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Short communicationt

BLOOD ACID BASE, GAS ALTERATIONS AND ELECTROLYTE CHANGES IN BOVINES WITH CHRONIC TRAUMATIC RETICULOPERITONITIS

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Summary

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The study evaluated blood acid base, gas alterations and electrolyte changes in twenty bovines with chronic traumatic reticuloperitonitis (TRP). Blood samples were collected by jugular venepuncture for blood gas and electrolyte analysis. The mean values of blood pH, partial pressure of carbon dioxide (pCO_2), actual bicarbonate (HCO_3), standard bicarbonate (SBC), actual base excess (ABE), standard base excess (SBE) and rumen chloride were higher than reference range values while potassium and chloride were lower. The mean sodium and anion gap were within the normal reference ranges. The consistent blood gas finding was primary metabolic alkalosis with compensatory respiratory acidosis except for two cases. The consistent electrolyte alterations were hypochloremia and hypokalemia. All of these modifications need to be considered during the treatment of chronic TRP cases. Blood gas analysis, along with other diagnostic tests may help in assessing the metabolic and respiratory status of TRP cases and guide appropriate treatment strategies.

Key words: acid-base balance, blood gases, bovines, electrolyte concentrations, traumatic reticuloperitonitis

Traumatic reticuloperitonitis (TRP) is one of the most common gastrointestinal causes of morbidity and mortality in cattle and buffaloes and the disease is a major concern to the veterinarians. Although the incidence of TRP has decreased over the last two decades, the clinical implications are unchanged. The most frequent cause of TRP is the accidental ingestion of metal items like nails or wires that perforate the reticulum (Constable *et al.,* 2017; Francoz & Guard, 2019). The perforation of reticulum may result in localised peritonitis, which occasionally involves adjacent organs, and in severe cases, generalised peritonitis. Several works have reported the clinical manifestations of TRP (Abdelaal & Floeck, 2015; Constable *et al.,* 2017; Francoz & Guard, 2019). Anorexia, decreased milk production, fever, ruminal

atony and tympany, abdominal pain, arched back, abdominal guarding, and tense abdomen are common symptoms of acute illness. On the other hand, the clinical symptoms in chronic disease are frequently less noticeable. Acute TRP is thought to be characterised by a brief audible grunt, which may occur spontaneously in response to reticular contractions or posture changes like lying down and standing up (Constable *et al.,* 2017). The cases which are presented to the veterinarians are usually of chronic nature and the typical clinical signs of TRP are not observed in such cases.

The clinical findings, laboratory results, radiographic and ultrasonographic findings of TRP have been documented in textbooks (Constable *et al.,* 2017; Francoz & Guard, 2019) as well as scientific literature (Abdelaal & Floeck, 2015; Braun *et al.,* 2018). Recently, the frequency of positive reactions to foreign body tests which foreign body test evoked the most positive answers have been described in 503 cattle with TRP, in addition to clinical and laboratory findings (Braun *et al.,* 2018). The electrolyte and acid-base disturbances in bovines are caused by various disorders of the digestive transit and the severe inflammatory conditions (Hussain *et al.,* 2015; Constable *et al.,* 2017; Hussain *et al.,* 2022). Although blood gas alterations in bovine traumatic pericarditis have been reported (Hussain *et al.,* 2018), information on blood gas alterations in TRP, especially chronic TRP is still lacking in literature. The present study was conducted to determine the blood acid base and gas alterations in bovines with chronic TRP.

This prospective study was performed with 20 bovines (13 buffaloes and 7 cattle) diagnosed with chronic TRP, which meant that the clinical signs were attributable to chronic TRP and not another concomitant disease or disorder. All the animals were greater than two years of age and had been admitted to the Large Animal Clinics of Guru Angad Dev Veterinary and Animal Sciences University, Punjab, India. The diagnosis of chronic TRP was based on the results of clinical examination, ultrasonography, radiography, and/or surgery or postmortem examination. TRP was diagnosed based on radiographic evidence of a foreign body that penetrated or perforated the reticular wall and on ultrasonographic changes of the reticular wall. Ultrasonography showed fibrin deposition in the perireticular area, increased thickness of reticular wall, decrease in the amplitude of reticular contractions and/or reduced or absent reticular motility. In all animals, the diagnosis of chronic TRP was based on more than one criterion. Blood samples for blood gas analysis were collected in heparinised syringes (1:1000)from the jugular vein after proper restraint of the animals. Blood gas analysis was carried out by RADIOMETER ABL 77 SERIES (ABL 77 v1.41, Analyser), within 5 minutes of collection (Hussain & Uppal, 2014). It was assured that atmospheric air did not enter the blood samples used for blood gas analysis. For electrolyte estimations, blood samples were collected in anticoagulant coated vials. Plasma was separated and transferred to a dry clean vial for storage at –20 °C till further evaluation. VITROS DT-II Chemistry system (Ortho-Clinical Diagnostics, Johnson and Johnson Company) was used for estimation of sodium, potassium and chloride. Anion gap was calculated by subtracting the sum of major anions (bicarbonate and chloride) from the sum of major cations (sodium and potassium). Rumen fluid samples obtained by a previously de-

scribed procedure (Hussain *et al.,* 2015) were evaluated for chloride concentration. Rumen chloride was estimated with the help of Bayer's diagnostic kits (colorimetric method) by using Microlab Autoanalyser (Merck). The data were presented as mean ± S.E.M and mean values were compared with the reference range (Kaneko *et al.,* 2008) for each parameter. The percentage of animals with abnormal values for each parameter is presented.

The mean values of the blood acid base gas parameters and electrolytes in bovines with chronic TRP along with the proportion of animals with abnormal values are presented in Table 1. The mean blood pH was higher than the reference interval indicating alkalosis. Similarly, the mean value of pCO_2 was higher than reference interval, indicating respiratory acidosis. The mean standard base excess (SBE) was greater than the reference range indicating metabolic alkalosis. SBE is a measure of the non-respiratory component of the acid-base balance, and a higher value suggests excess base in the blood. The overall imbalance was primary metabolic alkalosis with compensatory respiratory acidosis. The interpretation would have been the same as it was whether the metabolic component of acid base balance had been evaluated on the basis of HCO_3, standard bicarbonate (SBC), or actual base excess (ABE). So, under clinical situations, any of these measures can be used in order to interpret the metabolic component of the acid-base balance in chronic TRP. The mean anion gap was within the normal reference interval. The mean sodium concentration was within normal reference range and the mean potassium concentration was lower (Table 1). The chloride levels were below the normal range in the majority of animals. The mean rumen chloride concentration was increased as compared to the reference range.

The acid base balance is a highly integrated process in the body of an individual or animal in which certain variables

Table 1. Blood acid base gas parameters and electrolytes in 20 bovines with chronic traumatic reticuloperitonitis

	Chronic traumatic reticuloperitonitis	Reference values*	Percentage of animals with abnormal values	
			Increased	Decreased
pH	7.490 ± 0.018	7.32–7.44	75	10
pCO_2 (mmHg)	47.05±1.85	35–44	55	20
HCO_3 (mmol/L)	35.81±2.56	20–30	70	10
SBC (mmol/L)	34.61 ±2.04		70	10
ABE (mmol/L)	13.53 ± 2.56	– 4 to +4	70	10
SBE (mmol/L)	9.79 ± 1.70		70	10
Anion gap (mmol/L)	16.42 ± 3.06	14–20	35	40
Sodium (mmol/L)	133.55 ± 2.21	132–152	5	45
Potassium (mmol/L)	3.84 ± 0.34	3.9–5.8	10	70
Chloride (mmol/L)	85.15 ± 3.64	97–111	5	70
Rumen chloride (mmol/L)	37.62 ± 2.12	<25	80	–

*Kaneko *et al.* (2008); pCO_2: partial pressure of carbon dioxide, HCO_3: actual bicarbonate, SBC: standard bicarbonate, ABE: actual base excess, SBE: standard base excess.

notably pH, partial pressure of carbon dioxide (pCO_2) and bicarbonate (HCO_3) are controlled. Acid-base disorders are of important concern and should be understood since changes in acid-base balance are often the first signs of many diseases, and small variations in blood pH can affect how cells function in the body. Keeping in view the vitality of acid base disorders, the components of acid base balance should be interpreted cautiously. In this study, the acid base imbalances were evaluated using the recommendations of Haskens (1977) based on blood pH, pCO_2, and standard base excess (SBE). With the exception of base excess, which was interpreted in accordance with Haskens (1977), the normal intervals for the interpretation of the other parameters were taken as per Kaneko *et al.* (2008). It is important to note that the interpretation and management of acid-base disorders can be complex, and they require a thorough understanding of the patient's medical history, clinical context, and other laboratory values. Therefore, any diagnosis and treatment decisions should be on individual rather than group basis.

With primary acid base imbalances, bicarbonate and pCO_2 have been reported to deviate in the same direction, and in patients with acid base imbalances, a normal pH indicated a mixed acid base disturbance (Kaneko *et al.,* 2008). In present study, two cases showed mixed acid base disturbance while another two cases had primary metabolic acidosis with hyperkalemia. The metabolic acidosis in these advanced cases may be attributed to probable paradoxical aciduria (Constable *et al.,* 2017).

The Stewart theory defines alkalosis as an increase in strong ion difference, a drop in pCO_2, and a decrease in non-volatile weak acid buffers like proteins and phosphorus (Lallemand, 2014). Overall, our findings demonstrated that since SBE was greater than reference range, animals with chronic TRP have an acid base equilibrium that tends to alkalosis. This is mostly connected to the digestive system's sequestration of chloride (Cl^-) and hydrogen (H^+) ions. As the strong ion difference decreases due to decrease in chloride concentration, metabolic alkalosis results. Anion gap greater than or equal to 30 mmol/L and serum chloride concentration <80 mmol/L have been associated with a low survival rate in cattle with abomasal volvulus (Garry *et al.,* 1988). In present study only three animals had anion gap >30 mmol/L, out of which two died and one survived. A larger sample size however is needed for better interpretation.

On individual basis, 45% of animals were hyponatremic and 70% of animals were hypokalemic. Hypokalemia in the present study could be attributed to multiple causes. First, ruminant diet is a rich source of potassium and chronic anorexia or inappetance due to chronic TRP could have caused fall in plasma potassium. Second, hypokalemia could be attributed to intracellular shift of potassium subsequent to metabolic alkalosis or may be due to urinary loss of potassium (Ward *et al.,* 1993). The fall in chloride levels might be attributed to higher concentration of bicarbonate ion in plasma, which could have increased the secretion and excretion of chloride with urine (Kuiper & Breukink, 1986). The low chloride level has also been related to anorexia, dehydration and decreased rumeno-reticular motility (Constable *et al.,* 2017). Hypochloremia may also be attributed to chloride retention in rumen contents evidenced by increased rumen chloride concentration in present study.

In the present study the overall metabolic derangement, i.e. hypochloremic hypokalemic metabolic alkalosis, may be attributed to abomasal reflux proved by increased rumen chloride concentration. The abomasal reflux in the present study may be attributed to presence of reticular adhesions affecting rumeno-reticular motility and outflow of ingesta or generalised ileus due to peritonitis. Cnsequently to abomasal reflux, the addition of abomasal fluid into the rumen along with retention of saliva in rumen usually makes the rumen contents more watery. This fluid is then not exchanged with extracellular fluid of the body resulting in functional loss of large quantities of H^+ and Cl^- ions and hypochloremic alkalosis. Further, the digestive ileus, which occurs in chronic TRP after fibrin and exudate buildup in the peritoneal cavity (Constable *et al.,* 2017), reduces Cl^- and H^+ generation and causes these ions to be trapped in the abomasum, which accounts for the reduced ions concentration seen in chronic TRP. Additionally, the chronic anorexia decreases the supply and absorption of electrolytes, resulting in hyponatremia, hypokalemia, and hypocalcemia (Constable *et al.,* 2017; Hussain *et al.,* 2022).

Hypochloremic, hypokalemic metabolic alkalosis with a compensatory respiratory acidosis has been previously reported in bovines with many diseases like jejunal haemorrhage syndrome, intestinal obstruction, caecal dilatation, diseases of abomasum, vagal indigestion, peritonitis, late pregnancy indigestion, intussusception and toxaemias (Abutarbush *et al.,* 2004; Hussain *et al.,* 2014; 2015; Constable *et al.,* 2017; Bhutia et al., 2019). However, in traumatic pericarditis (the common complication of TRP), the common reported acid base imbalance was mixed acid base disturbance (Hussain *et al.,* 2018).

Our research explains the acid-base and electrolyte imbalances that the bovines develop during the course of chronic TRP. The animals demonstrate significant changes in blood gas parameters as well as in electrolytes. We suggest that all of these alterations should be taken into consideration when treating cases of chronic TRP. We also believe that the severity of blood gas alterations in chronic TRP can vary depending on the extent of infection, the type and size of the foreign object, and the time since the initial injury. The effect of foreign body type, duration of anorexia and extent of peritoneal inflammation may be evaluated in future studies.

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