The Pharma Innovation Journal 2023; SP-12(9): 1013-1017

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(9): 1013-1017

www.thepharmajournal.com
Received: 15-06-2023
Accepted: 22-07-2023

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Hemodialysis and conventional management of dogs with renal insufficiency

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Abstract
Out of 79 cases of common renal disorders, 29 were diagnosed for azoturia and renal insufficiency and hence, included for conservative medical management as group 1 dogs for 15 days. Inspite of every care that was taken with time to time administration of drugs, 5 dogs beyond 8 year of age that were showing severe azoturia (BUN, 350-475 mg/dl and serum creatinine, 7.2 to 8.3 mg/dl) were dead within few days after initiation of therapy. Hence, 24 cases were considered under group 1. However, by the end of the scheduled clinical management protocol, 8 dogs that did not showed any significant improvement clinically and in serum chemistry were found refractory and hence, included in group II and subjected for haemodialysis. However, fluid and other supportive drugs were also continued. Following therapy though there was a significant improvement in hematology, serum chemistry, among renal insufficiency cases of both the groups, a significantly difference was noticed with the values of group II cases that underwent hemodialysis. Though treatment was started for 29 dogs, in spite of every effort 5 dogs died during the first few days of initiation of medical management procedure and 8 dogs were found refractory and hence, 16 dogs that were shown under group I reported significant clinical improvement with absence of almost all the clinical signs by day 5 to 13 among all the dogs except for pedal edema (4/5 dogs) and ascites (5/7 dogs). Whereas, the same started improving from day 2 to 3 and reached complete absence by day 4 to 8 among all the dogs and without any mortality that were included under hemodialysis group.

Keywords: Azoturia, renal insufficiency, medical management, hemodialysis

Introduction
Kidney is a complex organ with many functions that play an essential role in health, disease and overall development and growth. Besides excreting the waste products of protein metabolism, kidneys regulate fluid, electrolyte and acid-base balance (Rose 1994) [1]. However, due to large functional reserve of the kidneys, nephropathy is often detected at advanced stage when its management is difficult and the condition becomes life threatening. The key to successful management of patients with renal insufficiency lies in the early detection of various disorders and initiation of aggressive therapy. Hence, the present research was undertaken to study comparative therapeutic aspects of renal insufficiency in dogs.

Materials and Methods
The present study was carried out in 237 dogs that were presented with the history and signs of chronic recurrent vomiting, weight loss and with different abnormalities of urine like polyuria, hematuria or stranguria, to Veterinary Hospital Bhoiguda, College of Veterinary Science, Rajendranagar, Hyderabad. These cases were subjected for through clinical examination and various diagnostic protocols like, urine analysis, serum chemistry and ultrasonography for diagnosing renal insufficiency.

Therapeutic Trial
Based on various diagnostic modalities, dogs presented with different signs suggestive of renal disorders were diagnosed for renal insufficiency and were treated accordingly with conservative medical management (group-I) for 15 days. Those cases that were non-responsive and refractory to the medical management were subjected for hemodialysis (group-II).

Group – I (Conservative medical management)
The medical management of renal insufficiency was limited to elimination of known causes of the renal injury and supportive therapies directed to the clinical and Clinicopathologic consequences of Uremia.

The treatment goals are to keep the animal alive for a sufficient period of time, while maintaining homeostasis and providing optimal conditions for the kidneys to recover, until the kidneys can regain function. To fulfill the goals of this study, the cases were treated with the following medications. A total of 29 dogs that were diagnosed for renal insufficiency were selected for therapeutic studies and subjected for therapy with the following schedule of drugs;

1. Fluid therapy (DNS and RL at 1:1 ratio) @ 20-50 ml/kg, slow i/v, SID
2. Inj. Graniset @ 0.05 mg/kg, iv, SID.
3. Inj. Rantac @ 0.5mg/kg, im, SID
4. Tab. Torsemide @ 0.1-0.5 mg/kg orally, BID
5. Inj. Petromox @ 20mg/kg, im, SID
6. Tab. Enam @ 0.5 mg/kg, po, SID
7. Sucralfate gel @ 0.5-1g orally.

The above therapeutic regimen was followed for fifteen days continuously. Inspite of rigorous therapy, five (5/29) dogs that were Severly Azotemic died during first few days of medical management. Out of the remaining 24 dogs, 8 cases did not show significant improvement in various diagnostic procedures even after completion of the medical management schedule and hence, included for hemodialysis group. Hence, only 16 dogs were considered for assessing the efficacy of medical management under group I. However, the specific causes were treated with respective therapeutic agents for considerable period.

Group – II (Hemodialysis)

Those renal insufficiency dogs (8 cases) that were refractory for medical management procedure were included under group II and selected for hemodialysis procedure. Hemodialysis was performed at five days interval on two different days i.e., on day 0 and 5. However other supportive drugs were also included for all these group II cases for considerable period. Hemodialysis involves placing a double-sided catheter in the jugular vein. This catheter allows blood to be withdrawn from one side and sent through a machine that clears out the toxins. The blood is returned to the body through the other side of the catheter (fig. 5 and 6). Hemodialysis can be intermittent (several hours a day) or continuous (24 hours a day). Continuous dialysis is usually called *continuous renal replacement therapy* (CRRT). Typically, different machines are used for intermittent versus continuous therapy.

The relative efficacy of hemodialysis over conservative medical management procedure was assessed based on alleviation of clinical signs, improvement in blood and urinary parameters and improvement in overall performance following therapy.

Results and Discussion

Based on the results obtained from various diagnostic modalities those dogs that were confirmed for renal insufficiency were subjected for therapeutic protocol. Out of 79 cases of common renal disorders, 29 were diagnosed for azoturia and renal insufficiency and hence, included for conservative medical management as group 1 dogs for 15 days. Inspite of every care, 5 dogs beyond 8 years of age that were showing severe azoturia (BUN, 350-475 mg/dl and serum creatinine, 7.2 to 8.3 mg/dl) were dead within few days after initiation of therapy. Hence, 24 cases were considered under group 1. Excluding 8/24 cases that were refractive for medical management. The details pertaining to the results of various diagnostic protocol of only 16 dogs was considered under Group I and is as follows;

Group 1

Haematological parameters

Following therapy with fluids, anti-emetics, H2 receptor blockers, diuretics, ACE inhibitors and other supportive drugs for 15 days, a significant improvement (p<0.01) in TEC (6.72±1.88×106 µl), Hb (11.94±1.56 gm percent) and PCV (43.64±1.12 percent) with a significant decrease (p<0.01) in TLC (12.10+1.34×103/µL) were noticed on day 15, when compared to before therapy values (4.92±1.24×106 µl, 10.20±0.98 gm percent, 36.74±1.32 percent and 14.42±1.12×103/µL), that were significantly different from apparently healthy dogs (7.57±0.05×106 µl, 12.48±0.04gm percent 45.49±0.03 percent and 10.48±0.17 ×103 µl). However, a non-significant difference in TEC (5.74±1.38×106 µl and 6.17±1.52×106 µl), Hb (10.82±1.02 g percent and 11.10±1.36 g percent), PCV (38.17±1.58 percent and 41.31±1.10 percent) and TLC (13.90±1.52×103 µl and 13.02±1.32×103 µl) were recorded on day 5 and 10, respectively. Similarly, a significant difference (p<0.05) was noticed with neutrophils (74.20±1.28 percent), lymphocytes (20.98±1.22 percent) and eosinophils (2.00±0.64percent) on day 15 when compared to that of day 0 values (77.32±1.22, 19.01±1.80 and 1.21±0.74). However, a non-significantly different neutrophil (75.05±0.92 percent and 75.34±1.12 percent), lymphocytes (20.02±1.46 percent and 19.36±0.84 percent) and eosinophils (1.92±0.64 percent and 2.10±0.28 percent) were recorded during the course of therapy (day 5 &10). The details of haematological alterations recorded among group 1 renal insufficiency dogs were presented in table 1.

Biochemical parameters

A significantly increased (p<0.01) BUN (56.14±2.12), creatinine (4.94 ±1.90) with a significant (p<0.05) hyperphosphatemia (8.36 ± 1.20) and hyperkalemia (6.02 ± 1.22) were recorded on day 10, when compared to that of apparently healthy dogs (23.17±0.12mg/dl, 1.22±0.10 mg/dl, 4.6±0.32 mg/dl and 4.02±0.92 mEq/L). From the table 2 it was clear that there was a significant decrease (p<0.01) in the values of BUN (28.22±1.74mg/dl), Cr (2.12±1.38 mg/dl), P (5.14±1.22 mg/dl) and K (4.10±1.20mEq/L) by the end of therapy (day 15). BUN also showed a significant decline (48.20 ± 2.36 mg/dl and 36.54 ± 1.22 mg/dl) on day 5 and 10 of therapy but serum creatinine showed a significant (p<0.01) decline on day 10 (3.68 ± 1.84 mg/dl) and non-significant decline on day 5 (4.12 ± 1.20 mg/dl). Similarly, serum phosphorus and K also reached non-significantly decreased values (7.88 ± 1.34mg/dl and 6.38 ± 1.54mg/dl; 4.98±1.36 mEq/L and 4.54 ± 1.48 mEq/L) on day 5 and 10 of the therapeutic schedule, respectively. Even though a non-significant improvement in Ca (7.86 ± 1.12 mg/dl and 8.54 ± 1.36 mg/dl), total protein (4.12 ± 1.52 g/dl and 4.82 ± 1.76 g/dl), albumin (1.98 ± 1.58 g/dl and 2.54±1.28 g/dl), sodium (139.22 ± 1.78 mEq/L and 139.98 ± 2.08 mEq/L) and chlorides (105.8 ± 1.56 mEq/L and 109.12 ± 1.50 mEq/L) were recorded during day 5 and 10, a significant (p<0.01) improvement was noticed on day 15 (9.20 ±1.12mg/dl, 5.68 ± 1.38g/dl, 2.96±1.36g/dl, 140.42± 1.22 mEq/L and 113.24± 1.56 mEq/L). These values also differ significantly on day 0 (7.02±1.02mg/dl, 3.96±1.10 g/dl, 1.52±1.34g/dl, 138.98±1.38

mEq/L and 102.8±1.28 mEq/L) when compared to that of apparently healthy dogs (9.72 ±0.40mg/dl, 6.26±0.18g/dl, 3.10±0.62g/dl, 141.50±0.36 mEq/L and 116.50±0.52 mEq/L).

Clinical signs

Medical management with respective drugs was started among 29 dogs that were diagnosed for renal insufficiency of varied causes. But, we could not save 05/29 dogs that were Severly Azotemic and hence, treatment was continued for 24 renal insufficiency dogs as group I cases. Though treatment was instituted for 24 dogs, 8 dogs were found refractory to scheduled clinical management protocol by the end of the therapeutic period (day 15), as they did not showed any significant improvement clinically and in serum chemistry & urine enzymology and hence, these cases (8/24) were included in group II. Thus, the clinical signs pertaining to the remaining 16 cases were considered as group I. Before initiation of therapy, generalized weakness and lethargy, loss of appetite, chronic recurrent vomiting, odorous breath, oral lesions, pyuria, respiratory distress, bloody stools, hematuria, stranguria, polydipsia, weight loss, abnormal posture, abnormal hair coat, pale or icteric mucosa, generalized edema, ascites and other associated signs were recorded. But following therapy, improvement in lethargy, appetite and emesis was recorded among 3, 4 and 8, 9, 11 and 11 and 16, 16 and 12 dogs, on day 5, 10 and 15, respectively. Though there was improvement in oral lesions and bad odour among 100 percent of dogs by day 15, improvement in these parameters was noticed among 3/11 and 2/9 and 9/11 and 7/9 dogs on day 5 and 10 of therapy. Signs associated with abnormalities of urine such as pyuria, hematuria and stanguria was absent among 0/2, 1/2, and 2/6 dogs on day 0 but with 100 percent improvement by the end of treatment. Similarly, improvement in other signs like respiratory distress, polydipsia, going down in condition and pale mucosa also showed marked improvement by day 15 among all the dogs which was recorded in only 2/7 and 5/7, 2/5 and 4/5, 4/16 and 9/16, 2/11 and 6/11 dogs, respectively, during the course of therapy that was on day 5 and 10. Whereas, improvement with respect to pedal edema, ascites and other systemic signs were recorded in only 1/5, 2/7 and 1/3 dogs on day 5. These particular findings were not improved among all the dogs by the end of 15 days of therapy.

Group II

By the end of the scheduled clinical management protocol, 8 dogs that did not showed any significant improvement clinically and in serum chemistry & urine enzymology were found refractory and hence, included in group II and subjected for hemodialysis. However, fluid and other supportive drugs were also continued. Serum and urine specimens were collected at three different intervels i.e., before hemodialysis (day o), fifth day after first hemodialysis and before second dialysis (day 5) and fifth day after second hemodialysis (day 10) and the results are detailed below.

Hematological parameters

Those renal insufficiency dogs that were refractory for the medical management protocol when subjected for hemodialysis, a significant (p<0.01) improvement (p<0.01) in TEC (7.32±0.68×106µl), Hb (12.12±1.28gm percent) and PCV (44.36±1.02 percent) with a significant decrease in TLC (10.98±1.22×103/µL) were noticed on day 10, when compared to day 0 levels (5.22±1.32×106 µl, 9.92±0.36gm percent, 35.32±1.62 percent and 14.10±1.28×103/µL), that were significantly different from apparently healthy dogs (7.57±0.05×106 µl, 12.48±0.04gm percent 45.49±0.03 percent and 10.48±0.17 ×103 µl), respectively. However, a non-significant difference in TEC (6.24±1.40×106 µl), Hb (11.10±1.36 g percent), PCV (41.31±1.10 percent) and TLC (12.02±1.12×103 µl) were recorded on day 5. Similarly, a significant difference (p<0.05) was noticed with neutrophil count (73.20±1.40 percent) lymphocyte count (21.98±1.80 percent) and eosinophil count (2.16±0.34 percent) was noticed on day 10 when compared to that of day 0 values (76.12±1.22, 19.01±1.42 and 1.81±0.22), respectively. However, a non-significantly different neutrophil count (74.30±1.36 percent), lymphocyte count (12.26±0.84 percent) and eosinophil count (2.24±0.54 percent) were recorded during the course of therapy (day 5). The details of hematological alterations recorded among group II renal insufficiency dogs were presented in table 3

Biochemical parameters

A significantly increased (p<0.01) BUN (51.22±1.36), creatinine (4.02 ± 1.44) with a significant (p<0.05) hyperphosphatemia (8.94 ± 1.52) and hyperkalemia (5.98 ± 0.52) were recorded among the cases of group II renal insufficiency dogs before hemodialysis, when compared to that of apparently healthy dogs (23.17±0.12mg/dl, 1.22±0.10 mg/dl, 4.6±0.32 mg/dl and 4.02±0.92 mEq/L). From the table 4, it was clearly emphasized that there was a significant decrease (p<0.01) in the values of BUN (25.02±1.02mg/dl), Cr (1.92±1.26 mg/dl), P (5.10±0.36 mg/dl) and K (4.10±0.04mEq/L) following hemodialysis (day 10). Blood urea nitrogen also declined significantly (32.12 ± 1.36 mg/dl) but with a non-significantly decreased serum creatinine (3.02 ± 1.06 mg/dl), serum phosphorus (7.65± 0.22mg/dl) and serum potassium (4.44 ± 0.36 mEq/L) were noticed on day 5 of the hemodialysis schedule. Even though there was a non-significant improvement in Ca (8.32±.04), T.P (5.22±1.26), albumin (2.82±1.42), Na (140.12±0.56) and chlorides (111.18±0.92) were recorded on day 5, a significant (p<0.05) improvement was noticed on day 10 (9.38±0.08, 6.02±0.12, 3.16±1.24, 141.42±0.84 and 115.56±1.08), respectively. These values also differed significantly on day 0 i.e., before hemodialysis (7.46±1.34, 3.52±1.88, 1.68±1.26, 138.08±1.4 and 106.12±1.88) when compared to that of apparently healthy dogs (9.72 ±0.40mg/dl, 6.26±0.18g/dl, 3.10±0.62g/dl, 141.50±0.36 mEq/L and 116.50±0.52 mEq/L).

Clinical signs

Generalized weakness and lethargy, loss of appetite, chronic recurrent vomiting, odorous breath, oral lesions, pyuria, respiratory distress, bloody stools, hematuria, stranguria, polydipsia, weight loss, abnormal posture, abnormal hair coat, pale mucosa, generalized edema, ascites and other associated signs were recorded on day 0. Following hemodialysis (day 5 and 10), improvement in lethargy, appetite and emesis was recorded among 6 and 8, 4 and 8 and 4 and 6 dogs, respectively. Though there was improvement in oral lesions and bad odour in all dogs by day 5, signs associated with abnormalities of urine such as pyuria, haematuria and stranguria was absent among 1/2, 3/3, and 3/4 dogs on day 5 but with 100 percent improvement by day 10(i,e., after second dialysis). Similarly, improvement in other signs like respiratory distress, polydipsia, going down in condition and pale mucosa also showed marked improvement on day 10

among all the dogs, which was recorded in only 5/7, 4/5, 5/8,and 6/7 dogs, on day 5, respectively. Whereas, improvement with respect to pedal edema, ascites and other systemic signs were recorded in only 2/3, 1/3 and 2/4 dogs, 5 days after first dialysis, but with 100 percent improvement on day 10 (i. e., five days after second dialysis).

Discussion

In the present study, the conventional medical management applied for group I cases of renal insufficiency was in agreement with Saravanan *et al*., (2012) [2], Nandy and Prathan (2006) [3]. Results of recent studies suggest that when markedly proteinuria dogs are treated with ACE inhibitors, a reduction in the magnitude of proteinuria is also observed (Lees *et al*., 2005) [4]. This benefit is independent of the effects of these inhibitors on systemic blood pressure. ACE inhibitors are contraindicated in animals that are dehydrated until hypovolemia can be corrected (Leyenda and Cathy 2012) [5]. Similarly, role of hemodialysis over conventional therapy was documented by Stanley and Langston (2012) [5]. Hemodialysis is chosen as preferred treatment in which the medical therapy fails to resolve the Azotemia. Dialysis should be initiated when the clinical consequences of Azotemia and fluid, electrolyte and acid base disturbances cannot be managed effectively with medical therapy alone. Animals with oliguria or anuria in which an effective diuresis cannot be induced with replacement fluids, osmotic, chemical diuretics and renal vasodilators should be subjected to dialysis (Cowgill & Francey 2005) [6]. Hemodialysis is an advanced extracorporeal renal replacement therapy for uremic patients with the capability to remove uremic toxins, correct fluid and electrolyte disorders and restore acid-base balance. Hemodialysis extends the life expectancy of patients with severe Uremia and expands the window of opportunity for recovery of the renal injury. Without hemodialysis, this window may be as short as hours to days in severe injuries and patients may die from Uremia before recovery had occurred, despite the potential for reversal of the renal damage in some of these cases. Despite its advantages, hemodialysis is a costly therapy and usually is applied at a late stage of the disease, when medical management has failed (Segev 2011) [7].

In the present study haemato-biochemical parameters showed significant improvement by day 15 among the dogs of group I, which received conventional medical therapy in contrary to that of group II dogs that were subjected to hemodialysis by day 10. Similar findings were also noticed with urine enzyme indices, that were significantly different on day 10 (i.e., 5days after 2nd hemodialysis procedure), when compared to that of group I dogs that received conventional medical management for 15 continuous days. In the present study therapeutic efficacy was also assessed based on clinical improvement that was related to the alleviation and absence of various clinical manifestations that were recorded before initiation of therapy. The signs related to GIT and urine abnormalities improved by day 10 to 15 and general signs by day 10 to 13 among the dogs of group I, that received a conventional medical management procedure. Though, the treatment was started for 29 dogs, 5 dogs died during the first few days of management procedure and the 8 dogs did not showed a significant improvement with respect to haematology, serum chemistry and urine enzyme indices. When these 8 refractory cases were subjected for hemodialysis, improvement in urine and GIT abnormalities was noticed by day 4 to 8 and with other signs by day 7, respectively. Further, no deaths were recorded among the renal insufficiency dogs of group II that were subjected for hemodialysis in contrary to that of death of 5 cases of group I. Further, it is also opined that 8 refractory cases that were successfully managed with hemodialysis would have not been improved and would have died if hemodialysis was not performed.

Table 1: Mean haematological findings of Group I renal insufficiency dogs (n=16)

Sl. No	Parameter	Apparently healthy dogs (n=10)	Day 0	Day 5	Day 10	Day 15
1	TEC (X 106/µL)	7.57±0.05	4.92±1.24**	5.74±1.38	6.17±1.52	6.72±1.88**
2	TLC (X 103/µL)	10.48±0.17	14.42±1.12**	13.90±1.52	13.02±1.32	12.10±1.34**
3	Hb (g %)	12.48±0.04	10.20±0.98*	10.82±1.02	11.10±1.36	11.94±1.56*
4	PCV (%)	45.49±0.03	36.74±1.32**	38.17±1.58	41.31±1.10	43.64±1.12**
5	Neutrophils (%)	73.80 ±0.18	77.32±1.22*	75.05±0.92	75.34±1.12	74.20±1.28*
6	Lymphocytes (%)	21.92±0.24	19.01±1.80*	20.02±1.46	19.36±0.84	20.98±1.22*
7	Eosinophils (%)	2.02±0.12	1.21±0.74*	1.92±0.64	2.10±0.28	2.00±0.64*
8	Monocytes (%)	2.26±0.10	2.00±0.32	2.51±0.22	2.60±0.64	2.30±0.34
9	Basophils (%)	0.58±0.34	0.46±0.12	0.50±0.48	0.60±0.34	0.52±0.22

Table 2: Mean Biochemical findings of Group I renal insufficiency dogs (n=16)

Sl. No	Parameters	Apparently healthy dogs (n=10)	Day 0	Day 5	Day 10	Day 15
1	BUN (mg/dl)	23.17±0.12	56.14±2.12**	48.20±2.36	36.54±1.22	28.22±1.74**
2	Creatinine (mg/dl)	1.22±0.10	4.94±1.90**	4.12±1.20	3.68±1.84	2.12±1.38**
3	Calcium (mg/dl)	9.72 ±0.40	7.02±1.02*	7.86±1.12	8.54±1.36	9.20±1.12*
4	Phosphorus (mg/dl)	4.6±0.32	8.36±1.20*	7.88±1.34	6.38±1.54	5.14±1.22*
5	Total Proteins(g/dl)	6.26±0.18	3.96±1.10**	4.12±1.52	4.82±1.76	5.68±1.38**
6	Albumin (g/dl)	3.10±0.62	1.52±1.34**	1.98±1.58	2.54±1.28	2.96±1.36**
7	Sodium (mEq /L)	141.50±0.36	138.98±1.38*	139.22±1.78	139.98±2.08	140.42±1.22*
8	Potassium (mEq /L)	4.02±0.92	6.02±1.22*	4.98±1.36	4.54±1.48	4.10±1.20*
9	Chloride (mEq /L)	116.50±0.52	102.8±1.28*	105.8±1.56	109.12±1.50	113.24±1.56*

Table 3: Mean haematological findings of Group II Renal Insufficiency dogs (n=08)

Sl. No	Parameter	Apparently healthy dogs (n=10)	Day 0	Day 5	Day 10
1	TEC (X 106/µL)	7.57±0.05	5.22±1.32**	6.24±1.40**	7.32±0.68**
2	TLC (X 103/µL)	10.48±0.17	14.10±1.28**	12.02±1.12**	10.98±1.22**
3	Hb (g %)	12.48±0.04	9.92±0.36*	11.10±1.36**	12.12±1.28*
4	PCV (%)	45.49±0.03	35.32±1.62**	41.31±1.10**	44.36±1.02**
5	Neutrophils (%)	73.80 ±0.18	76.12±1.22*	74.30±1.36*	73.20±1.40*
6	Lymphocytes (%)	21.92±0.24	19.01±1.42 *	12.26±0.84*	21.98±1.80*
7	Eosinophils (%)	2.02±0.12	1.81±0.22*	2.24±0.54*	2.16±0.34*
8	Monocytes (%)	2.26±0.10	2.60±0.30	2.60±0.62	2.14±0.26
9	Basophils (%)	0.58±0.34	0.62±0.30	0.60±0.70	0.52±0.22

Table 4: Mean Biochemical findings of Group II Renal Insufficiency dogs (n=08)

Sl. No	Parameters	Apparently healthy dogs (n=10)	Day 0	Day 5	Day 10
1	BUN (mg/dl)	23.17±0.12	51.22±1.36**	32.12±1.36**	25.02±1.02**
2	Creatinine (mg/dl)	1.22±0.10	4.02±1.44**	3.02±1.06**	1.92±1.26**
3	Calcium (mg/dl)	9.72 ±0.40	7.46±1.34*	8.32±0.04*	9.38±0.08*
4	Phosphorus (mg/dl)	4.6±0.32	8.94±1.52*	7.65±0.22*	5.10±0.36*
5	Total Proteins(g/dl)	6.26±0.18	3.52±1.88**	5.22±1.26**	6.02±0.12**
6	Albumin (g/dl)	3.10±0.62	1.68±1.26**	2.82±1.42**	3.16±1.24**
7	Sodium (mEq /L)	141.50±0.36	138.08±1.42*	140.12±0.56*	141.42±0.84.*
8	Potassium (mEq /L)	4.02±0.92	5.98±0.52*	4.44±0.36*	4.10±0.04*
9	Chloride (mEq /L)	116.50±0.52	106.12±1.88*	111.18±0.92*	115.56±1.08*

Conclusion

Hence, it may be concluded that renal insufficiency may be caused by nephritis, cystitis, secondary to urolithiasis, pyometra and other systemic causes which can be diagnosed by a battery of tests that include serum chemistry, urine analysis and diagnostic imaging techniques. Further, renal insufficiency dogs of mild to moderate intensity can be managed with conventional medical procedures but those cases that are non-responsive to medical management and / severely Azotemic can be effectively managed with hemodialysis.

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