RESEARCH ARTICLE

Ultrasonographic Diagnosis of Urinary System Affections in Dogs

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Abstract

In present investigation total 37 dogs with different urinary system affection were included. Common physical findings in urinary tract disease were stranguria / dysuria, haematuria, anuria and urinary incontinence. Ultrasonographic examinations showed hyperechoic calculi with acoustic shadow in case of kidney stone; lack of demarcation between the cortex and medulla and enlarged kidney in hydronephrosis, and non-homogenous small kidneys with loss of corticomedullary differentiation when dog was affected with chronic kidney disease. Cystic and urethral calculi ultrasonographically appeared as hyperechoic structures creating acoustic shadowing. Further renal mass, cystitis and urinary bladder mass were clearly diagnosed using ultrasonography. On the basis of present findings, we concluded that ultrasonography could be best exploited in the diagnosis of urinary system affections.

Keywords: Bladder mass, Cystic calculi, Cystitis, Dog, Hydronephrosis, Kidney stone, Renal mass, Ultrasonography.

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Introduction

The urinary system is chief excretory system and comprised of kidneys, ureters, urinary bladder and urethra. Overload on urinary system for performing its routine work, makes urinary tract more vulnerable and prone to a variety of affections that may be infectious or non-infections in nature. Immediate attention to the disease is demanded for appropriate diagnosis. The diagnosis of urinary tract affections can be usually made on the basis of clinico-physiological findings, haemato-biochemical analysis, urinalysis, survey radiography, contrast radiography and ultrasonography.

Clinico-physiological findings in dogs with urinary tract disease showed anuria, oliguria, stranguria/dysuria, haematuria, urination in inappropriate places, urinary incontinence, decreased volume of urine voided and dribbling of urine (Chew *et al.*, 2011). Complete blood count and routine serum biochemistry are usually normal if urinary tract infection is limited to the lower urinary tract (Chew *et al.,* 2011). However, in cases of cystitis, increased white blood cell count and in cases of urethral calculi increased blood urea nitrogen and serum creatinine is observed (Zotti *et al.,* 2007). Diagnostic ultrasonography is an important diagnostic tool and an outstanding non-invasive technique to assessment of the urinary tract problems in dogs because it is simple to use, affordable, and provides great real-time contrast resolution (Robotti and Lanfranchi, 2013). In patients with hematuria or dysuria, ultrasonography is frequently indicated as the first diagnostic imaging modality. Hence, this study was aimed to evaluate ultrasonographic diagnosis of urinary system affections in dogs.

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MATERIALS AND METHODS

A total of 37 dogs of either sex, irrespective of age, presented to Department of Veterinary Surgery and Radiology, Anand (India) with different urinary tract affection were included in present investigation. In all the dogs detailed physical, haemato-biochemical and ultrasonographical examinations were carried out for further evaluation.

Ultrasonographic examination

Ultrasonographic examination of urinary system was done after restraining the animal in a dorsal recumbency and shaving between pubis and umbilicus, on each side of the ventral midline. Coupling gel was applied on the skin surface to ensure an intimate contact between the transducer and body surface. Two-dimensional B-mode ultrasonography of the kidney and urinary bladder was performed using ultrasound machine 'esaote MyLab Five' equipped with

a micro convex probe (2.5-7.5 MHz) and 'esaote Mylab 40' equipped with an 4D volume probe (3.5-6.6 MHz). Ultrasonographic examination of the urethra was carried out using linear array probe (12.0-18.0 MHz).

Haemato-biochemical Parameters

Five milliliter blood was collected from the cephalic or saphenous vein from each dog and two milliliter of blood was transferred in K3EDTA vials for estimation of different haematological parameters. Another three-milliliter blood was collected in clot activator vials for estimation of different serum biochemical parameters.

RESULTS AND DISCUSSION

Out of 37 dogs, one dog was diagnosed with kidney stone, three dogs with hydronephrosis, one with chronic kidney disease, one bitch with renal mass, sixteen dogs with urolithiasis (ten cystic calculi and six urethral calculi), fourteen with cystitis, and one with transitional cell carcinoma. The haemato-biochemical findings and ultrasound pictures are shown in Table 1 and Plates 1 to 11.

Kidney Stone / Nephroliths

One dog with kidney stone had symptoms like polyuria, and occasionally haematuria. which concurred with the finding of Monica (2010). Dogs with kidney stones have no apparent signs; that is, the nephroliths are often not detected until diagnostic testing is done for other medical problems. Some symptoms that may occur include blood in urine (haematuria), vomiting, recurrent urinary tract infections, painful difficult urination (dysuria), and frequent urination with small volume (polyuria) (Monica, 2010). In this dog, 1.46 x 1.87 cm hyperechoic structure with acoustic shadow was present in left kidney (Plate 1) and round to oval shape 1.05 x 1.01 cm hyperechoic structure was observed in right kidney (Plate 2). Similar finding was observed by Natrup and Tobias (2007).

In case of kidney stone mean values of haemoglobin, PCV and TEC were within normal physiological range. However, neutrophilia and leucocytosis was observed due to urinary tract infection. Mean values of AST, ALT, total protein, BUN and creatinine were also within normal range as observed by Monica (2010).

Hydronephrosis

Three dogs with hydronephrosis were dull, depressed, mild anorectic with polyuria. Dogs with hydronephrosis showed lack of demarcation between the cortex and medulla of the kidney and renal pelvis appeared dilated hypoechoic structure on ultrasonographic examination (Plate 3). However, Rousset *et al.* (2011) claimed that, hydronephrosis dogs did not show any clinical signs due to continuous dilation of renal pelvis. The present USG observations concurred with the findings of Kumar *et al.* (2011) and Raposo *et al.* (2013).
In case of hydronephrosis mean values of haemoglobin, TEC and PCV were within normal range. However, the leucocytosis and neutrophilia observations concurred with findings of Kumar *et al.* (2011) and Raposo *et al.* (2013). Biochemical parameters viz, AST, ALT, BUN total protein and creatinine were also within normal range, as were observed by Raposo *et al.* (2013). However, Kumar *et al.* (2011) noted significant change in blood biochemistry of dogs with hydronephrosis.

Chronic Kidney Disease (CKD)

In one case of chronic kidney disease (CKD) anorexia, progressive lethargy and weight loss, distention of urinary bladder, limb edema, inability to stand, vomition and fever were observed, which concurred with the observations

Table 1: Haemato-biochemical findings in urinary tract disorders of dogs

Condition / Parameters	Kidney stone (n=1)	Hydro-nephrosis (n=3)	Chronic kidney disease (n=1)	Renal cell carcinoma (n=1)	Urolithiasis (n=16)	Cystitis (n=14)	Transitional cell carcinoma (n=-1)
Haemoglobin (g/dL)	16.2	14.66±1.20	10.7	11.5	15.28±1.57	15.93±1.46	12.8
PCV (%)	44	41.00±2.08	34	-	43.83±2.24	45.33±2.40	38
TEC (X106 / µL)	7.5	6.33±0.31	4.5	4.8	6.56±0.37	7.13±0.20	5.9
TLC (/µL)	21200	19400±529	26100	4000	17443±1329	19566±1745	9600
Neutrophils (%)	84	80.66±2.33	61	73	86.16±1.66	84.66±2.84	63
Lymphocytes (%)	12	15.66±2.60	39	25	9.50±1.21	11.66±2.72	34
Monocytes (%)	3	2.33±0.33	0	2	2.83±0.60	2.33±0.33	2
Eosinophils (%)	1	1.33±0.33	0	0	1.50±0.22	1.33±0.33	1
ALT (IU/L)	69	58.33±6.64	52	49	74.66±6.01	55.66±3.75	71
AST (IU/L)	37	27.66±2.02	38	30	30.16±1.57	30.33±4.09	28
BUN (IU/L)	21	20.00±2.64	72	32	58.83±3.80	21.66±2.33	22
Creatinine (mg/dL)	0.89	1.20±0.15	15.3	1.8	1.90±0.15	1.30±0.11	1.3
Total Protein (g/dL)	6.1	6.43±0.35	4.9	6.0	6.00±0.18	7.20±0.45	6.1

Plate 1: Sonograph of kidney stone showing round shape (1.46 x 1.87 cm) hyperechoic structure with acoustic shadow in left kidney in sagittal plane

Plate 2: Sonograph of kidney stone showing round to oval shape (1.05 x 1.01 cm) hyperechoic structure in right kidney in sagittal plane

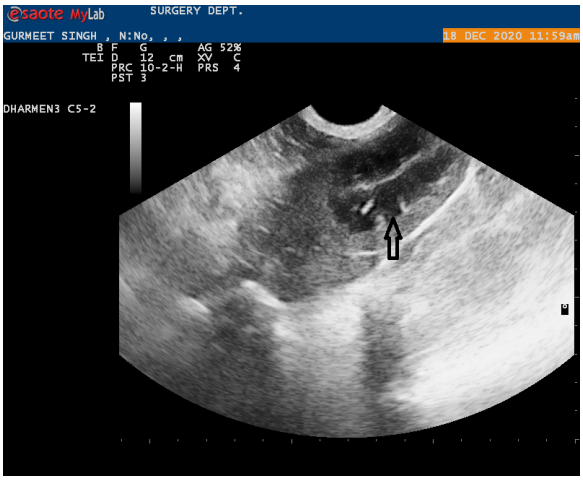

Plate 3: Sonograph of hydronephrosis showing lack of demarcation between the cortex and medulla (black arrow) in sagittal plane

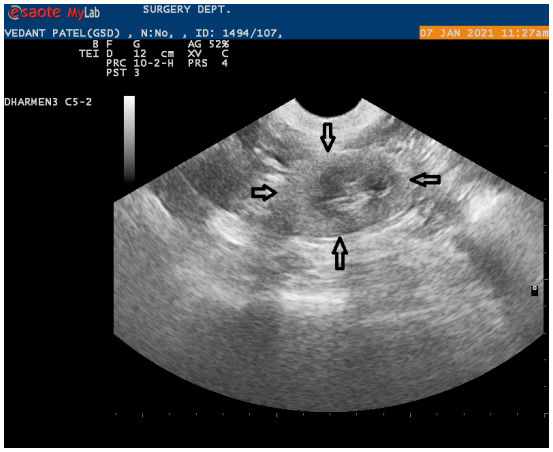

Plate 4: Sonograph of chronic kidney disease showing non-homogenous structure and loss of corticomedullary differentiation in sagittal plane

Plate 5: Sonograph of renal cell carcinoma showing irregular mass attached to right kidney

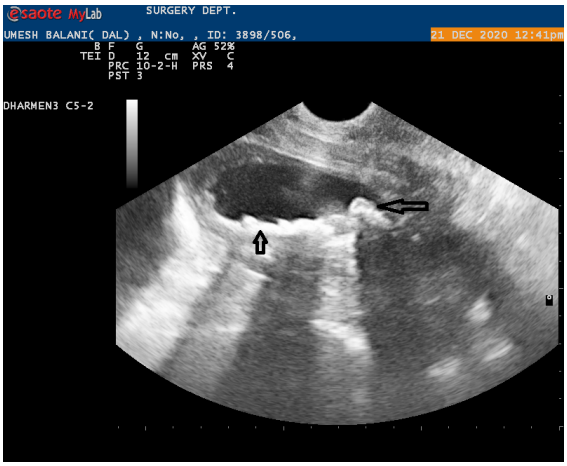

Plate 6: Sonograph of cystic calculi showing multiple, round to oval shaped hyperechoic structures (black arrow) creating acoustic shadowing in sagittal plane

of Kumar *et al.* (2011). Ultrasonographic examination of CKD revealed non-homogenous small kidneys with loss of corticomedullary differentiation. Renal parenchyma cannot be differentiated from surrounding tissue (Plate 4). Similar finding was observed by Natrup and Tobias (2007).

Dogs affected with CKD showed decreased haemoglobin, PCV, TEC values, whereas neutrophils were in normal range. However, leucocytosis and lymphocytosis were also

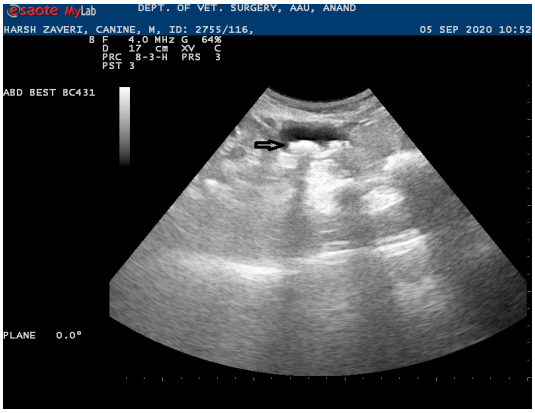

Plate 7: Sonograph of cystic calculi showing two, round to oval shaped hyperechoic structures (black arrow creating acoustic shadowing in sagittal plane

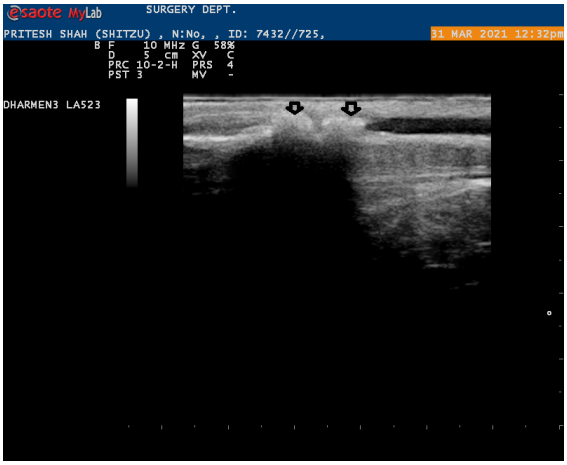

Plate 8: Sonograph of urethral calculi showing two, round to oval shaped hyperechoic structure creating acoustic shadow in sagittal plane of urethra

observed. These findings agreed with those observed by Lees *et al.* (2005) and Kumar *et al.* (2011). The causes of anaemia in urinary system disorder might be due to chronic renal disease which resulted from decreased production of erythropoietin and depressed erythrogenesis and/or shortened erythrocyte life span due to accumulation of uremic toxins (Brown, 2003). Among biochemical parameters, mean values of total proteins were decreased, however BUN and creatinine were markedly increased. Biochemical parameters such as AST, ALT were within normal physiological range. Similar findings were observed by Lees *et al.* (2005). The reason for increased creatinine was its diminished renal excretion in CRF, but creatinine was insensitive for early renal insufficiency; at least 75% loss of functional nephrons occurred before creatinine increases above the reference levels (Watson *et al.*, 2011).

Renal Cell Carcinoma

A Labrador retriever with renal cell carcinoma was presented with history of right-side abdominal distension and mild inappetence. Physical findings revealed palpebal abdominal mass on right side of abdomen. Similar observation was made by Bennett (2004) in dog with unilateral renal cell carcinoma.

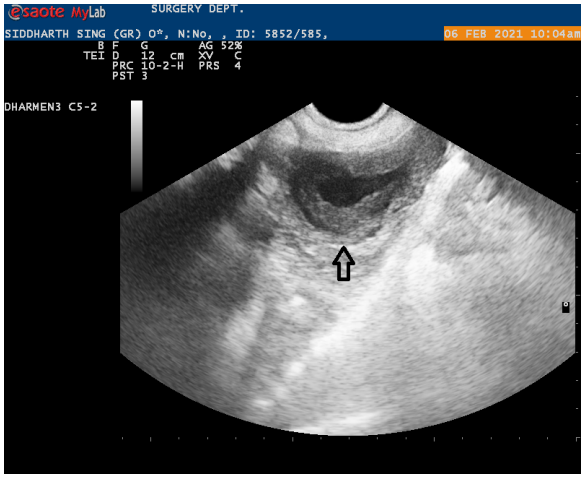

Plate 9: Sonograph of cystitis showing hyperechoic urinary bladder wall thickening 0.89cm in sagittal plane

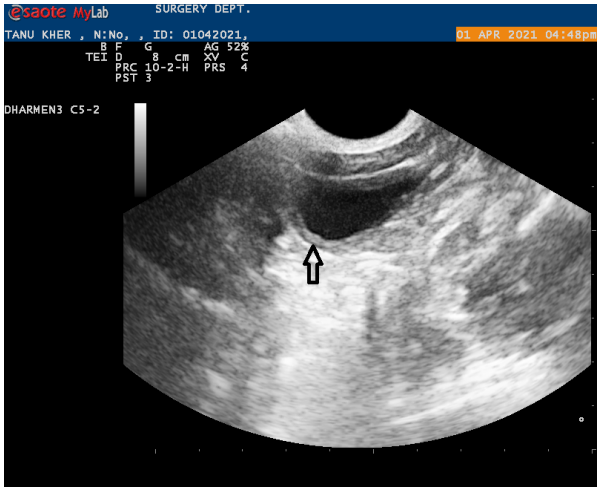

Plate 10: Sonograph of cystitis showing hyperechoic urinary bladder wall thickening 0.52cm in sagittal plane

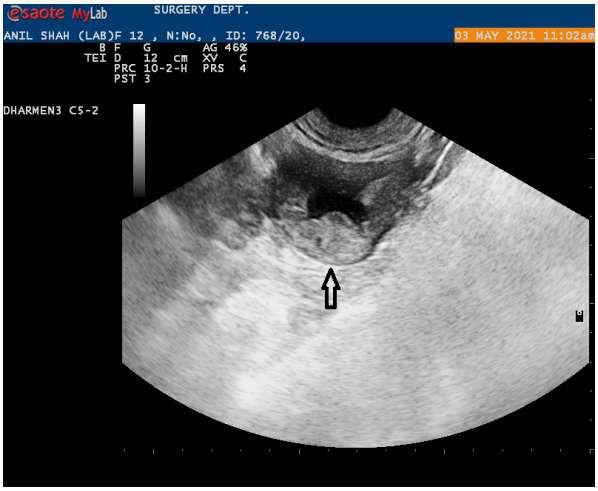

Plate 11: Sonograph of transional cell carcinoma showing show irregular hypoechoic to hyperechoic thickening of bladder wall in sagittal plane

Diagnostic ultrasonography revealed a large oval shaped mass in the right kidney with somewhat cavitated lesion (Plate 5). Later nephrectomy was performed and mass was

confirmed as renal cell carcinoma based on histopathology report. The left kidney appeared normal in shape and size with echogenicity. These observations were in line with Bennett (2004).

Haematobiochemical findings showed leukopenia and mild elevation of serum creatinine level. Other haematobiochemical parameters studied were within normal physiological limits (Table 1). According to Kontak and Campbel (2003) complete blood count and biochemical panel results are often within normal limits, especially if the tumor is unilateral.

Urolithiasis

Anamnesis in dogs with urolithiasis (ten cystic calculi and six urethral calculi) revealed urinary incontinence, stranguria, dysuria, polyuria, haematuria, persistent urinary tract infection, mild to moderate dehydration, anorexia, depression or lethargy and abdominal pain. These findings are affine to Singh *et al*. (2013) and Uma *et al*. (2018). Haematuria and dysuria exhibited by dogs might be due to irritation of bladder mucosa caused by uroliths (Singh *et al*., 2005). Small uroliths could cause partial or complete urinary obstruction of the urethra, leading to bladder distension, abdominal pain, urinary incontinence, stranguria and signs of post-renal azotaemia (anorexia, vomiting, and depression). In unattended cases, rupture of urinary bladder results in uroabdomen.

In ten dogs with cystolith ultrasonographic findings of urinary bladder revealed multiple, round to oval shaped hyperechoic structures creating acoustic shadowing (Plate 6, 7). Six dogs had urethral calculi in which ultrasonographic findings of urethra revealed one or two, round to oval shaped hyperechoic structure creating acoustic shadowing (Plate 8). The results are in accordance with the findings of Singh *et al.* (2005; 2013).

In present study the mean values of haemoglobin, TEC and PCV were within normal range in cystolith cases. However, leucocytosis and neutrophilia was observed in them. This is in consonant with the work of Sharma *et al.* (2005; 2013), and Uma *et al.* (2018). The increased neutrophils count may be due to prolonged urinary tract infection (Rajathi *et al*., 2006) followed by lymphopenia due to high level of stress and systemic or local infection (UTI) in animals or due to urethral obstruction (Kumar *et al*., 2010). In case of urolithiasis, biochemical findings like AST, ALT and total protein were within normal range. However, mean BUN and creatinine levels were found mildly elevated. These results are in accordance with the findings of Rajathi *et al.* (2006), Singh *et al.* and Uma *et al.* (2018). Increase amount of BUN and creatinine might also be due to dehydration or due to renal hypotension (Sharma *et al*., 2005).

Cystitis

The clinico-physiological findings in the dogs with cystitis were lethargy, dullness and depression with inappetence or anorexia, polydipsia, polyuria, pale mucous membrane, vomition and dribbling of bloody urine. Similar observations were also reported by Dennis *et al.* (2010). The nitrogenous waste products build up in blood stream and change the pH of blood which might be the cause of vomition and anorexia in cases of cystitis (Tripathi and Mehta, 2010). Ultrasonographic examination of cystitis showed hyperechoic thickened urinary bladder wall (0.52 to 0.89 cm) (Plate 9, 10), which concurred with Nyland *et al.* (2002). Normal wall thickness in a fully distended bladder is approximately 0.1 to 0.2 cm, but when empty it might be up to 0.5 cm. Almost empty urinary bladder should have three distinct wall layers - hyperechoic serosa, hypoechoic muscular layer and hyperechoic mucosa, which appear as a double reflective line under a high-frequency transducer (Dennis *et al*., 2010).

Haematological parameters such as haemoglobin, TEC and PCV were within normal range. However, leucocytosis, and neutrophilia were found in all three cases. Similar findings were observed by Sharma *et al.* (2005). Rajathi *et al.* 2006, stated that biochemical parameters viz., AST, ALT, BUN, total protein, and creatinine were within normal range or mildly elevated in case of cystitis or urolithiasis and concurred with present findings.

Transitional Cell Carcinoma (TCC)

Dogs with transitional cell carcinoma had stranguria, haematuria and pollakiuria as were reported by Nyland *et al.* (2002) and Hanazano *et al.* (2014). The dog with intra-luminal mass in the urinary bladder did not show any radiographic signs on the survey radiographs, but in case of transitional cell carcinoma irregular hypoechoic to hyperechoic thickening of bladder wall was noted (Plate 11), which is in accordance with Hanazano *et al.* (2014).

Haemato-biochemical findings in transitional cell carcinoma showed neutrophilia, leucocytosis, whereas haemoglobin, PCV, TEC, AST, ALT, BUN, total protein and creatinine were within normal range. Similar findings were also observed by Suwankanit and Manee-in (2018).

CONCLUSION

Clinico-physiological signs and haemato-biochemical profile could be useful in urinary system disorders and it should be correlated with the ultrasonographic findings for final diagnosis in dogs. On ultrasonography, cystolith and nephroliths were visible as hyperechoic structures with distinct acoustic shadowing, kidney become small with a non-homogenous structure and loss of corticomedullary differentiation in chronic kidney disease. Renal cell carcinoma (renal mass), transitional cell carcinoma (bladder mass), cystitis and hydronephrosis were identified by using ultrasonography.

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