RESEARCH ARTICLE

Urological and Ultrasonographic Studies on Kidney Diseases in Dogs in Udaipur Region of Rajasthan

Gyarsi Lal Yadav[1*], Tarunpreet[2]

Abstract

The objective of present study was early diagnosis of renal failure in dogs by simple laboratory procedure of urinalysis. A total of 1,524 cases of dogs suffering from different ailments were registered at Veterinary Clinical Complex of College and Veterinary Polyclinic, Udaipur. Dogs were suspected for kidney diseases on the basis of history and presenting clinical signs. Though detailed urinalysis, haemato-biochemical changes and ultra sonographic examination, 48 dogs were confirmed for kidney diseases. Total of 20 dogs with kidney diseases were included in study, *i.e.,* 10 dogs affected with acute kidney injury (AKI) and 10 with Chronic kidney disease (CKD), and 10 healthy dogs served as control. Urine samples from dogs of all three groups were collected by catheterization method and subjected to physical, chemical, and microscopic examination. On physical examination, the colour of urine of dogs was found to vary from pale yellow, dark yellow, yellow-brown, to red colour and transparency from clear to turbid with AKI and CKD. Dipstick urinalysis revealed highly significantly ($p<0.01$) decreased specific gravity of urine in dogs with CKD. There was a highly significant ($p<0.01$) decrease in the mean values of urine pH in dogs affected with AKI and CKD as compared to healthy dogs. Proteinuria, glucose, crystals, casts, renal epithelial cells and WBCs in urine were the main findings of urinalysis. Ultrasonography of kidneys revealed enlargement in size and distinct cortico-medullary junction in dogs affected with AKI, whereas in CKD there was reduction in size, reduced cortico-medullary distinction and loss of internal renal architecture. It is concluded that urinalysis is a reliable test to early diagnosis of renal damage.

Key words: Dog, Urinalysis, AKI, CKD, Proteinuria.

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Introduction

Urinalysis is the clinical laboratory's third most important diagnostic screening test. Urinalysis is a very effective test for determining the occurrence, severity, and duration of urinary tract disorders. It is the most effective approach for detecting renal dysfunction before kidney failure occurs (Yadav *et al*., 2020). The urinary system plays a vital function in waste product removal and electrolyte homeostasis. Any urinary system disease can lead to metabolic abnormalities, as well as acid-base and electrolyte imbalances (Dehmiwal *et al*., 2015). Urinalysis is a simple, inexpensive, and useful disease detection tool that can be performed in a short period. Prostatic diseases are primarily caused by untreated urinary tract infections, which can progress to renal failure in male dogs (Punia *et al*., 2018). In Veterinary medicine, urinalysis is a very helpful procedure that is used to screen urine for germs, casts, crystals, and cellular components to identify kidney disorders before renal failure occurs (Tufani *et al*., 2017).

Structural and functional renal damage impairs kidney functions, resulting in the loss of components such as protein, glucose, ketones, and so on through urine. Proteinuria in dogs is mainly caused by poor renal reabsorption of filtered proteins. Urine-specific gravity evaluation is considered an important method for identifying renal function issues since it helps determine the amount of water expelled (Athaley *et al*., 2018). Ultrasonography is a non-invasive and quite useful technique for the detection and characterization of renal parenchymal details. In chronic kidney disease (CKD), the main findings observed in B-mode ultrasound images are increased cortical echogenicity, loss of cortico-medullary junction, irregular renal contour, and decreased size of the kidney (Bragato *et al*., 2017). This study was aimed to assess urological and ultrasonographic findings in kidney diseases of dogs in Udaipur region of Rajasthan.

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Materials and Methods

The study was conducted following IAEC/CPCSEA approval (No. IAEC/RES/04/10). For present study 10 apparently healthy dogs of different breeds and either sex were used as control group, and 20 dogs which were identified as suffering from kidney diseases on the basis of clinical signs, urinalysis, electrocardiographic, haemato-biochemical and ultra sonographic examination, and were equally subdivided into acute kidney injury (AKI) and chronic kidney disease (n=10 each).

Collection and Evaluation of Urine Samples

For urinalysis, the urine sample (5 mL) was collected aseptically in sterile plastic container from each dog (healthy & diseased) either during spontaneous urination or by urinary catheterization (Rizzi *et al*., 2017) and kept in the refrigerator at 4-8 °C for further analysis*, viz.,* physical, chemical and microscopic examinations.

Chemical examination of urine was done using dipstick method (Subapriya *et al.,* 2020) for the presence of leukocytes, ketone bodies, nitrite, urobilinogen, bilirubin, protein glucose, haemoglobin, and RBC. The measurements of urinary specific gravity and urine pH were done by using Roche Combur-10 Urine Test Strips (Berg *et al.,* 1989).

The microscopic examination of the urine was done by taking 5 mL of fresh urine sample, which was centrifuged at 1650 x g for 5 min, and after discarding the supernatant and pipetting the sediment onto a clean glass slide and putting a cover slip, the sediment was examined in the light microscope under both low-power (10X) and high-power (40X) magnification for casts, crystals, epithelial cells, erythrocytes, leukocytes, bacteria, and other sediments (Coles, 1986; Rohini, 2022).

Ultrasonographic Examination

Ultrasonography was performed by using ExaGO Veterinary Ultrasound Scanner. A convex probe with a frequency range of 2.5 MHz to 5.0 MHz was used to perform ultra sonographic examinations on dogs. Any changes in shape, size, echogenicity, and architectural details of kidneys were recorded. Renal size was calculated by the ratio of renal length and aortic luminal diameter (Mareschal *et al.,* 2007). (Normal range 5.5-9.1, K/Ao ratio >9.1 increased kidney size, and K/Ao ratio < 5.5 is reduced kidney size).

Statistical Analysis

Data generated were statistically analyzed by IBM-SPSS (Software Packages for Social Sciences) version 30 software using standard techniques (Snedecor and Cochran, 1994).

Results and Discussion

Urinalysis: Physical Examination

On physical examination, the colour of urine of AKI and CKD affected dogs was found to vary from pale yellow (20% and 40%, resp), dark yellow (30% each), yellow-brown (10% each) to red (40% and 20%) colour and transparency varied from clear (20% and 70%) to turbid 80% and 30%, resp), while in healthy dogs it was amber colour, clear without any turbidity. These findings were in accordance with Karunanithy (2019) and Sharma *et al*. (2020). Dark yellow coloured urine could be attributed to concentrated urine with lesser amounts of water. The yellow-brown colour showed the presence of bile pigment, which could be due to poly systemic disease affecting the liver, whereas colourless urine indicates dilute urine during the polyuric phase of renal failure. Urine turbidity or sediment changes may be caused by an accumulation of WBCs, RBCs, renal epithelial cells, or cellular or granular casts (Sharma *et al*. (2020).

Urine Dipstick Chemical Examination

Results of dipstick urine analysis of healthy dogs and dogs affected with AKI and CKD are depicted in Table 1. The mean values of urine pH and specific gravity of healthy dogs were within the normal range as quoted in the Merck manual. There was a highly significant ($p<0.01$) decrease in the mean value of urine pH in dogs affected with AKI and CKD as compared to healthy dogs, which might be caused by uraemia and previous use of medicines such as furosemide, which can alter urine pH (Sharma *et al.*, 2020). The specific gravity did not vary significantly ($p>0.05$) between the healthy dogs and the dogs affected with AKI, whereas it varied significantly ($p<0.01$) between the healthy dogs and the dogs affected with CKD. This was in agreement with the findings of Chaitanya (2020) and Rimer *et al*. (2022). The conditions like acute nephritis, the oliguric phase of renal failure, protein-losing and nephro-toxic nephrosis, and early renal dysfunction may all contribute to the unchanged specific gravity of urine in renal failure dogs (Sharma *et al*., 2020). Katoch *et al.* (2017) opined that isosthenuria develops when 67% of the nephrons became non-functional. Increased solute load per surviving nephron (solute diuresis), disease-induced alteration of the renal medullary architecture and counter-current multiplier system, and decreased renal responsiveness to antidiuretic hormone may all lead to a drop in specific gravity (Meyers *et al*., 1991).

In the present investigation, it was found that dogs affected with AKI and CKD exhibited a varying degree of severity of proteinuria and glycosuria (Table 1). The similar findings were also reported by Chaitanya (2020), Sharma *et al*. (2020), Rimer *et al*. (2022) and Chand *et al.*

Table 1: Dipstick urine analysis of healthy and dogs affected with AKI and CKD

S. No.	Parameters		Healthy (n=10)	AKI (n=10)	CKD (n=10)
1.	pH (Mean ± SE)		6.84±0.064	5.60±0.16**	5.30±0.15**
2.	Urine Sp. Gr. (Mean ± SE)		1.024±0.00	1.023±0.001	1.012±0.001**
3.	Leukocyte	(+)	Nil	2(20%)	1(10%)
		(++)	-	1(10%)	1(10%)
		(+++)	-	1(10%)	1(10%)
4.	Nitrite		Negative	1(10%)	0
5.	Protein	(+)	Nil	5(50%)	6(60%)
		(++)	-	3(30%)	3(30%)
		(+++)	-	2(20%)	1(10%)
6.	Glucose	(+)	Nil	2(20%)	1(10%)
		(++)	-	1(10%)	2(20%)
		(+++)	-	1(10%)	2(20%)
7.	Ketone body		Negative	0	0
8.	Urobilinogen		Normal	0	0
9.	Bilirubin	(+)	Nil	1(10%)	1(10%)
		(++)	-	1(10%)	0
		(+++)	-	2(20%)	1(10%)
10	RBC	(+)	Nil	1(10%)	1(10%)
		(++)	-	0	0
		(+++)	-	3(30%)	1(10%)
11.	Hb	(+)	Nil	2(20%)	0

** Significant at 1% level

(2024). The finding of trace to severe proteinuria in dogs affected with CKD correlated well with Sharma *et al*. (2020). Haemorrhage, infection, intravascular haemolysis, or kidney disease might all result in proteinuria (Sharma *et al*., 2020). Similarly glycosuria can be due to tubular injury caused by nephrotoxins, and some dogs with particular familial renal disorders (Chand *et al*., 2024).

It was also observed that varying degrees of leukocytes were present in urine of dogs affected with both AKI and CKD (Table 1). These findings corroborated with earlier reports (Sharma *et al*., 2020; Rimer *et al*., 2022; Chand *et al.,* 2024). It might be due to inflammation anywhere in the urinary tract, and increased numbers of these cells were suggestive of renal affections (Di-Bartola, (2005). It was found that haematuria ranging from severity of + to +++ was observed in dogs affected with both AKI and CKD (Table 1). The finding of traces to severe positive occult blood test was in accordance with Athaley *et al*. (2018), Chaitanya (2020), Sharma *et al*. (2020) and Rimer *et al*. (2022). This might be due to iatrogenic haematuria caused by the collection, pathological haematuria caused by urinary tract haemorrhage, renal infarctions, calculi, and infection of any part of the urinary system or genital sources of erythrocytes if the sample is voided (Wamsley and Alleman, 2007). In the present findings, trace haemoglobinuria was present in dogs affected with AKI, which might be due to intravascular haemolysis. The presence of bilirubinuria ranging from severity of + to +++ was also observed in dogs affected with both AKI and CKD (Table 1). This might be due to a poly systemic etiology of renal dysfunction, including liver and bile duct dysfunction (Osborne *et al*., 1972). None of the cases was found positive for the ketone test, and the level of urobilinogen was normal in all the cases affected with kidney diseases.

Microscopic Urinalysis

Results of microscopic examination of urine of healthy, and AKI and CKD affected dogs are depicted in Table 2. In the study, it was observed that the presence of WBC/Pus cells, RBC, cast crystals, renal epithelial cells and spermatozoa were comparatively higher in AKI affected dogs than with CKD and healthy dogs. The presence of bacteria was found to be higher in dogs affected by AKI compared to healthy dogs. These results showed a resemblance with the reports of Sharma *et al*. (2016), Tufani *et al*. (2017), and Sharma *et al*. (2020).

In the present study, pyuria was noticed in dogs affected with both AKI and CKD, which was similar to the findings of Tufani *et al*. (2017), Karunanithy (2019) and Sharma *et al*. (2020). Bacteriuria was also noticed in dogs affected with AKI, which was in accordance with Rimer *et al*. (2022). The presence of bacteria and white blood cells/pus cells indicates inflammation anywhere in the urinary tract (Osborne *et al*., 1972). In the present study, haematuria was noticed in dogs affected with both AKI and CKD. Dogs with bladder rupture and lower urinary tract obstruction (urolith)

Table 2: Microscopic examination of urine of healthy and dogs affected with AKI and CKD

S.No.	Parameters	Healthy N=10	AKI N=10	CKD N=10
1.	WBC/Pus cells	Few	6(60%)	3(30%)
2.	RBC	Few	4(40%)	2(20%)
3.	Renal epithelial cells	Nil	3(30%)	2(20%)
4.	Casts	Nil	4(40%)	1(10%)
5.	Crystals	Few	5(50%)	2(20%)
6.	Spermatozoa	Occasional in male	2(20%)	1(10%)
7.	Bacteria (rods)	Nil	1(10%)	0

frequently exhibit haematuria. The renal epithelial cells noticed in dogs affected with both AKI and CKD, were similar to the findings of Karunanithy (2019), and Sharma *et al.* (2020). The presence of epithelial cells in urine may indicate ischemic, nephrotoxic, or degenerative renal diseases (Tufani *et al*., 2017).

Microscopic examination of urine samples further revealed cylindruria (cast) and crystalluria in dogs affected with both AKI and CKD, which was in accordance with Tufani *et al*. (2017), Karunanithy, (2019), Sharma *et al*. (2020), Rimer *et al*. (2022) and Chand *et al.* (2024). Urinary casts found in the urine samples of dogs could be caused by protein solidification in the lumen of the kidney tubules, specifically in the nephron, indicating kidney disease rather than lower urinary tract disease (Tufani *et al*., 2017). Granular casts in the current study indicate nephron stasis, which was primarily associated with tubule-interstitial disease, and an excess of granular casts indicated accelerated tubular degeneration, but this could also be seen in patients with glomerular disease when large amounts of filtered plasma protein precipitated in urine (Vaden *et al*., 1997). Struvite crystals (Fig. 1) usually resemble as colourless, three-dimensional, prism-like crystals, or “coffin lids,” while calcium oxalate dehydrate crystals (Fig. 2) were usually colourless squares with intersecting lines connecting their corners, giving them an envelope-like appearance. Bilirubin crystals are needle-like to granular yellow crystals formed by water-soluble conjugated bilirubin (Tufani *et al*., 2017). Spermatozoa cells also noticed in dogs affected with both AKI and CKD were in agreement with Kandula and Karlapudi (2015).

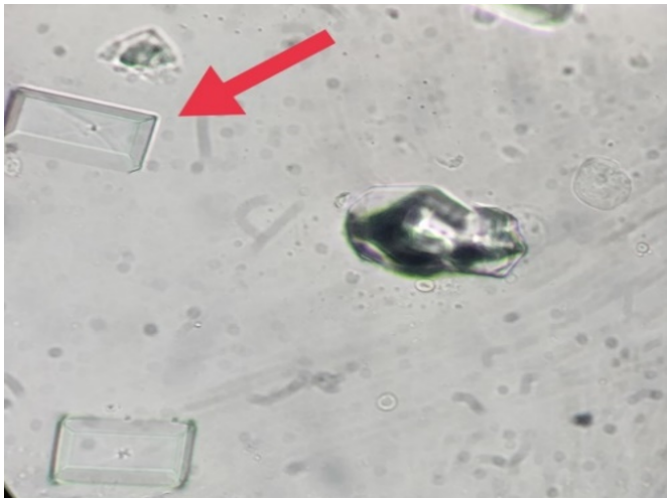


Fig. 1: Struvite/triple phosphate crystals (red arrow)

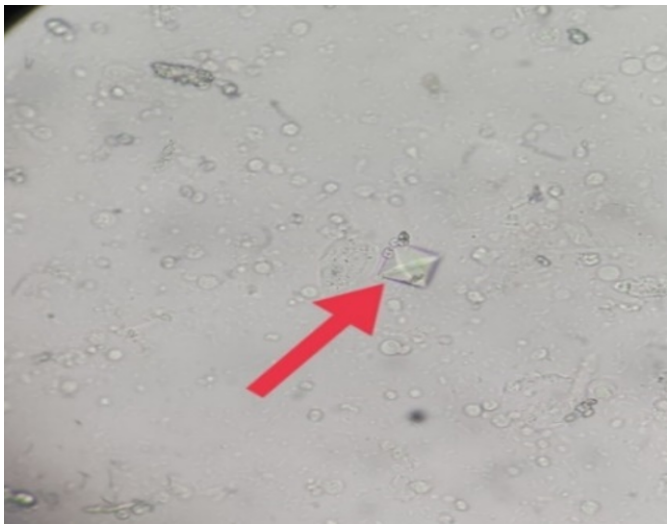


Fig. 2: Calcium oxalate dehydrate crystal (red arrow)

Ultrasonographic Findings

A total of 48 cases were diagnosed for renal diseases, *viz.,* renomegaly and smaller/ shrunken kidneys. In the present study, ultrasound assessed 10 dogs with acute kidney injury (AKI) and 10 dogs with chronic kidney disease (CKD) for size, contour, appearance, and internal renal architecture.

The ultrasonographic findings of dogs affected with AKI were regular contour, renomegaly (Fig. 3), distinct cortico-medullary junction, increased cortical echogenicity and normal internal renal architecture. These findings were identical with those reported in earlier studies of Jayaraja *et al*. (2015), Shereen (2021), and Rohini (2022). This study revealed an increase in kidney size in dogs with AKI, which was in agreement with d’Anjuo and Penninck (2015).

The ultrasonographic findings in dogs affected with

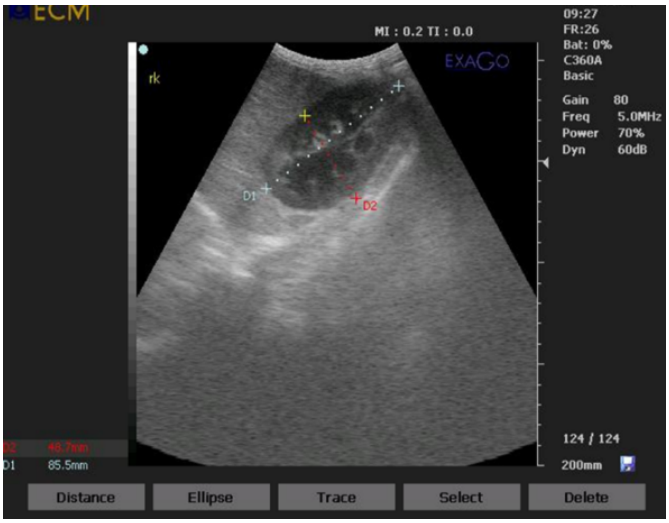


Fig. 3: Enlarge right kidney/renomegaly (K/Ao; 9.39), with regular renal contour, distinct cortico-medullary junction and normal/well defined internal renal architecture in dog with AKI

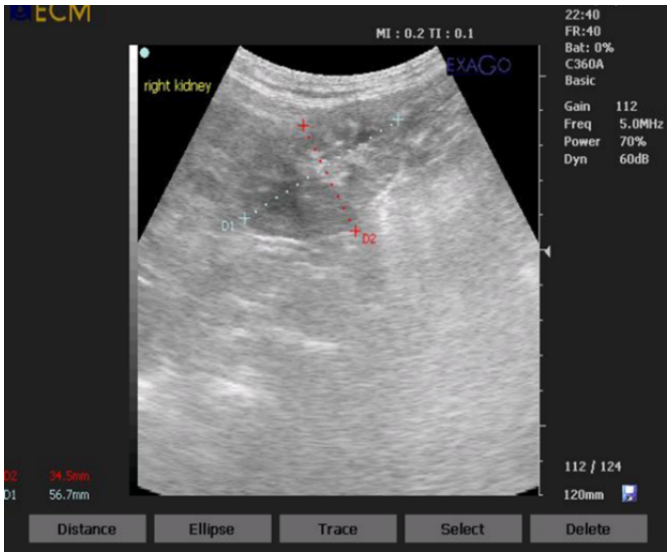


Fig. 4: Small sized right kidney (K/Ao; 4.61), with irregular contour, loss of cortico-medullary differentiation and loss of internal renal architecture in CKD dog

CKD were small-size kidneys (Fig. 4), irregular renal contour, abnormal or loss of internal renal architecture, indistinct/loss of cortico-medullary junction and increased cortical echogenicity. The present findings were in agreement with Oburai *et al*. (2015), Karunanithy (2019), Shereen (2021) and Chand *et al*. (2024). Reduced renal size and contour abnormality, which are associated with the loss of cortico-medullary differentiation, occur in the late stages of CKD, indicating a poor prognosis for the patient (Bragato *et al*., 2017). Inflammatory renal disorders (interstitial nephritis, glomerulo-nephritis, and pyelonephritis) are frequently associated with a reduction in cortico-medullary differentiation (Slike and George, (2011). The chronic nature of the disease was indicated by a decrease or loss of cortico-medullary differentiation, which was caused by an increase in both cortical and medullary echogenicity (Jayaraja *et al*., 2015). Mareschal *et al*. (2007) on ultrasonography reported the normal renal length to aortic luminal diameter ratio (K/Ao) as 5.5 to 9.1 in healthy normal dogs. The values below or above the normal range are indicative of any abnormality leading to reduced renal function in dogs affected with renal diseases.

Conclusion

Urinalysis is a simple but time consuming procedure that normally requires significant amount of labour. Urinalysis including physical, chemical and microscopic examination of freshly collected urine is the most effective tool for early diagnosis of renal impairment in dogs. Ultrasonography of kidneys and bladder further confirm of the size, contour and crystals/stones in the kidney parenchyma, cystitis and or cystic calculi. Therefore, it was concluded that urinalysis followed by USG is of great importance for early diagnosis of renal impairment and enables us to provide early treatment and thereby increases the recovery rate of renal patients.

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