Abstract

Dogs with progressive chronic kidney disease (CKD) have haematological alteration of different intensities reflected on the complete blood count parameters. The purpose of this study was to evaluate changes in haematobiochemical and electrolyte parameters in dogs with CKD. The present study was conducted on 30 dogs suffering from CKD. Major alteration in hematological profile were overall lower levels of hemoglobin (9.15 ± 0.67 g/dl), TEC (4.47 ± 0.30 x 10^9/mm^3), PCV (29.22 ± 2.05 %) values and platelet count (196.23 ± 18.31 x 10^9/L) in all the affected dogs. Affected dogs were showing higher mean TLC count and percentage lymphocytes as compared to reference values. All affected dogs were showing azotemia of various degrees along with mean values of alkaline phosphatase towards higher side (201.65 ± 21.61 U/L), GGT (11.79 ± 1.47 U/L), hyperphosphatemia (11.25 ± 1.17 mg/dl), hyponatremia (140.96 ± 1.69 mmol/L), slight hyperkalemia (5.13 ± 0.22 mmol/L), hypocalcaemia (8.93 ± 0.43 mg/dl). Complete blood count and serum characteristics in CKD provides useful information about the progress of the disease as well as anemia type appreciation offering additional information for therapeutic protocol adjustment for amelioration of induced haematobochemical and electrolyte consequences.

Keywords: haematobiochemical, electrolyte alteration, electrolyte alteration

1. Introduction

Chronic kidney disease (CKD) is defined as the presence of structural or functional abnormalities of one or both the kidneys that have been present for an extended period, usually 3 months or longer (Polzin, 2011) [25] or azotemia of renal origin that has been present for more than 2 weeks (Barber, 2003) [1]. CKD is said to be the most common kidney disease in dogs, with prevalence varying from 0.05 to 3.74%. Renal insufficiency induces haematological and serum biochemical alterations in affected dogs. Anemia parallels the degree of renal impairment and its most important cause is failure of renal erythropoietin secretion. Other factors include chronic blood loss, hemolysis and bone marrow suppression by retained uremic factors (Dodds and Nicholls, 1983) [11]. In diagnosis of renal disorders, the determination of non-protein substances especially urea, creatinine and enzymes alkaline phosphatase and gamma-glutamyltransferase (Pradhan and Roy, 2012) [27] is very important because significantly increased values are usually the result of accumulation of these substances in blood due to defective kidney elimination (Benjamin, 1985) [29]. Serum creatinine is currently used to stage the severity of CKD in dogs using the IRIS (International Renal Interest Society) staging system with serum creatinine > 1.4 mg/dl being considered azotemic in most dogs. Considering these facts, the present study was planned to investigate haematobochemical and electrolyte alterations in dogs suffering from chronic kidney disease.

2. Materials and Methods

The present study was conducted at Veterinary Clinical Complex (VCC), Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar during period from August (2016) to May (2017). Total 266 cases of dogs suspected for kidney disease were screened based on the patient’s history and clinical signs. Furthermore laboratory examination (haematobochemical examination, routine urinalysis and urine culture for antimicrobial sensitivity) and imaging techniques (radiology and ultrasonography) were used for confirmatory diagnosis of renal disease. Thirty dogs suffering from chronic kidney disease due to various etiologies were diagnosed on account of clinical signs and elevated serum creatinine (>1.4 mg/dl) and blood urea (>30mg/dl) levels.
For haematobiochemical studies, 6ml of venous blood was collected aseptically from each dog and immediately after collection, 2 ml were transferred in EDTA coated vial and remaining 4 ml blood sample was transferred in clot activator coated plain vials for harvesting serum. The serum was separated by centrifugation at 3000 rpm for 7 min and then stored at -20°C in aliquots for biochemical analysis. Blood samples collected were subjected to haematological examinations comprising of haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), total platelet count (TPC), total leukocyte count (TLC) and differential leukocyte count (DLC) using fully automated haematology cell counter (MSAs, Melet Schloesing Laboratories, France). The serum samples were analyzed for total protein, albumin, globulin, ALT/SGPT, AST/SGOT, total and direct bilirubin, blood urea, serum creatinine, alkaline phosphatase (ALP) and gamma-glutamyltransferase (GGT) by using fully automated random access clinical chemistry analyzer (EM Destiny 180, Erba Diagnostics Mannheim GmbH-Germany). The serum samples were also analyzed for estimation of sodium, potassium and chloride ions using fully automated electrolyte analyzer (Easylyte® expand Na/K/Cl/Ca analyzer). The haematobiochemical values were compared with standard values available in literature (Kaneko et al., 2008) [16].

3. Results and Discussion

3.1 Haematological profile

The dogs suffering from chronic kidney disease showed lower mean values of haemoglobin, TEC, PCV, MCV, MCH and MCHC than reference values (Table 1). These findings suggest that affected dogs were suffering from microcytic hypochromic anaemia possibly due to various pathogenesis involved such as shortened survival period and haemolysis of red blood cells due to uremia (Ly et al., 2004) [20], loss of blood in gastrointestinal tract as melena and haematemesis, loss from urinary tract in haematuria due to poor platelet production (Castaldi et al., 1996) [6] and due to deficiency of erythropoietin production by the diseased kidneys (Silverberg et al., 2002) [19]. Similar findings of lower haemoglobin, TEC, PCV were reported by Pradhan and Roy (2012) [27] and Sharma et al. (2015) [15]. Results of PCV were in accordance to Couto (2009) [23] and Patil (2011) [24] who demonstrated significantly decreased PCV in CRF dogs ranging from 20 to 30 % and 27.1 to 29.9 %, respectively as compared to the healthy dogs.

Table 1: Haematological parameters (Mean±SE) of dogs affected with chronic kidney disease.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± S.E.</th>
<th>Reference value</th>
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<tbody>
<tr>
<td>Hb (g/dl)</td>
<td>9.15 ± 0.67</td>
<td>12-19</td>
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<tr>
<td>TEC (10⁶/mm³)</td>
<td>4.47 ± 0.30</td>
<td>5-7.9</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>65.43 ± 1.04</td>
<td>66-77</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>29.22 ± 2.05</td>
<td>35-57</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>20.31 ± 0.49</td>
<td>21-26.2</td>
</tr>
<tr>
<td>MCHC (g/dl)</td>
<td>31.22 ± 0.70</td>
<td>32-36.3</td>
</tr>
<tr>
<td>Platelets (10⁹/µL)</td>
<td>196.23 ± 18.31</td>
<td>211-621</td>
</tr>
<tr>
<td>TLC (10⁵/mm³)</td>
<td>16.40 ± 2.73</td>
<td>5-14.1</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td>31.03 ± 1.51</td>
<td>8-21</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>62.03 ± 2.59</td>
<td>58-85</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>5.34 ± 1.73</td>
<td>2-10</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>1.21 ± 0.21</td>
<td>0-9</td>
</tr>
<tr>
<td>Basophils (%)</td>
<td>0.39 ± 0.06</td>
<td>0-1</td>
</tr>
</tbody>
</table>

Mean values of ALT/SGPT in dogs with chronic kidney disease (Table 2) were within reference range while elevated mean values of AST/SGOT were recorded in affected dogs. ALT is the most liver specific enzyme in the cat and dog while AST is a less specific liver enzyme than ALT, as there are high levels of AST activity in both skeletal muscle and red blood cells (Richter, 2004) [30]. Research advances during the past several decades have contributed much to our understanding of how chronic kidney disease (CKD), its associated comorbidities (e.g., diabetes, osteoporosis, cardiovascular disease), its complications (e.g., metabolic acidosis, excess glucocorticoid production, inflammation and/or impaired insulin/ insulin-like growth factor-1 signaling) and its therapies (e.g., dialysis) all stimulate the loss of skeletal muscle mass (Carrero et al., 2016) [3]. Loss of
the skeletal muscle mass during the CKD might be the reason of increased values of AST observed in the CKD patients. Mean values of ALP (Table 2) were towards the higher side (112.65 ± 21.61 U/L) but within the referenced range (1-114 U/L). Ross et al. (2007) [32] Meyers and Hostetter (2008) [31], Kumar (2013) [18] and Puri et al. (2015) [19] also reported elevated serum ALP in dogs suffering from CKD. Suggestive reason of elevated ALP in CKD might be secondary renal hyperparathyroidism (Center, 1996) [7] which has been reported to be associated with increased mortality in the CRF dogs (Beddhu et al., 2009) [3]. Slight elevated mean value of GGT (Table 2) as compared to reference range (1-9.7 U/L) was observed. Finding of elevated serum GGT in present study is in agreement with Heiene et al. (1991) [14] and Pradhan and Roy (2012) [27]. Suggestive reason of increased GGT value in CKD might be its more release from the damaged renal tubular cells (Pradhan and Roy, 2012) [27]. Targhera et al. (2010) [37] reported a strong independent relationship of increased serum GGT concentrations with CKD. Therefore, serum GGT may be considered as an early predictor for the development of CKD (Ryu et al., 2007) [133]. Overall mean values of total bilirubin (Table 2) were within the reference range while higher value of direct bilirubin was observed. Elevated mean values of total bilirubin were also observed by Beckel et al. (2005) [35] in dogs suffering from renal failure due to leptospirosis. Mild to moderate bilirubin in urine of dogs with CRF has been observed (Srivastava et al., 2012; Kumar, 2013) [16, 18] which may be due to low threshold for bilirubin (Duncan et al., 1994) [15] or due to concurrent polysytemic etiology of renal dysfunction including liver and bile duct (Osborne et al., 1972) [33]. Mean values of total protein (Table 2) was within reference range while mean values of albumin was towards the lower side in all affected dogs as compared to reference range. Hypoalbuminemia might be observed due to gastrointestinal or renal protein loss of albumin. Similar findings were also observed by Pradhan and Roy (2012) [27] whereas Kandula and Karlapudi (2014) [15] reported hypoproteinemia (3.26 ±1.84 g/dl) and hypoalbuminemia (1.38 ±1.28 g/dl) in dogs with chronic kidney disease. Mean values of globulin (Table 2) in were towards the higher side of reference range and that might be the suggestive reason for normal level observation of total protein. The progress of an infection is usually associated with marked changes in the serum proteins, production of acute phase proteins (APP’s) by liver and most of the APP’s are globulins (Kaneko et al., 2008) [16]. Thereby, the concurrent infection might be the reason of increased globulin and total protein level.

Overall mean value of serum potassium levels was towards the higher side of reference range in affected dogs as shown in table 3, which is in consistent with findings of Patil (2011) [24] and Puri et al. (2015) [19] who observed high serum potassium level in dogs affected with CRF. Overall slight hyponatraemia (Table 3) was observed in affected dogs. Non-significant changes has been reported in the mean value of sodium in cases suffering from CRF (Meyers and Hostetter, 2008; Vidyadhara, 2010; Patil, 2011; Kumar, 2013) [21, 40, 24, 18].

Suggestive reasons of hyponatraemia include hypotension, pain, and renal injury which activate the sympathetic nervous system, renin angiotensin-aldosterone system and antidiuretic hormone release (Prowle et al., 2010) [28], which results in decreased renal perfusion, decreased GFR and increased proximal tubular reabsorption of sodium and water in advanced renal failure (DiBartola, 2006) [10].

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Table 3: Serum electrolyte parameters (Mean±SE) of dogs affected with chronic kidney disease

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± S.E.</th>
<th>Reference value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺ (mmol/L)</td>
<td>140.96 ± 1.69</td>
<td>134-152</td>
</tr>
<tr>
<td>K⁺ (mmol/L)</td>
<td>5.13 ± 0.22</td>
<td>3.9-5.1</td>
</tr>
<tr>
<td>Cl⁻ (mmol/L)</td>
<td>117.39 ± 1.47</td>
<td>110-124</td>
</tr>
<tr>
<td>Total calcium (mg/dl)</td>
<td>8.93 ± 0.43</td>
<td>9.1-11.7</td>
</tr>
<tr>
<td>Phosphorus (mg/dl)</td>
<td>11.25 ± 1.17</td>
<td>2.8-5.3</td>
</tr>
</tbody>
</table>

Results of the present study revealed slight hypocalcaemia (Table 3) in affected dogs. Pradhan and Roy (2012) [27] and Kumar (2013) [18] also reported highly significant decrease in the mean value of calcium in cases suffering from CRF. Similar findings were also observed by Kumar (2013) [18] and Ross et al. (2007) [32] in stage II, III and IV of CRF. Suggestive reason of hypocalcaemia may be the less absorption of calcium in the intestine due to less production of calcitriol from the damaged kidney (Nagode et al., 1996) [22]. Elevated mean value of Phosphorus (Table 3) was observed in all affected dogs as compared to reference value. Similar findings were also reported by Kandula and Karlapudi (2015) and Tivanana (2015) [19].

4. Conclusions

Dogs with chronic renal failure showed abnormal haematological and biochemical parameters. In chronic renal failure, impaired production of erythropoietin due to loss of renal parenchyma, increase haemolysis, suppression of bone marrow erythropoesis, hematuria and gastrointestinal blood loss were associated with anemia. Rise in biochemical and electrolyte parameters such as BUN, serum creatinine and phosphorus was directly proportional to the severity of disease and loss of the renal function, while inversely proportional to the prognosis of the disease. Complete blood count and serum characteristics provides useful information about the progress of the disease as well as anemia type appreciation offering additional information for therapeutic protocol adjustment for amelioration of induced haematoo-biochemical and electrolyte consequences.

5. References


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