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Research Articles

Electrolyte, blood gas and acid-base imbalance in canine chronic renal disease in dogs

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Abstract

Chronic kidney disease (CKD) in dogs is a progressive and often irreversible condition where the kidneys gradually lose their ability to filter waste, regulate fluid balance and maintain essential electrolyte levels. Acid-base disturbances are commonly identified in critically ill veterinary patients. So, the present investigation was aimed to study blood gas, acid base and electrolyte alteration in canine chronic kidney disease. Study was conducted on 20 dogs suffering from stage IV chronic kidney disease out of which 10 cases were found to be positive for haemoprotozoan infection through microscopic examination or rapid diagnostic kits. Haematologically mean values of TEC, PCV and Platelets were significantly reduced. Biochemically the mean values of Creatinine, SGPT and SGOT were significantly increased. Mean values of HCO3, pCO2, BE and BB were significantly decreased as compared to healthy dogs on venous blood gas and acid-base analysis. Electrolyte and mineral estimation revealed significant decrease in the values of sodium, chloride, calcium and magnesium whereas phosphorus were increased. The assessment of blood gas, acid-base balance, electrolyte levels and timely presentation of clinical cases played a crucial role in managing canine chronic kidney disease.

Keywords: Chronic kidney disease, Acid-base, Electrolytes

Introduction

Electrolyte and acid-base balance are essential components of physiological homeostasis in dogs, influencing vital processes such as neuromuscular function, fluid regulation, and cellular metabolism. Acid-base disturbances in dogs can occur due to a variety of conditions, including renal insufficiency, diabetic ketoacidosis (DKA), prolonged vomiting or diarrhoea, shock, and respiratory diseases that impair gas exchange (Tvedten *et al.,* 2016). The present study describes on electrolyte, blood gas and acid-base imbalances in dogs with chronic kidney disease.

Materials and Methods

The present study was carried out on dogs presented during the period of February, 2024 to August, 2025 in the Department of Veterinary Medicine, Veterinary Clinical Complex, College of Veterinary and Animal Sciences, CSKHPKV Palampur (H.P). Preliminary screening was done on the basis of patient's history and presenting clinical signs as depression, inappetence, dehydration, pyrexia, enlarged lymph nodes, vomiting, diarrhoea, polydipsia, polyuria, halitosis, dental tartar and seizures. In addition to haemato-biochemical estimation, electrolyte, mineral analysis, blood gas and acid-base analysis were performed. Blood smear examination (Fig. 1) and serological detection kits (Fig. 2) were used for the detection of haemoprotozoan infection. Dogs in stage IV of chronic kidney disease as per IRIS staging were selected. On this basis, a total of 20 dogs suffering from stage IV CKD were included in the present study. 10 apparently healthy dogs independent of sex and breed presented for routine health check-ups and regular vaccination were considered as healthy control group.

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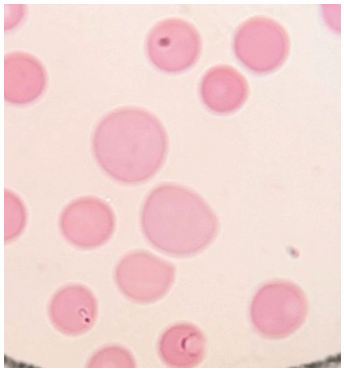

Fig. 1: Babesia gibsoni observed in a Giemsa-stained peripheral blood smear

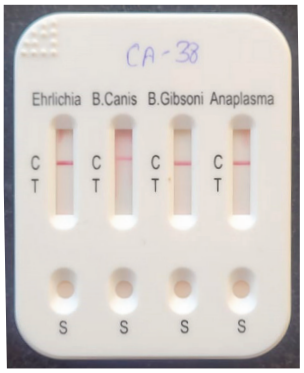

Fig. 2: Qualitative immunochromatographic assay kit

Results and Discussion

Out of 20 dogs in stage IV of chronic kidney disease, 10 were found to be positive for haemoprotozoan infection representing 50% of the cases. Most common clinical signs observed were depression, dehydration, inappetence, vomiting and pale mucous membrane. These findings were in accordance with Nakang *et al*. (2019) and Kumar *et al*. (2020), The mean values of rectal temperature, heart rate and respiration rate varied non significantly as compared to healthy animals. The mean values of haematological parameters of dog with stage IV CKD are presented above in Table 1.

Table 1: Mean values of haematological parameters in dogs with stage IV chronic kidney disease

Parameters	Healthy Control (n=10)	CKD (n=20)
Hb (g/dl)	13.47±0.34	10.93±0.92
PCV (%)	38.87±1.04	28.5±2.3**
TEC ($\times 10^{12}$/L)	6.49±0.21	4.45±0.38 **
TLC (10^9/L)	11.13±0.6	19.71±4.13
N (%)	79.68±0.85	80.747±2.82
L (%)	15.3±0.62	10.221±2.127
M (%)	4.04±0.27	7.463±0.818**
E (%)	1.35±0.18	1.205±0.2686
MCV (fl)	61.57±0.47	64.68±1.42
MCH (pg)	21.88±0.4	24.69±0.35***
MCHC (g/dl)	35.18±0.58	252.41±41.5**
Platelets (10^9/L)	299.2±23.72	121.88±15.58***

* Significant at 5% (P<0.05); ** Significant at 1% (P<0.01); ***Significant at 0.1% (P<0.001)

The mean values of PCV, TEC and platelets were significantly decreased whereas mean values of MCH and MCHC were significantly increased. These findings are in accordance with Sharma *et al*. (2015), Devpriya *et al.* (2018) and Eashwar *et al*. (2024). Anaemia in canine chronic kidney disease is multifactorial and associated with decreased erythroid precursor cells, gastrointestinal bleeding, and systemic inflammation as noted by Crivellenti *et al.* (2023). Decreased platelet count was also reported by Sharma *et al.* (2015) which can be attributed to the reduced thrombopoietic activity in uremic dogs. The mean values of biochemical parameters in dogs with stage IV CKD are presented above in Table 2

Table 2: Mean values of biochemical parameters in dogs with Stage IV Chronic Kidney Disease

Parameters	Healthy (n=10)	CKD (n=20)
Glucose (mg/dl)	102.67±2.66	126.152±10.498
Bilirubin (mg/dl)	0.22±0.04	1.62±1.215
AST (U/L)	38.05±3.98	86.06±15.04*
ALT (U/L)	33.92±2.4	88.35±11.402**
ALP (U/L)	79.25±8.72	179.43±51.606
TP (g/dl)	6.6±0.35	6.632±1.167
Creatinine (mg/dl)	1.01±0.08	15.08±1.48***
BUN (mg/dl)	25.14±4.54	515.31±174.18

* Significant at 5% (P<0.05); ** Significant at 1% (P<0.01);*** Significant at 0.1% (P<0.001)

The mean values of AST, ALT and creatinine were significantly increased as compared to healthy animals. These findings were in accordance with Bradea *et al* (2013), Puri *et al*. (2015), and Devpriya *et al*. (2018). Reason for increased creatinine was its diminished renal excretion in CRF and at least 75% loss of functional nephrons as mentioned by Lefebvre (2011). Elevations in liver enzymes like ALT and AST are not exclusive to primary liver diseases. They can also occur in extrahepatic conditions including circulatory disturbances and systemic illnesses, which are common in advanced CKD as stated by Alvarez *et al.* (2009). The mean values of electrolyte estimation in dogs with stage IV CKD are presented above in Table 3.

Table 3: Mean values of electrolyte and mineral estimation in dogs with stage IV chronic kidney disease

Parameters	Healthy (n=10)	CKD (n=20)
Sodium (mmol/L)	151.8±1.71	141.3±2.8*
Potassium (mmol/L)	4.7±0.16	5.09±0.4
Chloride (mmol/L)	110.05±1.85	102.96±1.89*
Calcium (mg/dl)	10.56±0.27	9.737±0.219*
Phosphorus (mg/dl)	5.07±0.12	6.774±0.478*
Magnesium (mg/dl)	1.78±0.07	1.39±0.084**

* Significant at 5% (P<0.05); Significant at 1% (P<0.01); ***Significant at 0.1% (P<0.001)

The mean values of electrolytes in dogs with stage IV CKD showed a significant decrease in the values of sodium, chloride, calcium and magnesium whereas the mean values of phosphorus was increased as compared to healthy dogs. These findings are in accordance with Kandula and Karalpudi (2015), Puri *et al.* (2015) and Sumit *et al.* (2018). Suggestive reason for hyperphosphatemia was declining kidney function because the kidneys are the primary route of phosphorus excretion and reduced kidney function results in phosphorus retention (Sonu *et al*., 2019). Sakaguchi (2022) stated that tubular dysfunction or interstitial fibrosis may play a pivotal role in the development of hypomagnesemia in CKD, which impairs tubular magnesium reabsorption. Hyponatremia observed could be due to hypotension, pain, and renal injury which activates sympathetic nervous system, renin angiotensin-aldosterone system and antidiuretic hormone release (Prowle *et al*., 2010) leading to increased absorption of sodium and water. Hypocalcaemia may be due to increase in GFR leading to abrupt increase in serum phosphorus concentration, causing a decrease calcium concentration due to chelation of phosphorus. This was in agreement with Schenck et al. (2005). The mean values of blood gas and acid-base analysis in dogs with stage IV CKD are presented above in Table 4.

Table 4: Mean values of blood gas and acid-base analysis in dogs with stage IV chronic kidney disease

Parameters	Healthy (n=6)	CKD (n=20)
pH (mmHg)	7.35± 0.02	7.2705±0.025
pCO2 (mmol/L)	38.15± 2.02	27±0.202***
HCO3 (mmol/L)	20.16± 0.52	11.484±0.771***
AnGap (mmol/L)	30.26± 1.25	30.266±2.278
tCO2 (mmol/L)	20.8± 0.65	12.273±0.785***
BE (mmol/L)	-6.08± 0.84	-12.773±1.189**
BEact (mmol/L)	-6.26± 1.12	-14.173±1.201**
BEecf (mmol/L)	-5.98± 1.34	-13.805±1.037***
BB (mmol/L)	42.92± 0.46	33.184±1.309***
stHCO3 (mmol/L)	20.16± 0.42	13.926±0.8522***
st pH	7.34± 0.01	7.1507±0.027**
cH+ (nmol/L)	49.63± 0.81	55.015±3.364

* Significant at 5% (P<0.05); ** Significant at 1% (P<0.01); ***Significant at 0.1% (P<0.001)

The mean values of $HCO_{3,}$ $pCO_{2,}$ BE and BB were significantly decreased as compared to healthy dogs. These findings were in accordance with Koenhemsi and Gonul (2019) and Lippi *et al.* (2023). The decreased HCO_3 concentration in CKD patients possibly was due to reduced reabsorption of filtered bicarbonate as number of functioning renal tubules become limited as CKD progresses (Buduk *et al*., 2020). In CKD a common finding is metabolic acidosis which stimulates compensatory hyperventilation leading to a decrease in arterial pCO_2. BE reflects the amount of excess or insufficient level of bicarbonate in the system and BB refers to the total concentration of buffering anions in the blood, mainly HCO_3 along with proteins, phosphates, and haemoglobin. Altered blood gas and electrolyte changes were also associated with the severity of the disease and loss of kidney function. The assessment of blood gas, acid-base balance, electrolyte levels and timely presentation of clinical cases played a crucial role in managing canine chronic kidney disease.

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References

Alvarez, L. and Whittemore, J. 2009. Liver enzyme elevations in dogs: physiology and pathophysiology. *Compend. Contin. Educ. Vet.,* **31(9):** 408–410, 412–413.

Crivellenti, S., Crivellenti, L.Z., Gilor, C. 2023. Anaemia in canine chronic kidney disease is multifactorial and associated with decreased erythroid precursor cells, gastrointestinal bleeding, and systemic inflammation. *Am. J. Vet. Res.,* **84(10)**: 1–6.

Bradea, A., Codreanu, M., Vlagioiu, C. and Simion, V. 2013. Hematologic aspects in chronic kidney disease (CKD) in dogs. *Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca Vet. Med.,* **70(2)**: 191–194.

Buduk, S.Y., Sinha, R., Bera, A.K. and Suresh, R.V. 2019. Electrolyte and acid-base alterations in dogs with renal dysfunction. *Int. J. Sci. Environ. Technol.* **8(1)**: 10–15.

Carrero, J.J., Johansen, K.L., Lindholm, B., Stenvinkel, P., Cuppari, L. and Avesani, C.M. 2016. Screening for muscle wasting and dysfunction in patients with chronic kidney disease. *Kidney Int.,* **90(1)**: 53–66.

Devipriya, K., Lavanya, C., Selvaraj, P. and Napolean, R.E. 2018. Early diagnosis of renal insufficiency in dogs with haemato-biochemical findings. *J. Entomol. Zool. Stud,.* **6(5)**: 703–705.

Eashwar, A., Ashwinii, R., Sagare, R., Krishna, C. J., Senthil, N. R. and Tejashree, M. 2024. Haemato-biochemical alterations in dogs suffering from chronic renal failure. *Int. J. Vet. Sci. Anim. Husbandry*, **SP-9(4)**: 01–03.

Kandula, S. and Karlapudi, S. K. 2015. Prevalence of renal disorders in dogs – a clinical study. *Int. J. Agric. Sci. Vet. Med.*, **2(3)**: 146–148.

Koenhemsi, L. and Gonul, R. 2019. Determination of renal blood flow with Doppler ultrasound and the hypertension prevalence and acid-base level in dogs with chronic renal failure. *J. Istanbul Vet. Sci.,* **3**: 6–12.

Kumar, C., Kamran, A. and Isloor, S. 2020. Clinical signs observed in different stages of chronic kidney disease in dogs. *Int. J. Livest. Res,.* **10**: 249–252.

Lefebvre, H. 2011. Renal function testing. In: *Nephrology and Urology of Small Animals*, Bartges, J. and Polzin, D. (eds.) Wiley-Blackwell, Ames, IA, USA, pp. 91–96.

Lippi, I., *et al.* 2023. Serum bicarbonate deficiency in dogs with acute and chronic kidney disease. *Vet. Sci.,* **10(5)**: 363.

Nakang, H., Changkija, B., Baishya, B.C., Mahato, G., Devi, P. and Kalita, M. 2019. Clinical and haemato-biochemical alterations in canine renal dysfunction. *International Journal of Livestock Research,* **9(8)**: 164–171.

Prowle, J.R., Echeverri, J.E., Ligabo, E.V., Ronco, C. and Bellomo, R. 2010. Fluid balance and acute kidney injury. *Nat. Rev. Nephrol.,* **6(2)**: 107–115.

Puri, D., Dua, K., Sood, N.K., Randhawa, S. and Dhaliwal, P.S. 2015. Study of renal dysfunctions in geriatric dogs. *Vet. Pract.*, **16(1)**: 44–46.

Sakaguchi, Y. (2022). The emerging role of magnesium in CKD. Clinical and Experimental Nephrology, **26(5)**: 379–384.

Schenck, P.A. and Chew, D.J. 2005. Calcium, phosphorus, parathyroid hormone, and renal secondary hyperparathyroidism. *Am. J. Vet. Res.,* **66(8)**: 1330–1336.

Sharma, A., Ahuja, A., Srivastava, M. and Kachhawa, J.P. 2015. Haemato-biochemical changes in dogs suffering from chronic renal failure. *Indian J. Canine Pract.,* **7(2)**: 102–107.

Sonu, A.K., Charaya, G., Bangar, Y., Agnihotri, D. and Kumar, T. (2019). Haemato-biochemical alterations in dogs suffering from chronic renal failure. *Indian J. Vet. Med.,* **39(1)**: 31–35.

Sumit, Goel, P., Kumar, P., Gulia, D., Jhambh, R., Sindhu, N. and Chaudhary, R. N. 2018. Haematobiochemical and serum electrolytes alteration in dogs with chronic kidney disease. *Pharma Innov. J.*, **7(11)**: 302–306.

Tvedten, H. and Willard, M.D. 2016. Laboratory diagnosis of renal disorders. In: *Small Animal Clinical Diagnosis by Laboratory Methods*. V edn., Elsevier. pp.126-130.

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