RESEARCH ARTICLE

Evaluation of Cardiac Troponin Levels, and Electrolyte Changes Associated with Electrocardiographic Alterations in Diarrheic Kankrej Cattle Calves

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Abstract

The present study was undertaken from February 2024 to July 2024 at Livestock Research Station, Sardarkrushinagar, Gujarat, India on Kankrej calves (n=20) up to 2 months of age suffering from diarrhea. The diarrheal calves were equally divided into two treatment groups T1 and T2 (n=1 0 each), and a group of healthy calves (n=10) served as control for comparison of the findings. Both diseased and control animals were evaluated for serum cardiac troponin I (cTnI), electrolytes Na, K & Cl, and ECG parameters before (day 0) and on day 10 after treatment. Therapeutic interventions such as antibiotics (as per ABST results) and fluid therapy (NSS & RL) were continued in both T1 and T2 groups until the clinical signs resolved. Additionally, the T2 group received probiotic supplementation containing *Lactobacillus sporogenes* and *Saccharomyces cerevisiae*. Electrolytes Na, K & Cl imbalance was observed during this study. After treatment, sodium and chloride levels increased in both groups, while potassium levels significantly decreased ($p<0.05$) in Group T2 (treated with probiotics). Compared to the healthy control group (C). A significant ($p<0.05$) increase in cardiac troponin I (cTnI) was recorded in diarrheic calves (255.60 ± 23.76 vs. 224.80 ± 34.47 ng/L), which after treatment reduced significantly ($p<0.05$) in both groups T1 and T2, indicating the impact on cardiac biomarkers in diarrheic calves. Electrocardiography recorded a significant ($p<0.05$) increase in QRS duration and T-wave amplitude in both the groups of diarrheic calves.

Key words: Cardiac troponin, Electrocardiography, Electrolytes, Kankrej calves.

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Introduction

In India, calves are crucial for the future of dairy farms. Although cattle farms have made great improvements in husbandry practices, calf diarrhea is still a problem. Disease diagnosis and management is a crucial aspect of ensuring the survival and well-being of neonatal calves, particularly in the context of preserving indigenous breed germplasm. During the initial three weeks of life, diarrheal diseases are the most prevalent and are economically significant health issues affecting neonatal calves. Diarrhea is frequently associated with imbalances in intestinal absorption, movement, secretion, and damage to the intestinal mucosal barrier whatever may be the inciting factor (bacteria, virus, protozoa, dietary changes, etc). Substantial fluid loss in diarrhea leads to hypovolemia and cardiovascular changes. Monitoring cardiac troponin levels serves as a sensitive early indicator of subclinical myocardial injury in diarrheic calves. Concurrently, alterations in electrolytes particularly sodium, potassium, and chloride are critical determinants of dehydration severity, and resultant cardiovascular dysfunction. Dehydrated calves show significantly ($p<0.05$) reduced ST intervals and QRS amplitudes, whereas there is a significant increase in QRS durations. In diarrheal calves, P waves are occasionally flattened or invisible, whereas T waves are frequently tall and peaked (Beg *et al.,* 2020). Hence, this study was aimed to evaluate cardiac troponin levels, and electrolyte changes associated with electrocardiographic alterations in diarrheic Kankrej cattle calves.

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Materials and Methods

The present study was carried out from February 2024 to July 2024 at the Livestock Research Station, Kamdhenu University,

Sardarkrushinagar-Dantiwda, Gujarat, India following approval of the Institute's Animal Ethics Committee (IAEC) (No.: VETCOLL/IAEC/2024/22/ PROTOCOL-03).

Selection Criteria and Study Design

Kankrej calves up to 2 months of age were screened for the presence of diarrhea. Diarrhea was defined as calves passing feces with a consistency that ran through slightly opened fingers (Trefz *et al.,* 2018). Both diseased and control animals were evaluated for various parameter on day '0' (before treatment) and after 10 days of treatment.

For treatment, 20 calves with diarrhea were equally divided into two treatment groups, T1 and T2. Therapeutic interventions such as antibiotics (as per the antibiotics sensitivity results; amikacin, gentamicin or oxytetracyclne) and fluid therapy (NSS & RL) were continued in both the groups until the clinical signs resolved. Additionally, the T2 group received multi-species probiotic supplementation containing *Lactobacillus sporogenes* and *Saccharomyces cerevisiae*. A group of 10 healthy calves from the same farm served as control for comparison of different parameters with diseased calves before and after treatment.

Blood Sampling and Analysis

Approximately 2 mL of blood samples were collected aseptically from the jugular vein of selected calves in clot activator vials for the estimation of selected serum parameters. The serum separated out was stored with a drop of merthiolate at -20°C in a deep freeze until analysed. Cardiac Troponin I (cTnI) analysis was carried out using the Puregene Bovine ELISA Kit (Genetix Biotech Asia Pvt. Ltd., New Delhi). Potassium (K), sodium (Na), and chloride (Cl) were analyzed using an automatic electrolyte analyzer (Sensa core ST-200 CL plus Electrolyte Analyzer, Hyderabad, India).

Electrocardiography (ECG)

Calves were subjected to electrocardiography (ECG) in either right lateral recumbency or standing position on a rubber mat without any sedation, using a bipolar base-apex lead system. The positive electrode (left arm) was placed over the cardiac apex in the fifth left intercostal space at the level of the elbow, while the negative electrode (right arm) was positioned in the left jugular furrow at the lower one third. An earth electrode was placed at the 7th dorsal spine, as recommended by Radostits *et al*. (2007). The electrocardiogram was recorded in quiet and calm surroundings using the electrocardiographic machine (BPL Cardiart 6208 View) at a paper speed of 25 mm/sec, and an amplitude of 1 mV per 10 mm. The recording was done in lead I.

Statistical Analysis

Data analysis was performed using the SPSS software package (version 20). One-way ANOVA was employed to compare parameters between the groups. A t-test was conducted to analyze pre-treatment and post-treatment parameters within each group, as recommended by Snedecor and Cochran (1994).

Results and Discussion

Electrolytes Profile

The mean (± SE) values of electrolytes in different groups of calves are presented in Table 1. As compared to the healthy control group, a significant ($p<0.05$) decrease in sodium (Na) was recorded in diarrheic calves (T1 and T2). After treatment, sodium (Na) and chloride (Cl) levels were significantly ($p<0.05$) increased in both groups. A non-significant increase in potassium (K) was noted in diarrheic calves, compared to the healthy group, while after treatment, a significant ($p<0.05$) decrease in K was observed in group T2.

Similar to our findings, Singh *et al*. (2014) observed significant increase in potassium with significant drop in sodium and chloride. El-Seadawy *et al.* (2020) measured serum sodium levels at 132.32 ± 1.57 mEq/L, potassium at 7.01 ± 0.04 mEq/L, and chloride at 78.85 ± 2.15 mEq/L. Changkijia (2002) and Özkan *et al.* (2011) found notable changes in electrolyte levels in diarrheic calves (increase in K concentrations along with reduction in Na and Cl concentrations) as compared to healthy controls. Aly *et al.* (1996) detected a notable drop in sodium, and chloride as well as an increase in serum potassium. Shehta *et al.* (2022) found a significant increase in serum potassium with a significant decrease in sodium, and mentioned that the observed changes in serum sodium, chloride, and potassium levels may be the result of hypovolemia concurrent with a decrease in glomerular filtration rate, which is a critical factor in the pathophysiology of hyperkalemia, as well as excessive water loss with feces, which causes dehydration and impaired cell membrane permeability.

Cardiac Troponin I (cTnI) Levels

The mean ± SE values of the concentration of cTnI for different groups are presented in Table 1. In overall comparison, a significant ($p<0.05$) elevation was observed in cTnI concentration in diarrheic calves (groups T1 and T2) as compared to the healthy control group, After treatment, cTnI levels were significantly ($p<0.05$) decreased in both groups T1 and T2. Ayvazoğlu *et al.* (2024) reported significantly higher serum cTnI level of the calves with neonatal sepsis than in the control group (0.19±0.01 vs. 0.04±0.00 ng/mL), and concluded that cTnI can be suggested as a useful prognostic and diagnostic biomarker for cardiac dysfunctions in calves with suspected sepsis. Shehta *et al.* (2022) observed significant increase in cardiac troponin I (0.39 ± 0.01 ng/mL), and mentioned that the pathophysiology behind the elevation of troponin levels in sepsis is believed due to myocardial dysfunction. Proposed causes of this dysfunction include demand ischemia, direct cardiac myotoxic effects from endotoxins, cytokines, and reactive oxygen radicals, as well as disruptions in regional coronary blood flow. The elevation of cardiac troponin I in neonatal calves with diarrhea might

be due to myocardial stress from dehydration and electrolyte imbalances, along with inflammatory responses and hypoxia that contribute to myocardial injury. Monitoring troponin levels can thus serve as a valuable indicator of cardiac function and overall health in these animals.

Electrocardiography

Electrocardiographic findings for different groups of calves are presented in Table 2. Compared to the healthy control group, a significant increase in QRS duration and T amplitude with a non-significant increase in heart rate was observed in diarrheic calves in both groups (T1 and T2). In group T2, heart rate, QRS duration, S-T segment, and T amplitude were significantly decreased and returned to normal levels after treatment. Bifid P wave, negative T wave, tachycardia, and arrhythmia were the electrocardiographic abnormalities found in diarrheic calves (Fig 1).

Table 1: (Mean ± SE) values of electrolytes and cTnI concentrations in treatment groups T1, T2, and control calves before and after treatment

Parameters		Treatment-T1	Treatment-T2	Control	p value
	Before	131.76± 2.18^{ab}	130.63± 0.69^{a}	135.65± 0.75^{b}	**0.042**
Sodium (mmol/L)	After	135.68± 0.98	134.14± 1.35	135.49± 0.55	0.513
	p value	**0.025**	**0.023**	0.731	
	Before	4.71± 0.22	4.90± 0.17	4.55± 0.08	0.349
Potassium (mmol/L)	After	4.32± 0.73	4.35± 0.10	4.54± 0.09	0.179
	p value	0.073	**0.002**	0.900	
	Before	99.54± 1.59	100.03± 1.55	103.41± 0.48	0.094
Chloride (mmol/L)	After	103.01± 0.67	104.60± 0.75	103.57± 0.36	0.200
	p value	0.061	**0.003**	0.589	
	Before	224.80±34.47^{b}	255.60±23.76^{b}	138.90±13.21^{a}	**0.009**
cTnI (ng/L)	After	119.20± 16.04	160.70± 19.63	140.50± 11.14	0.204
	p Value	**0.003**	**0.001**	0.893	

Group T1= Antibiotics + Fluid therapy, T2= T1 + probiotics (*L. sporogenes* and *S. cerevisiae*).

Means bearing different superscripts (a, b) in a row differ significantly from each other (p<0.05).

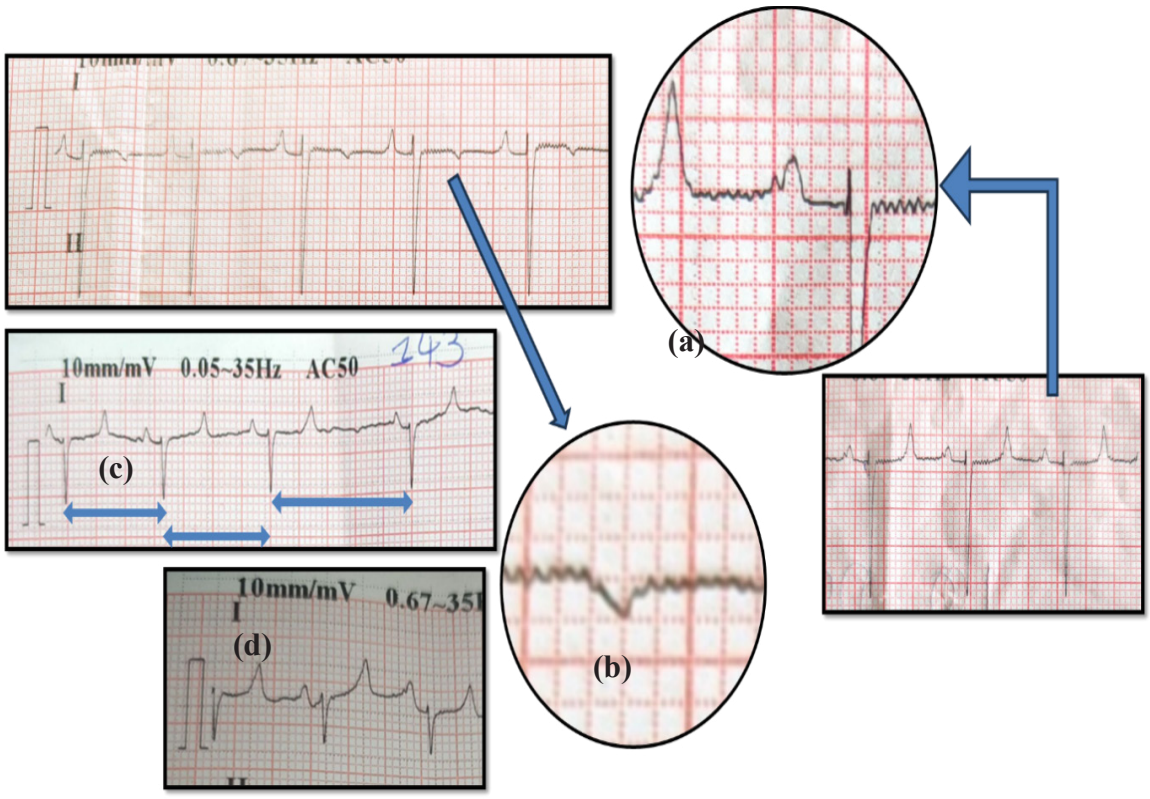

Fig.1: Different electrocardiographic findings of diarrheic calves: (a) Bifid P wave, (b) Negative T wave, (c) Irregular RR interval, (d) Peaked T wave.

Beg *et al.* (2020) also observed similar increased heart rate of dehydrated animals from 90.33±9.71 beat/min to 104.33±9.03 beat/min, accompanied by significant cardiac arrhythmias. In dehydrated animals, there were significantly decreased ST intervals, while QRS durations (0.077±0.007 msec) increased significantly. Additionally, P waves were occasionally flattened or not visible, and T waves were often tall and peaked in diarrheic calves. Özkan *et al.* (2011) mentioned that compared to the healthy calves, the amplitudes and the durations of the QRS and the T waves were significantly ($p<0.01$ increased in hyperkalemic and diarrheic calves before treatment. Tajik *et al.* (2010) pointed out hyperkalemia as the first possible cause of ECG abnormalities during calf diarrhea. ECG patterns during diarrhea in calves may be useful in determining the degree of changes in serum electrolyte levels and in assessing the illness severity. Weldon *et al.* (1992) discovered that newborn calves with acute diarrhea have acid-base and electrolyte imbalances that are frequently linked to hypeprkalemia, a condition linked to heart irregularities and muscular diseases. Electrolytes, particularly sodium, potassium, and chloride, are lost in the diarrheal fluid and their serum changes have

Table 2: Electrocardiographic findings in calves of treatment groups T1, T2, and control before and after treatment

Parameters		Treatment-T1	Treatment-T2	Control	p value
	Before	108.20± 10.10	115.50± 7.72	94.30± 4.63	0.169
Heart rate (BPM)	After	94.80± 4.66	96.50± 4.92	94.60± 5.22	0.957
	p value	0.144	**0.004**	0.952	--
	Before	0.142 ±0.01	0.155± 0.01	0.140± 0.02	0.765
P amplitude (mV)	After	0.133± 0.01	0.118± 0.01	0.134± 0.01	0.699
	p value	0.343	0.121	0.800	--
	Before	0.058± 0.006	0.054± 0.007	0.050± 0.006	0.720
P duration (s)	After	0.048± 0.004	0.042± 0.005	0.039± 0.003	0.390
	p value	0.397	0.269	0.120	--
	Before	0.174± 0.005^{b}	0.118± 0.007^{a}	0.155± 0.010^{b}	**0.001**
P-R interval (s)	After	0.155± 0.01	0.142± 0.009	0.152± 0.12	0.680
	p value	0.058	**0.046**	0.872	--
	Before	0.700 ± 0.16	0.740 ± 0.13	0.810± 0.15	0.870
S amplitude (mV)	After	0.850± 0.16	0.84± 0.18	0.820± 0.14	0.992
	p value	0.334	0.706	0.965	--
	Before	0.068± 0.005^{b}	0.052± 0.003^{a}	0.053± 0.005^{a}	**0.039**
QRS duration (s)	After	0.045± 0.005	0.039± 0.003	0.046± 0.003	0.408
	p value	**0.005**	**0.013**	0.226	--
	Before	0.126± 0.01	0.110± 0.006	0.148± 0.013	0.061
S-T segment (s)	After	0.150± 0.01	0.146± 0.01	0.142± 0.01	0.905
	p value	0.206	**0.008**	0.708	--
	Before	0.390± 0.06^{b}	0.370 ± 0.07^{b}	0.140± 0.01^{a}	**0.005**
T amplitude (mV)	After	0.145± 0.04	0.165± 0.03	0.150± 0.01	0.907
	p value	**0.006**	**0.007**	0.555	--
	Before	0.095± 0.007	0.079± 0.009	0.079± 0.006	0.331
T duration (s)	After	0.077± 0.007	0.071± 0.007	0.078± 0.01	0.826
	p value	**0.041**	0.558	0.836	--
	Before	0.319± 0.02^{b}	0.272± 0.01^{ab}	0.250 ± 0.04^{a}	**0.021**
Q-T interval (s)	After	0.283± 0.01	0.268± 0.01	0.256± 0.01	0.582
	p value	0.172	0.874	0.691	--

Means bearing different superscripts (a, b) in a row differ significantly from each other ($p< 0.05$).

an important impact on the ECG. Dehydration from diarrhea can result in reduced blood volume, which might affect the heart's ability to generate a normal electrical signal. The body compensates for this by altering the heart's electrical activity, which can manifest as changes in the QRS duration and T wave amplitude.

Conclusion

The overall incidence of diarrhea in Kankrej calves on an organised farm was observed to be 45.45%. Hyponatremia, hypochloremia, and hyperkalemia were observed with increased concentration of cardiac troponin I in diarrheic calves. Following treatment with antibiotics and fluid therapy alone or with multi-species probiotics, all these biochemical changes returned to normal in diarrheic calves. Electrocardiography recorded a significant ($p<0.05$) increase in QRS duration and T-wave amplitude in diarrheic calves. The stress on the cardiovascular system from dehydration and electrolyte imbalances can increase myocardial oxygen demand, possibly leading to alterations in the ECG pattern.

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