# Occurrence Study of Renal Disorders in Canines Using Renal Function Markers and Nephrosonographic Modalities

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## ABSTRACT

Renal disorders are relatively common in dogs and are frequently associated with a poor prognosis in the later stages. Renal disorders may slowly progress to renal failure which is one of the most serious problems in the canine population, affecting approximately 2-5% of all dogs. In recent years, renal failure is the major cause of death in young and older dogs. The incidence of renal disorders in dogs is high in the form of renal failure viz. acute renal failure (ARF) and chronic renal failure (CRF). In the present study, dogs were screened for renal disorders on the basis of clinical signs and confirmation of renal disorders was done on the basis of renal function markers and nephrosonographic examination. The overall occurrence of renal disorders in dogs at VCC, Jabalpur was 2.66 per cent while among suspected dogs, it was 59.84 per cent. Age wise occurrence was significantly higher (5.50%) in dogs of more than 8 years of age group followed by dogs of 4-8 years of age i.e. 2.49%. Gender wise occurrence showed a non-significant difference in renal disorders among male and female dogs. Amongst different breeds, Spitz/ Pomeranian had the highest occurrence (11.24%). Echotextural alterations were recorded in 47 dogs having CRF, whereas 6 dogs with initial stages of CRF and 26 dogs with ARF had not possessed any abnormality upon diagnostic imaging.

### HIGHLIGHTS

⊙ Overall occurrence of renal disorders in dogs at VCC, Jabalpur was 2.66 per cent**.**
⊙ Echotextural alterations were the most common findings in dogs with CRF.

Renal insufficiency is a clinical disorder characterized by alterations in homeostasis of water, electrolyte, acid-base, hormonal, haematological and cardiovascular functions. In recent years, renal failure is the major cause of death in young and older dogs. The incidence of renal disorders in dogs is high in the form of renal failure viz. acute renal failure and chronic renal failure. The classification of renal disorders in dogs as acute renal failure (ARF) and chronic renal failure (CRF) depends upon the nature and onset of disease. ARF is a clinical disease linked to the sudden onset of failure of hemodynamic, filtration and excretory mechanisms of the kidneys with subsequent accumulation of metabolic (uremic) toxins and dysregulation of fluid, electrolyte and acid-balance (Cowgill and Elliott, 2000). Chronic renal failure or disease (CRF) is characterized by

progressive and irreversible decline of nephron function and the outcome is largely dependent on the presence of concomitant cardiac pathology (Bartges, 2012). Treatment for this condition is extremely difficult might be due to tremendous complexity. It is increasingly important to study the incidence of renal failure in a specific climatic zone in relation to various factors such as age, gender, and breed susceptibility.

A renal function marker is a characteristic that can be objectively measured, evaluated and used as a predictor of healthy or unhealthy biological processes, or pharmacologic reactions to therapeutic interventions. Therefore, creatinine and Blood urea nitrogen are the functional marker for kidney failure i.e., specific to the kidney and safe as well as affordable to be used in routine clinical settings.

Nephrosonography is the ideal imaging test for evaluating renal damage (Monteiro and Froes 2009) and often performed in the investigation of renal failure. Ultrasound in renal disorders measures kidney size, parenchymal quality and hemodynamic parameters by means of Doppler ultrasound, which provides information about microvascular and parenchymal lesions (Hanamura *et al.*, 2012). The interpretation of several ultrasonographic changes that occur during this time period may aid in the diagnosis of renal failure.

Keeping in view the aforementioned issues, the purpose of this article was to investigate the occurrence of renal failure in dogs in VCC Jabalpur (M.P.), on the basis of renal function markers as well as the use of modern diagnostic nephrosonography to highlight and differentiate various disorders affecting the kidney.

## MATERIALS AND METHODS

Place and duration of work the proposed study was conducted in the Department of Veterinary Medicine, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Jabalpur for a period of six months i.e. from April 2022 to September 2022.

### Experimental animals

For the present study, a total of 2974 dogs presented at Veterinary Clinical Complex, College of Veterinary Science & A.H., Jabalpur (M.P.) were screened for a period of six months i.e. from April 2022 to September 2022. The dogs were screened for the presence of clinical symptoms viz. inappetence, polydipsia, polyuria, anuria, oliguria, malena, vomiting, ascites, halitosis, weight loss, distended abdomen, oedema and duration of illness etc. All the screened dogs were further suspected for renal disorders on the basis of clinical signs and duration of illness. Confirmation was done on the basis of renal markekrs i.e., creatinine and BUN and nephrosonography.

### Collection of blood samples

Approximately 2 ml blood sample was collected in clot activator vials, aseptically from a cephalic vein or saphenous vein of dogs suspected of renal disorder. Serum was harvested after centrifugation, frozen and stored at -20°C until further biochemical analysis.

### Renal function markers

For confirmation of renal disorders in dogs, Serum creatinine (mg/dl) and blood urea nitrogen (mg/dl) were estimated by using CHEM-5 plus semi autoanlyzer using readymade kits manufactured by Erba Manheim, Transasia biochemical (India) Pvt. Ltd.

### Diagnostic imaging (Nephrosonography)

Diagnostic imaging was performed to confirm renal disorders in the suspected dogs. Nephrosonographic examination was performed by using Philips HD7 XE Ultrasound machine with 3-12MHz. linear array transducer for internal structure. The dogs were kept in minimal stress conditions so that the evaluation was not affected. The echogenicity of identifiable lesions was on the grey scale 2-D imaged and classified subjectively as normal hyperechoic, hypoechoic, anechoic or mixed echogenicity pattern as compared to normal echo pattern of the canine kidney.

## STATISTICAL ANALYSIS

The chi-square test of significance was applied to the qualitative data pertaining to the occurrence of the disease.

## RESULTS AND DISCUSSION

A total of 2974 dogs were screened for renal disorders, out of which 132 dogs showed clinical signs pertaining to renal disorders. Out of 132 suspected dogs, 79 were affected with renal disorders. Therefore, the overall occurrence of renal disorders in the dog population was 2.66 per cent and among the suspected dogs, the occurrence was 59.84 per cent. Age wise occurrence was significantly higher in the age group of more than 8 years i.e. 5.50 per cent (47 out of 855) followed by 4-8 years of age group i.e. 2.49 per cent (23 out of 922) and the minimum occurrence was recorded in 0-4 years of age group i.e. 0.75 per cent (9 out of 1197). Breed wise significantly higher occurrence was recorded in Spitz/Pomeranian i.e., 11.24 per cent (19/169) followed by German Shepherd i.e. 5.74 per cent (26/453), Golden retriever i.e. 5.41 per cent (2/37), Rottweiler i.e. 1.53 per cent (1/65), Pug i.e. 2.33 per cent (2/86), Labrador retriever i.e. 1.72 per cent (16/931), other breeds (French Mastiff, Lhasa apso and Belgian Malinois etc.) 1.47 per cent (1/68) and the lowest occurrence was recorded in non-descript dogs i.e. 1.01 per cent (12/1189) and no significant difference was noted in gender wise occurrence. The results are outlined in table 1.

Among 79, confirmed cases of renal disorders were further classified in 32.91% with Acute renal failure and 67.09% with Chronic renal failure on the basis of duration of illness and clinical signs related to them. Among 79 dogs, 47 dogs with chronic renal failure showed absolute alterations in echotexture of kidney parenchyma. Echotextural alterations were recorded in 47 dogs having CRF, whereas 6 dogs with initial stages of CRF and 26 dogs with ARF had not possessed any abnormality upon diagnostic imaging. Multiple changes were observed in CRF affected dogs like hydronephrosis in 08 dogs, hyperechoic medulla in 07 dogs, shrinkage in the size of kidney in 03 dogs, altered cortex was seen in 13 dogs, abnormal renal contour in 03 dogs, loss of corticomedullary differentiation in 11 dogs, nephrolith in 02 dogs, dilated renal pelvis in 01 dog, hypovascularisation was observed in 04 dogs. The results are depicted in table 3 and Fig. 1, 2 & 3.

**Table 1:** Occurrence of renal disorders in dogs at VCC, Jabalpur

| Particulars | No. screened | No. affected | Occurrence (%) |
|---|---|---|---|
| **Overall occurrence of renal disorder in dogs** | | | |
| Total Dog population | 2974 | 79 | 02.66% |
| Dogs suspected for renal disorders | 132 | 79 | 59.84% |
| **Age wise occurrence of renal disorders in dogs** | | | |
| 0-4 years | 1197 | 9 | 0.75% |
| 4-8 years | 922 | 23 | 2.49% |
| >8 years | 855 | 47 | 5.50% |
| $\chi^2$ value = 43.56; p< 0.01 (significant) | | | |
| **Breed wise occurrence of renal disorders in dogs** | | | |
| Spitz/ Pomeranian | 169 | 19 | 11.24 |
| German Shepherd | 453 | 26 | 5.74 |
| Golden Retriever | 37 | 2 | 5.41 |
| Rottweiler | 41 | 1 | 2.44 |
| Pug | 86 | 2 | 2.33 |
| Labrador Retriever | 931 | 16 | 1.72 |
| Others (French Mastiff, Lhasa Apso, Belgian Malinois etc.) | 68 | 1 | 1.47 |
| Non-descript | 1189 | 12 | 1.01 |
| $\chi^2$ value = 81.973; p< 0.01 (significant) | | | |
| **Gender wise occurrence of renal disorders in dogs** | | | |
| Male | 2036 | 61 | 2.99% |
| Female | 938 | 18 | 1.92% |
| $\chi^2$ value = 2.881; p> 0.05 (non-significant) | | | |

**Table 2:** Distribution of renal disorders in dogs at VCC, Jabalpur (n=79)

| Renal disorder | Number affected | Percentage (%) |
|---|---|---|
| Acute renal failure | 26 | 32.91 |
| Chronic renal failure | 53 | 67.09 |

**Table 3:** Nephrosonographic findings in dogs suffering from renal disorder (n=79)

| Sl. No. | Findings | Frequency | Percentage |
|---|---|---|---|
| 1 | Hydronephrosis | 8 | 10% |
| 2 | Hyperechoic medulla | 7 | 9% |
| 3 | Shrinkage in size | 3 | 4% |
| 4 | Altered cortex | 12 | 15% |
| 5 | Abnormal renal contour | 3 | 4% |
| 6 | Loss of cortico-medullary junctions | 11 | 14% |
| 7 | Nephrolith | 2 | 3% |
| 8 | Dilated renal pelvis | 1 | 1% |
| 9 | Hypovascularisation | 4 | 5% |
| 10 | No abnormality detected | 32 | 41% |

The results of the present study correlate well with the findings of Tufani *et al.* (2015), Singh *et al.* (2020) and Chaitanya *et al.* (2020) who also reported an overall occurrence of renal diseases as 2.58 per cent, 1.69 per cent and 3.48 per cent, respectively. However, a comparatively higher occurrence of renal disorder was reported by Nabi *et al.* (2018) who reported an overall occurrence of renal disorder as 12.03 per cent at IVRI, Izatnagar. Similarly, Srikanth and Kumar (2015) and Mshelbwala *et al.* (2016) reported a higher occurrence, 22.79 per cent and 22.81 per cent respectively while the comparatively lower occurrence of renal disorder was reported by Thade *et al.* (2019) i.e. 0.93 per cent at Nagpur. The results of the present study indicated the presence of renal disorders in dogs at VCC, Jabalpur, although there is a variation in the occurrence rates as compared to the results of previous studies. These differences might be due to increased urbanization and environmental pollution, the presence of comorbidities like certain haemoprotozoan diseases, malnutrition and indiscriminate use of therapeutic drugs (Katoch *et al.*, 2018). Differences in experimental design and procedure may also account for the differences in estimating the occurrence percentage. The results of this study is in accordance with Kavitha *et al.* (2013)*,* Tufani *et al.* (2015), Devipriya *et al.* (2018) and Chaitanya *et al.* (2020) who reported higher age wise occurrence in more than 8 years of the age group of dogs. Higher occurrence of renal disorder was also reported by Karunanithy *et al.* (2019) and Meena *et al.* (2022) in dogs of 6-10 years and 6-8 years age group, respectively. The possible reason of the occurrence of renal disorders in senile dogs might be due to reduced blood flow to the renal system, impaired resorption processes in the nephrons, incapability of filtering cells, reduction in concentrating capability, morphological deterioration of nephrons and immune-compromised condition with the increasing age. The pattern of the breed wise occurrence is lined well with the result of Oburai *et al.* (2015), Karunanithy *et al.* (2019) and Chaitanya *et al.* (2020) who reported higher breedwise occurrence of renal disorders in Spitz breed (54.84%) and Pomeranian breed (30.82%). On the contrary, Ahmed *et al.* (2011), Kandula and Karlapudi (2014) and Nabi *et al.* (2018) reported higher occurrence of renal failure in Labrador breed and lower occurrence in Pomeranian breed of dogs, while Thade *et al.* (2019) reported higher occurrence in mixed breeds/ND. The breed wise relative differences in renal disorders might be due to geographical location, genetic

makeup, breed abundance and managemental practices. A small body size or breed was an extremely important predictor of renal disorder in dogs (Bartlett *et al.,* 2010). Pomeranian/Spitz breed was found to be more sensitive to urinary disorders like urethritis, urolithiasis, cystitis and other systemic conditions, so this breed is more prone to renal disorder. The result of the present study commensurate with the findings of Sahu *et al.* (2021) and Meena *et al.* (2022) who observed no significant difference in gender wise occurrence of renal disorders in dogs. However, Chaitanya *et al.* (2020) reported higher occurrence of ARF in males whereas higher occurrence of CRF in females. Kandula and Karalapudi (2014), Mukherjee *et al.* (2014) and Nabi *et al.* (2018) reported higher occurrence with female dogs, while Tufani *et al.* (2015), Oburai *et al.* (2015), Karunanithy *et al.* (2019) and Thade *et al.* (2019) observed higher occurrence of renal disorders in male dogs.

In the present study, no significant difference in gender wise occurrence of renal disorders in dogs might be attributed to various factors like anatomical features associated with risk of urolithiasis, cystitis and urinary tract infections. Along with this, facts related to diets, environmental hygiene and maintenances, pattern of water intake, other infectious causes can also act as predisposing factor in different genders. Renal failure is a reversible and irreversible physio-pathological phenomenon. It is the most serious issue into the canine and around 2-5% of dogs suffer to these problems. Renal failure classified into acute and chronic renal failure on the basis of clinical signs, duration of illness, haematobiochemical parameters and urinary protein markers. The results of this study in accordance to Chaitanya *et al.* (2020) who reported 18.24% dogs suffered with ARF where as 81.76% dogs were suffered with CRF. However, Tufani *et al.* (2015) reported that i.e., acute renal failure was observed in 58% and chronic renal failure in 42% dogs. The occurrence of chronic renal failure was higher in the present work due to the progressive nature and ability of compensatory mechanism. The renal disease developed at any age of life which was diagnosed in later life of aged dogs as CRF. However, acute renal failure was due to sudden loss of nephron which can be under diagnosed and might be due to decreased blood flow to the kidneys, loss of filtering cells, impaired resorption processes in the nephrons, decrease in concentrating ability, morphological changes
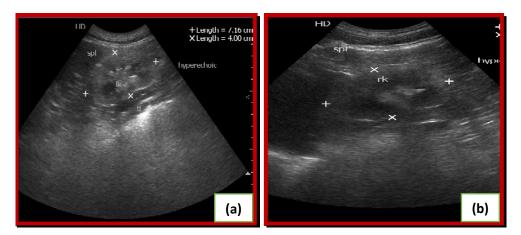
**Fig. 1:** Ultrasonogram of 8 year old Spitz showing **(a)** Left kidney cortex is hyperechoic to spleen **(b)** Right kidney cortex is hyperechoic to liver
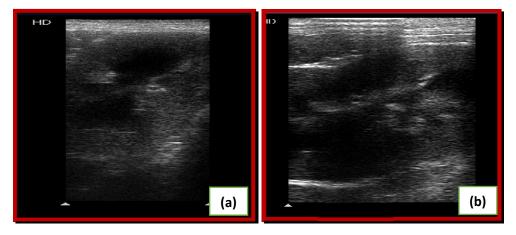


**Fig. 2:** Ultrasonogram showing **(a)** Mild hydronephrosis in left kidney of 6 year old GSD **(b)** Moderate hydronephrosis in right kidney of 12 year old Labrador Retriever dog
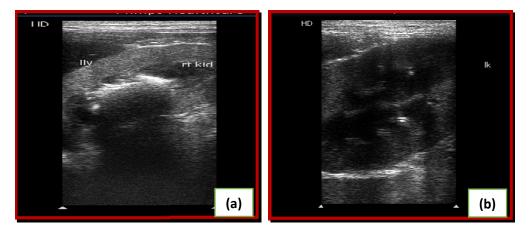


**Fig. 3:** Ultrasonogram of left and right kidney in 8 year male non descript dog showing **(a)** Hyperechoic mineralization of tubule **(b)** Hyperechoic nephrolith with distal acoustic shadow

of nephrons and deprived immunity with the advancement of periods leads to CRF (Brown *et al.*, 2015).

In this study, ultrasound was found to be a quick, practical and sensitive method for identifying changes in renal size and parenchymal structure which play an important role in diagnosing the disorders. The ultrasonographic changes observed in dogs with CRF were in consistent with the findings of Perondi *et al.* (2020), who concluded, increased cortical echogenicity, abnormal corticomedullary junction and dilated pelvis were the most prevalent abnormalities in chronic renal failure. Similarly, Kumar *et al.* (2011) also reported the significant nephrosonographic alterations in the dogs with renal failure *i.e.* shrinkage in size of kidneys with loss of corticomedullary demarcation, hyper echoic cortical region, dilated renal pelvis, hydronephrosis, nephroliths, nephrocalcinosis and renal cysts in dogs with renal failure. Koch *et al.* (2013) found irregular renal profile in 88.3% of dogs with CKD, in association with other ultrasonographic abnormalities, such as a diffuse increase in echogenicity and loss of cortico-medullary ratio and asymmetry. Singh *et al.* (2020) documented the significant ultrasonographic observations i.e., hydronephrosis (8.33%), hyperechoic cortex (33.30%), reduced sized kidney (25.00%), loss of cortico-medullary junction (58.33%), renomegaly (12.50%) and renal calculi (4.16%) in CRF. Further in dogs with ARF, without even a doubt, has progressive structural involvement that progression from mild renal injury to severe renal injury is seen. However, the diagnostic utility of ultrasonography for assessing structural involvement of kidneys in disease progression has only been examined to a limited extent, instead of that nephromegaly, indistinct cortico-medullary junction hypoechoic renal pyramids, hyperechoic renal cortex and hyperechoic medullary rim sign may be characteristic ultrasonographic features of kidneys in dogs with ARF and severe azotemia (Bhadesiya *et al.*, 2017). The ultrasonographic observations of decreased kidney size and the loss of architectural details has been reported in the present study which might be attributed to the gradual loss of functional nephrons over a few months to years, which are strongly associated with advanced stages of CRF rather than initial stages (Felaki *et al.*, 1992) and complete loss of corticomedullary definition could be due to chronic interstitial nephritis, a potential cause of CRF. Markedly increased echogenicity of the renal cortex comparable with spleen and liver is may be related to

glomerulosclerosis and fibrosis due to chronic nephritis. The absence of a distinct cortico-medullary junction in the current study could also be due to chronic interstitial nephritis or glomerulonephritis. The ultrasonographic findings such as a hyperechoic medullary rim and marked renal pelvic dilation with hydronephrosis after a long-standing obstruction might suggest nephropathy leading to CRF. The presence of solitary or multiple renal cysts without clinical symptoms is usually of congenital origin and in most cases, is an incidental finding during an ultrasonographic examination (Kumar *et al.*, 2011). Nephroliths, which were highly hyperechoic structures in the renal pelvis with intense distal acoustic shadow and were seen as a distinctive, white gritty band close to the cortical medullary junction (Kruger *et al.*, 1996). In dogs and cats, color doppler can also be applied to illustrate the presence or reduction of intrarenal arterial flow, which is related to renal function (Baltazar *et al.,* 2016). There is a correlation between the blood flow and creatinine levels in dogs with CKD (Lee *et al.*, 2015).

## CONCLUSION

The overall occurrence of renal disorders in dogs was 2.66%. Out of this, 32.91% had acute whereas 67.09% had chronic renal failure. Dogs of above 8 years of age had more occurrence with spitz breed being most affected with renal disorders. Nephrosonography revealed normal echotexture in all the dogs with acute renal failure while multiple echotextural alterations were observed in dogs having CRF. Diagnosis of renal failure is typically based on a consistent history, physical examination, laboratory data, and imaging studies, all of which play an important role in distinguishing acute from chronic renal failure. As a result, the initial diagnostic workup in acute renal failure in dogs is aimed at identifying the underlying cause, so that the latter can be eliminated and further kidney injury can be minimized to become a chronic condition.

## ACKNOWLEDGEMENTS

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