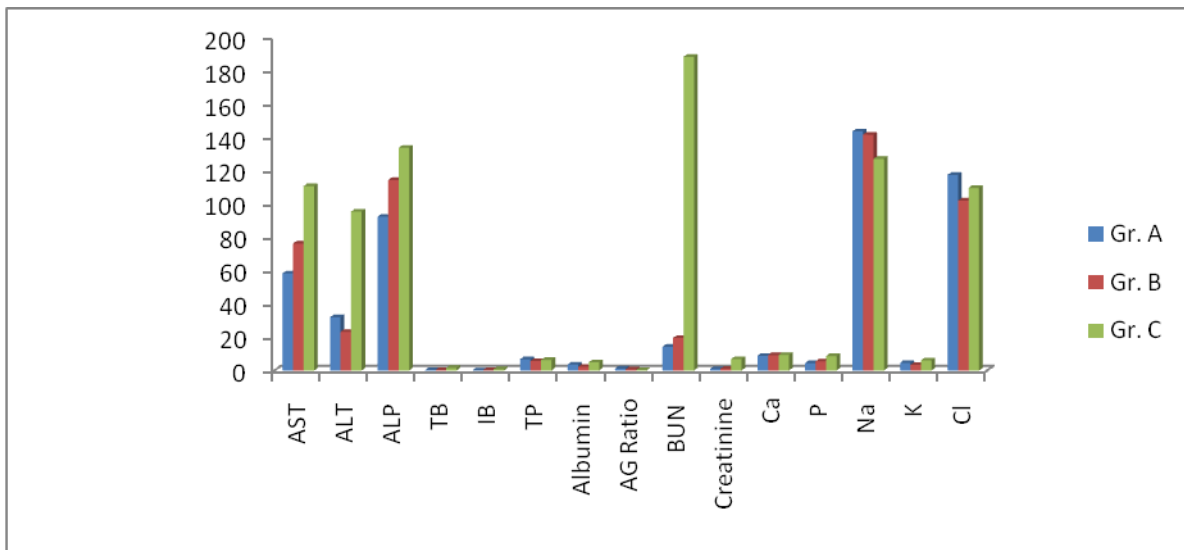


Fig.9 Correlation between ECG and haemogram of gastroenteritis disease affected dogs

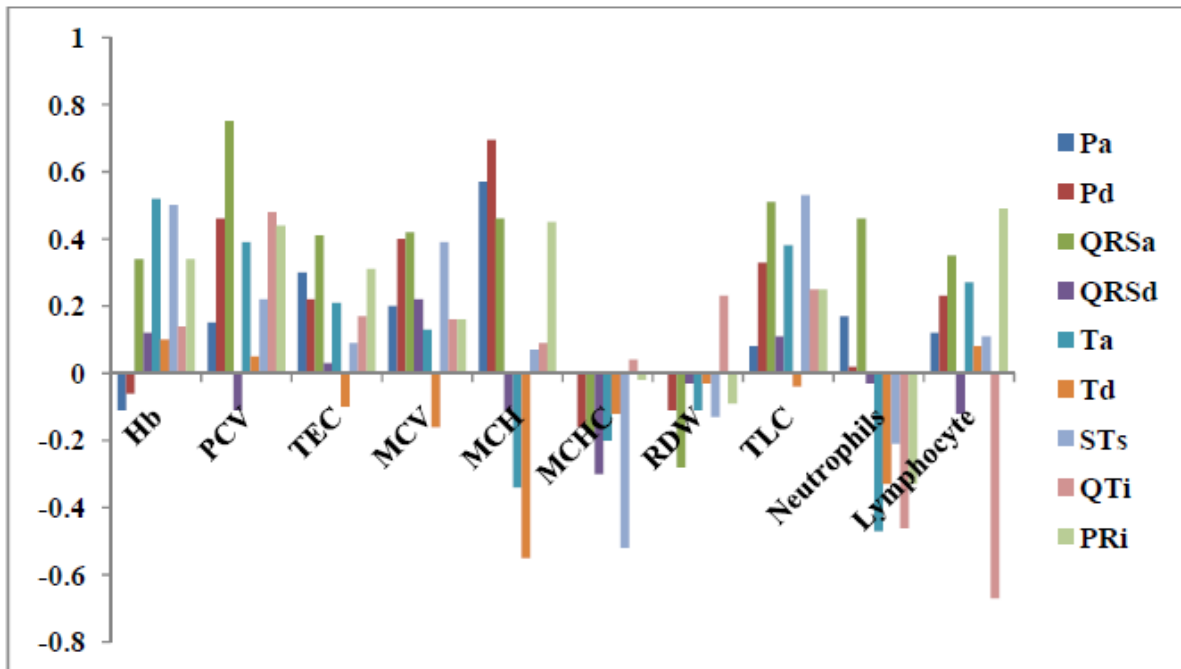


Fig.10 Correlation between ECG and biochemical of gastroenteritis disease affected dogs

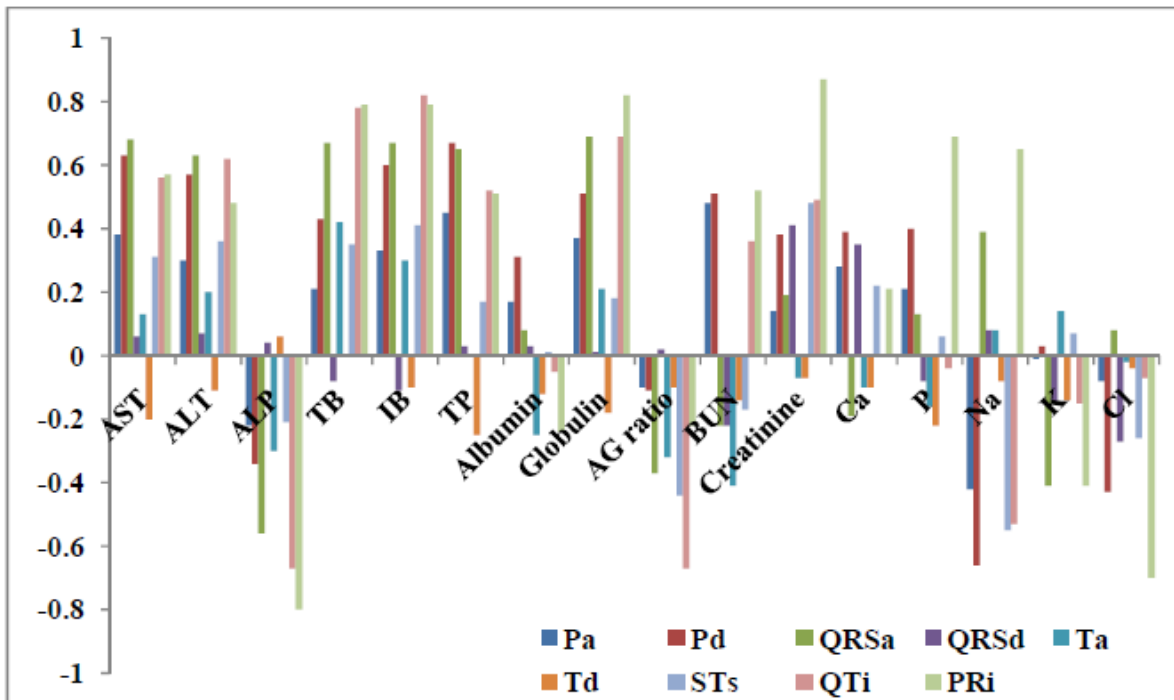


Fig.11 Correlation between ECG and haemogram of urinary tract disease affected dogs

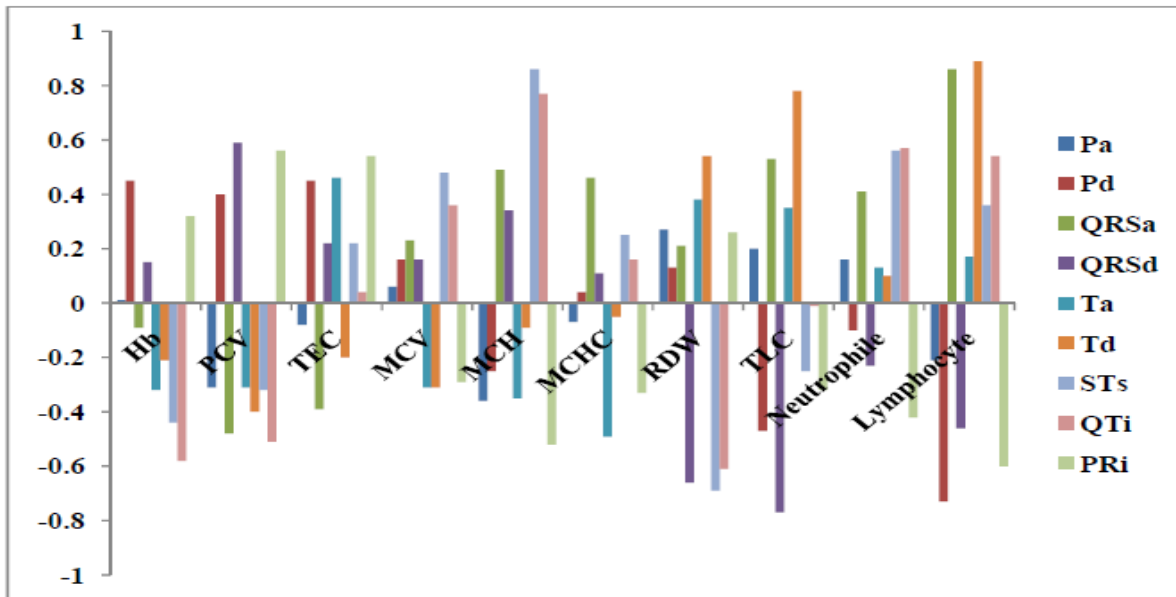
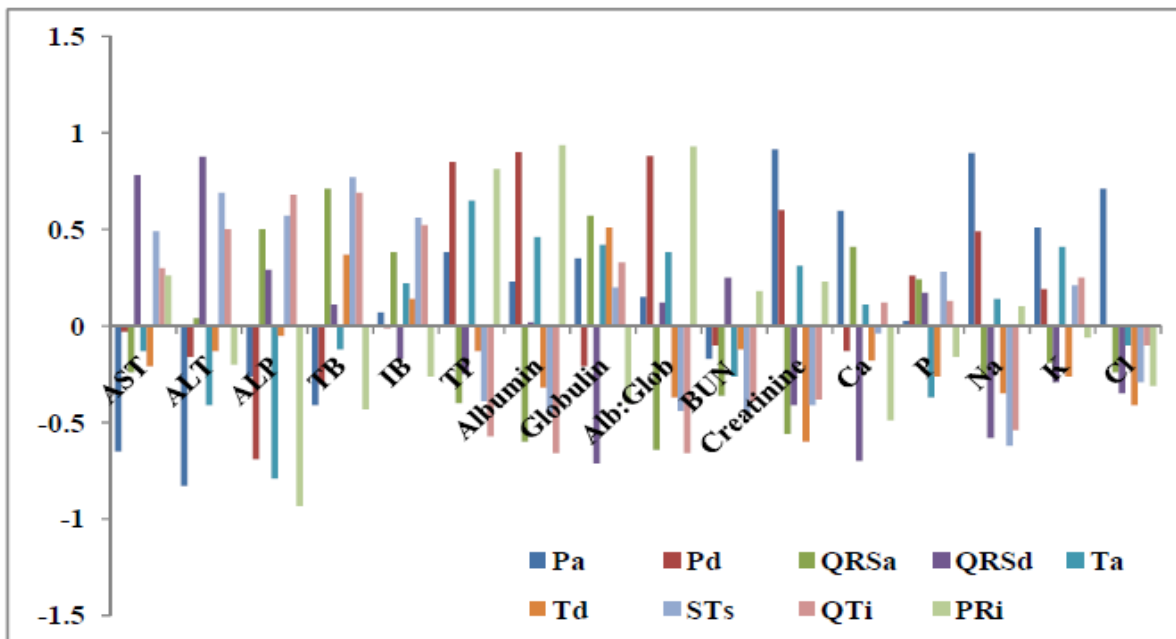


Fig.12 Correlation between ECG and biochemical of urinary tract diseases affected dogs



In case of Gr.C, decreased level of haematological parameters might be depressed renal erythropoietin factor production from impaired kidney. Blood loss in the form of hematemesis or malena and decreased RBCs survival due to impaired kidney function

(Dharmadheeranet *al.*, 2003, Biswas *et al.*, 2005, Baruah *et al.*, 2005). Increase in MCV might be due to macrocytic normochromic type of anemia found in chronic renal failure and sort of liver involvement (Mallela *et al.*, 2006).

Table.7 Correlation between ECG and biochemical of urinary tract diseases affected dogs

Parameters	Pa	Pd	QRSa	QRSd	Ta	Td	STs	QTi	PRi
AST	-0.65	-0.03	-0.24	0.78	-0.13	-0.21	0.49	0.30	0.26
ALT	-0.828	-0.16	0.04	0.878	-0.41	-0.13	0.69	0.50	-0.20
ALP	-0.26	-0.69	0.50	0.29	-0.79	-0.05	0.57	0.68	-0.931**
TB	-0.41	-0.30	0.71	0.11	-0.12	0.37	0.77	0.69	-0.43
IB	0.07	-0.01	0.38	-0.17	0.22	0.14	0.56	0.52	-0.26
TP	0.38	0.85*	-0.40	-0.25	0.65	-0.133	-0.39	-0.57	0.814
Albumin	0.23	0.90*	-0.60	0.02	0.46	-0.32	-0.45	-0.66	0.935**
Globulin	0.35	-0.21	0.57	-0.71	0.42	0.51	0.20	0.33	-0.40
AG ratio	0.15	0.88	-0.64	0.12	0.38	-0.37	-0.44	-0.66	0.93**
BUN	-0.17	-0.10	-0.36	0.25	-0.26	-0.12	-0.45	-0.39	0.18
Creatinine	0.915	0.60	-0.56	-0.41	0.31	-0.60	-0.41	-0.38	0.233
Ca	0.597	-0.13	0.41	-0.70	0.11	-0.18	-0.04	0.12	-0.49
P	0.025	0.26	0.24	0.17	-0.37	-0.26	0.28	0.13	-0.16
Na	0.0894	0.49	-0.26	-0.58	0.14	-0.35	-0.62	-0.54	0.10
K	0.51	0.19	-0.19	-0.29	0.41	-0.26	0.21	0.25	-0.06
Cl	0.71	0.00	-0.24	-0.35	-0.10	-0.41	-0.29	-0.10	-0.31

*P≤ 0.05** P≤ 0.01

Biochemical Analysis

Biochemical analysis in present study (Table 3 and Fig. 8 and 9) revealed that there was significant (P<0.05) decrease of AST (76.33 ± 5.46 IU/L and 110.83 ± 4.91 IU/L), ALP (114.44 ± 8.20IU/Land 133.83 ± 5.55IU/L) in Gr.B and Gr.C respectively as compared to Gr.A (AST-58.28 ± 3.97IU/L and ALP-92.35 ± 6.85IU/L). But ALT (95.5 ± 3.87IU/L), BUN (188.5 ± 7.61 mg/dl), creatinine (6.81 ± 1.92mg/dl) and P (8.62 ± 2.56mg/dl) in Gr. C were significantly (P<0.05) increase as compared to Gr. A and Gr. B (Table 3). The Albumin level in case of Gr.B (2.18 ± 0.53g/L) was significantly (P<0.05) decreased as compared to Gr. A and Gr.C (Table 3). The rest biochemical did not show any significant alteration as compared to healthy dogs. These observations were in corroboration with the findings of Dharmadheeran *et al.*, (2005) and Shah *et al.*, (2013). Decrease in Albumin and increase AST in gastroenteritis infected dogs

might be due to involvement of liver and severe protein losing enteropathy due to intestinal villi damage or intestinal haemorrhage (Grigonis *et al.*, 2002). Increase in ALP might be due to hepatic hypoxia secondary to severe hypovolemia or the absorption of toxic substances due to loss of the gut barrier (Shah *et al.*, 2013). Increased BUN and serum creatinine concentration indicated the renal dysfunction. These values were elevated, when 70-75 per cent of the nephrons become non-functional. Loss of phosphorus homeostasis due to excretion failure in chronic kidney disease results in hyperphosphatemia (Craver *et al.*, 2007).

Correlation studies

The correlation statistic between ECG and haematology of GE affected dogs revealed a positive correlation between Pd and MCH and QRSa and PCV (Table 4 and Fig. 9).

Similarly positive correlation between Pd and TP, QRSa and AST, QT_i and globulin and PR_i with Globulin and creatinine were recorded in this study (Table 5 and Fig. 10). But QT_i and PR_i were negatively correlated with ALP.

Similarly, correlation statistic between ECG and haematology of UTD affected dogs revealed a positive correlation between STs and MCH. The study also revealed positive correlation of Pd with TP and albumin and QRSd with ALT and PR_i with TP, Albumin and A/G ratio (Table 6 and Fig.10). But there was negative correlation of PR_i with ALP (Table 6 and 7; Fig.10–12).

These findings are in agreement with other workers who also reported about correlation between ECG and haemato-biochemical changes (Tatina *et al.*, 2013; Tilley, 1992). Decrease HB, PCV and TEC lead to anaemia and as result myocardial hypoxia developed which showed increased T wave amplitude, P wave duration, QRS complex and QT interval (Tatina *et al.*, 2013; Tilley, 1992; Scheet *et al.*, 1985).

In the present study, it was concluded that the ECG parameters like P wave duration, T wave amplitude and QRS complex were altered in the extra-cardiac diseases of dogs viz. gastroenteritis and urinary tract diseases. There was a positive correlation between ECG and haemato-biochemical parameters in gastroenteritis and urinary tract diseases. These findings might be help for the better management of extra-cardiac diseases in dogs.

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